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Correlation of calcium and magnesium intakes to frequency of muscle cramps in female college athletes

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ABSTRACT

Muscle cramps are involuntary, painful, sudden contractions of skeletal muscles that can cause detrimental effects on athletic performance. Recent data suggest that low intakes of dietary calcium (Ca) and magnesium (Mg) can enhance or cause muscle cramps. The purpose of this study was to determine the correlation between Ca and Mg intakes and muscle cramping in female college athletes. Athletes completed a 24-hour dietary recall and a survey on frequency and location of muscle cramps. Of those surveyed, 8 participated in basketball, 21 in softball, and 10 in gymnastics. Calcium and Mg intakes were calculated from dietary recall data using Food Processor® nutrient analysis software. Data are reported as means ± standard deviation (SD). T-tests were performed to determine significant differences between groups. The average daily intakes of Ca above and below the dietary reference intake (DRI) were 1516 ± 559 mg/day and 504 ± 296 mg/day, respectively, for the athletes that cramped and 1620 ± 299 mg/day and 645 ± 250 mg/day, respectively, for the athletes that did not experience cramping. The average daily intakes above and below the DRI for Mg in the cramping group were 423 ± 103 mg/day and 180 ± 65 mg/day, respectively. The average daily intakes for those consuming Mg above and below the DRI in the non-cramping group were 476 ± 80 mg/day and 190 ± 64 mg/day, respectively. No significant differences in the intakes of Ca and Mg were found between groups that cramped and those that did not report cramping. The results of this study suggest that a high intake of Ca coupled with a low intake of Mg is positively correlated to muscle cramping.

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MEET THE STUDENT- AUTHOR

Jennifer Schneider

I am currently a senior in the School of Human Environmental Sciences pursuing a B.S. degree in food, human nutrition, and hospitality with a concentration in dietetics. I am also completing a minor in biology and have completed the University of Arkansas' pre-medical program. I have been a part of various organizations, such as The Student Dietetics Association and Dale Bumpers Student Ambassadors, and have been employed by the University as a fitness instructor. I have enjoyed my time in the honors program because it has given me many opportunities, including a study abroad trip to Italy and research in my desired area, which I could not have received elsewhere. After I graduate, I plan to complete my dietetic internship and continue my education in medical school. Someday, I hope to incorporate principles of nutrition into more medical treatments.

INTRODUCTION

Muscle cramps are involuntary, painful skeletal muscle contractions that can occur in people in a normal or diseased state (Parisi, et al., 2003). Muscle cramps have been associated with many causes including hydration status, electrolyte imbalance, toxins, nerve and tissue damage, and disease. The focus of this study was to determine the effect of calcium (Ca) and magnesium (Mg) intakes on muscle cramping.

Calcium has been the focus of many bone-related ailments, but is often overlooked when analyzing its effect in muscle cramping. Calcium is a major contributor to muscle contraction due to its ionic stat. Calcium is found in many foods including milk products, certain seafood, legumes, and cruciferous vegetables. The majority of adults absorb 20%-50% of the ingested Ca, but the percentage of absorption varies greatly with the intake of other foods or supplements. Vitamin D and some carbohydrates have been found to increase the absorption of Ca. However, phytates and oxalates alter the form of Ca so that it is unable to be absorbed by the human body. Sodium and excess fatty acids have also been shown to decrease Ca absorption (Lopez, et al., 2002).

Magnesium is the fourth most plentiful cation found in the human body (Bilbey and Prabhakaran, 1996) and functions in many nutritional and biochemical reactions. Magnesium is especially important in maintaining necessary electrical gradients between muscle and nerve cell membranes (Maughan, 1999). Magnesium plays key roles in muscle contractions and electrical gradient maintenance. Magnesium levels in the body are easily altered. Serum levels are often lowered by excessive sweating (Bilbey and Prabhakaran, 1996) and by high intakes of phytic acid and fiber (Lopez, et al., 2002). However, there is evidence indicating that carbohydrates, especially fructose, help increase Mg serum levels when Mg intake is either too low or too high to maintain normal balance (Milne and Nielson, 2000). Magnesium is found in a variety of foods, with the richest sources being green leafy vegetables, some seafood, nuts, legumes, and whole-grains. Despite the abundance of Mg in the food supply, only about 40% is normally absorbed in adults with adequate intakes (Bilbey and Prabhakaran, 1996).

