Relationship of Serum Magnesium and Vitamin D Levels in a Nationally-Representative Sample of Iranian Adolescents: The CASPIAN-III Study

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Date of Submission: Jul 25, 2013

Date of Acceptance: Oct 21, 2013

How to cite this article: Kelishadi R, Ataei E, Ardalan G, Nazemian M, Tajadini M, Heshmat R, *et al*. Relationship of serum magnesium and vitamin D levels in a nationally-representative sample of Iranian adolescents: The CASPIAN-III study. Int J Prev Med 2014;5:99-103.

ABSTRACT

Background: This study aims to assess the relationship of serum Mg and vitamin D levels in a nationally-representative sample of Iranian adolescents.

Methods: The study participants consisted of 330 students, aged range from 10 to 18 years, consisting of an equal number of individuals with and without hypovitaminosis D. The correlation between serum 25 hydroxy vitamin D (25(OH) D) and magnesium (Mg) concentrations was determined.

Results: The mean age of participants was 14.74 ± 2.587 years, without significant difference between those with hypovitaminosis D and those without it. The mean 25(OH) D level was 6.34 ± 1.47 ng/ml in the group with hypovitaminosis D and 39.27 ± 6.42 ng/ml in the group without it. The mean Mg level was 0.80 ± 0.23 mg/dl with lower level in the group with hypovitaminosis D than in others (0.73 ± 0.22 mg/dl vs. 0.87 ± 0.22 mg/dl, respectively) and according to *t*-test analysis, significant lower levels in the deficient group was observed ($P = 0.0001$). The linear regression analysis showed the meaningful relationship between Mg and 25(OH) D serum levels ($P = 0.0001$).

Conclusions: Our study revealed significant associations between serum Mg and 25(OH) D levels. This finding may be of use for further studies on the prevention and management of hypovitaminosis D in children and adolescents. Further longitudinal studies shall evaluate the underlying mechanisms and the clinical significance of the current findings.

Keywords: Adolescents, iran, magnesium, vitamin D

Original Article

INTRODUCTION

Vitamin D is a lipid soluble vitamin with steroidal structure. It has an extensive range of cellular and molecular functions. It plays key roles in different organs as bone mineralization by maintaining serum calcium and phosphorus concentrations at required levels, cellular differentiation and replication in many body organs, glucose homeostasis, muscle and skeletal function

etc., Adequate intake of this vitamin can prevent the risk of some skeletal as well as non-skeletal disorders as autoimmunity, atopic conditions, some types of cancers, chronic hepatitis C and cardiometabolic diseases.[1-4] It seems that blood levels of vitamin D during childhood encompass a great value to prevent the abovementioned disorders in adulthood.[5]

The main source of vitamin D is its synthesis in the skin by sun exposure; however it is well-documented that vitamin D deficiency is prevalent in all regions of the world[6-9] even in sunny regions, as in the Middle East and North Africa (MENA).[7]

The population of MENA region has one of the greatest prevalence rates of hypovitaminosis D with lower bone density than in Western countries. Different factors as low dietary intake, lack of enough sun exposure, air pollution, latitude and season can be attributed as the reasons of hypovitaminosis D.[10-14] However, the effects of some essential elements like magnesium shall be taken into account in this regard.[1,3,5,15,16]