Calcium and Mg play complementary roles in muscle contractibility**.** Individual muscle fibers contain two types of filaments, myosin and actin. When separated, these filaments create muscle relaxation and, when united, create muscle contraction. In order for the fibers to come together, Ca must be present to help activate the actin filament, troponin C, so that myosin can bind with it. Magnesium has the potential to act as an antagonist to Ca because it can compete for the same muscle binding sites as Ca at the troponin C location (Landon and Young, 1993). When there is an abundance of Mg in the body, it will take the place of Ca and inhibit a contraction. Conversely, when there is an excess of Ca and a minimal amount of Mg, there is an increased chance of muscle contraction.

The purpose of this study was to determine the relationship between Ca and Mg intakes and muscle cramping in female college athletes. Current research proposed 3hypotheses that will be tested: low intakes of Ca will show a positive correlation with muscle cramping; low intakes of Mg will show a positive correlation with muscle cramping; high intakes of Ca accompanied by low intakes of Mg will positive correlate with muscle cramps. College athletes were chosen as subjects for the study because of the combination of physical and mental strain their bodies endure. Low blood levels of Ca and Mg may be related to muscular cramping (Parisi et al., 2003).

METHODS AND MATERIALS

Research protocol was submitted to the Institutional Review Board at the University of Arkansas. Approval was granted before any data were collected.

Collection of Data. The head coaches of six female college athletic teams were contacted and informed about the research project by telephone and e-mail. The teams consisted of softball, track and field, soccer, gymnastics, basketball, and swimming. Of the six teams, three participated in the survey: basketball, softball, and gymnastics. The surveys were distributed either directly to the team or given to the coach. The basketball team received direct instruction from the researcher in how to complete the survey; whereas, instructions were given to the softball and gymnastics coaches who administered the surveys. The survey requested information on each athlete's sport, food allergies, medications, frequency of exercise per week, frequency and location of muscle cramps, frequency of menstrual cramps, height, weight, and age. An informed-consent form from each participant was completed before surveys were administered. Participants completed a 24-h food intake form to document food intakes. All parts of the survey had to contain complete information for the survey to be considered valid. Each survey was given a letter code to designate sport: BA for basketball, SB for softball, and GM for gymnastics. A number was assigned to each survey to assure confidentiality. The basketball team submitted 12 surveys with 4 discarded because of missing data. The softball team submitted 23 surveys of which 2 were discarded due to missing data. The gymnastics team submitted 10 completed surveys.

Recording and Analyzing Data. Height, weight, gender, activity level, and information from the surveys were entered into Food Processor® Nutrition Analysis Software from ESHA Research, Salem, Oregon to determine individual mineral requirements and mineral intakes. Food Processor® software was used because of its accuracy, extensive food and nutrient database, and means of data export (McCullough, et al., 1999). All survey and mineral intake data were entered into Microsoft Excel® for statistical analysis. Due to differing heights, weights, and ages of the athletes, ESHA Food Processor estimated varying recommended intakes of Ca and Mg for individual athletes. One thousand mg/day of Ca and 310 mg/day of Mg, the dietary reference intakes (DRI) for the minerals, (Yates and Schlicker, 1998), were used as the standard intakes to determine high and low intakes of these minerals. . Data were reported as mean ± standard deviation (SD). The student's t-test was used to determine level of statistical significance between the groups who cramped and the group that did not cramp.

RESULTS AND DISCUSSION

No significant differences in intakes of Ca or Mg were found among the athletes that reported cramping and those who did not report cramping. Data were combined for intakes above the DRI and below the DRI. Results of this study rejected the hypothesis that a low intake of Ca would be positively correlated with cramping. The average intakes of Ca and Mg above and below the DRI are shown in Table 1. In the cramping group, the mean Ca intakes above and below the DRI were 1516 ± 559 mg/day and 504 ± 296 mg/day, respectively. However, the average intake of Ca in athletes that did not experience cramping above and below the recommended amount was 1620 ± 299 and 645 ± 250 mg/day, respectively. The intakes Ca and Mg of the group experiencing cramps were lower in both the high and low intake categories compared to the non-cramping group; however, the differences were not statistically significant. Results did not support the first hypothesis.

Data from this study also reject the second hypothesis that a low intake of Mg is correlated with muscle cramps. The average intake of Mg in athletes that experienced cramping above and below the recommended amount was 423 ± 103 and 180 ± 65 mg/day, respectively. The average Mg intake above the dietary reference intake was 476 ± 80 mg/day and below recommended levels was 190 ± 64 mg/day. These results were similar to those obtained for Ca. However, the differences between the averages for the two groups were not statistically significant (Table 1). The results do not support the second hypothesis that a low intake of Mg is linked with muscle cramping.

The average intakes of Ca and Mg in the cramping and non-cramping groups did not differ significantly. However, results suggest a correlation between athletes with a high Ca intake coupled with a low Mg intake with muscle cramping. Seven athletes that experienced cramps were found to have an intake of Ca above the recommended amount. Four of these 7 athletes or 57% had an intake below the recommended amount of Mg. This finding sup-

ports a possible relationship between high Ca levels and low Mg levels with muscle cramping. However, further investigation is needed to determine the validity of these results.

Data collection and analysis could have been more complete. Diet recall data were often incomplete when participants failed to describe serving sizes, methods of preparation, and brands of the foods consumed. In order to enter data as correctly as possible, similar foods that were not specifically defined by the athlete were recorded as commonly consumed foods. For example, all entries from the athletes that only stated "milk" were recorded as "one cup of 2% milk" for each of those athletes. If "pizza" was entered in the survey, Tony's® 6-inch cheese pizza was used to determine nutritional values. This was done to eliminate any bias and to standardize terminology among incomplete inputs from the athletes. Depending on the participant, this method may have resulted in either over- or underestimating of intakes.

Twenty-four-hour recalls from memory often do not represent the true, normal eating habits of a person. It is likely that some of the participants under or over consumed on the day that the survey was completed. Lack of instruction may have had an impact on participants' understanding of the survey and dietary recall. It is important to have on-site instruction and inspection of the completed survey to assure the collection of accuracy, comprehensive data. Further research should include food diaries, food frequency records, blood mineral tests, and standardized data collection to confirm the results of this study.

Results from this study should not be considered conclusive. More participants need to be recruited and different analytical techniques should be implemented.

LITERATURE CITED

Bilbey, D. and V. Prabhakaran. 1996. Muscle cramps and magnesium deficiency: Case report. Canadian Family Physician. 12:1348-1351.

Landon, R. and E.A. Young. 1993. Role of magnesium in regulation of lung function. J. Amer. Diet. Assoc. 93:674-677.

Lopez, W. H., F. Leenhardt, C. Coudray and C. Remesy. 2002. Minerals and phytic acid interactions: Is it a real problem for human consumption?. International J. Food Sci. Tech. 37:727-739.

Maughan , R. J. 1999. Role of micronutrients in sport and physical activity. British Medical Bull. 55. 683-690.

McCullough, M., N.M. Karanja, P. Lin, E. Obarzanek, K.M. Phillips, R. Laws, W.M. Vollmer, E.A. O'Connor, C. Champagne and M.M. Windhauser. 1999. Comparison of 4 nutrient databases with chemical composition data from the dietary approaches to stop hypertension trial. J. Amer. Diet. Assoc. 99:45-53.

Milne, D. B. and F.H. Nielsen. 2000. The interaction between dietary fructose and magnesium adversely affects macromineral homeostasis in men. J. Amer. College Nutr. 19:31-37.

Parisi, L., F. Pierelli, G. Amabile, G. Valente, E. Caladriello, F. Fattapposta, P. Rossi and M. Serrao. 2003. Muscular cramps: Proposals for a new classification. Acta Neurologica Scan. 107:176-186.

Schwellnus, M. P., N. Drew and M. Coolins. 2008. Muscle cramping in athletes-risk Factors, Clinical Assessment and Management. Clin. in Sports Med. 27:183-194.

Schwellnus, M. P., J. Nicol and T.D. Noakes. 2004. Serum electrolyte concentrations and hydration status are not associated with exercise associated muscle cramping (EAMC) in distance runners. Brit. J. Sports Med. 38:488-92.

Yates, A. A. and S.A. Schlicker. 1998. Dietary reference intakes: The new basis for recommendations for calcium, and related nutrients, B vitamins, and choline. J. Amer. Diet. Assoc. 98:699-706.

Table 1. Consumption above and below the dietary reference intakes (DRI)[1] for calcium and magnesium by female athletes with and without muscle cramping.

Mineral	Cramping	Non-Cramping
Calcium	(mg/day)	(mg/day)
Above DRI	1516 ± 559[2,a]	1620 ± 299[a]
Below DRI	504 ± 296[a,b]	644.65 ± 250[a,b]
Magnesium	(mg/day)	(mg/day)
Above DRI	423 ± 103[c]	476 ± 80[c]
Below DRI	180 ± 65[c,d]	190 ± 64[c,d]

[1] DRI for calcium and magnesium is 1000 mg and 310 mg/day, respectively.
[2] Data reported as group means ± SD.
[a-d] Means followed by the same letter superscript are not significantly different at $P \leq 0.05$.

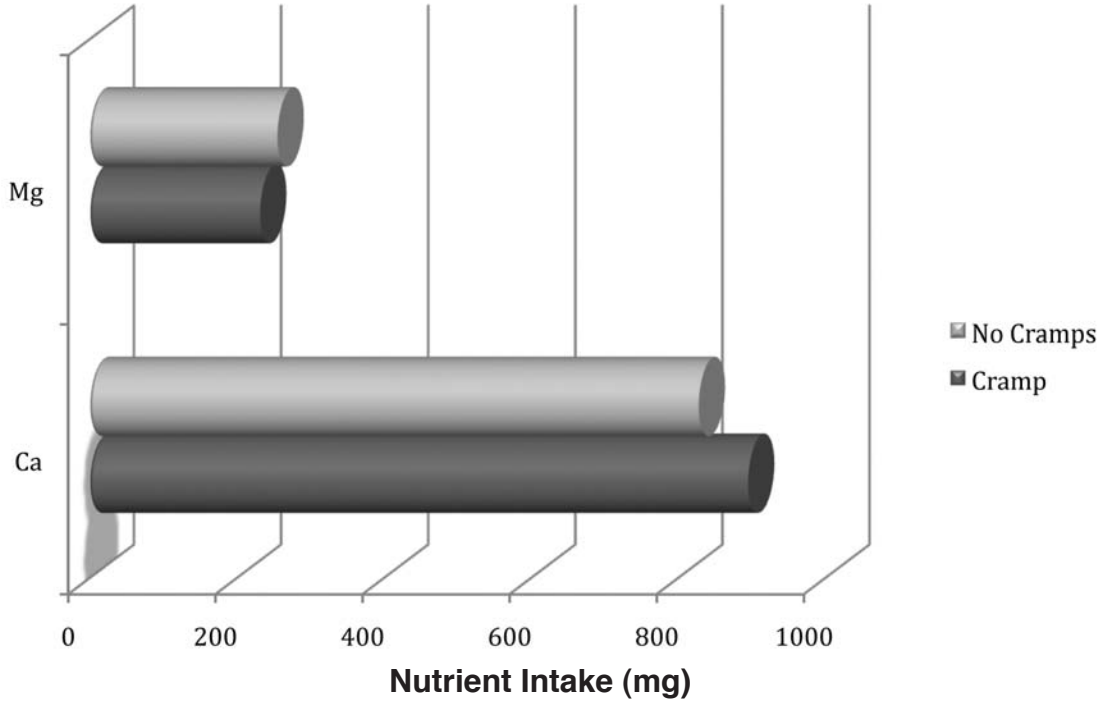

Fig. 1. Overall reported cramping and average nutrient intake.

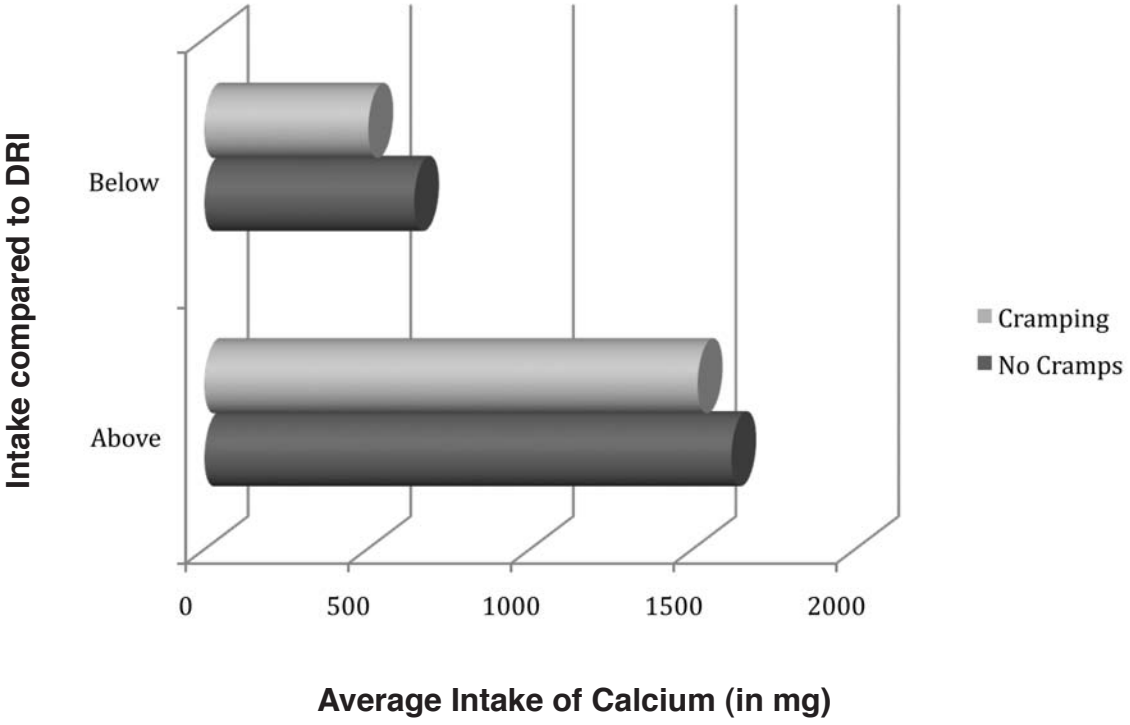

Fig. 2. Average calcium intakes among athletes above and below DRI.

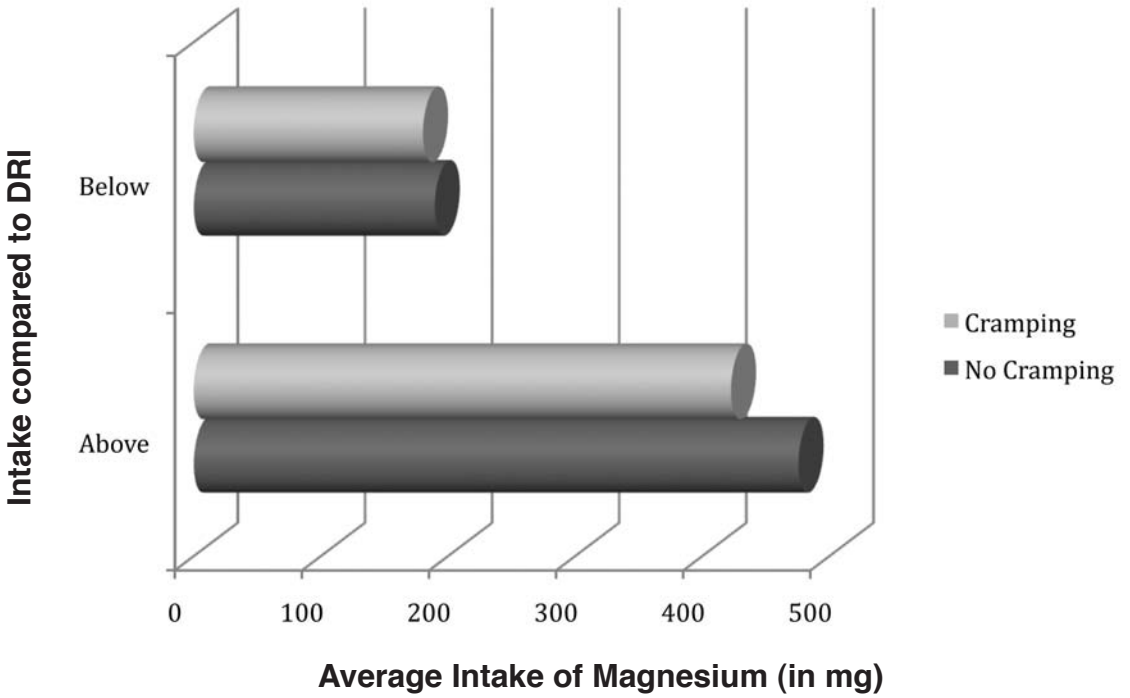

Fig. 3. Average magnesium intakes among athletes above and below DRI.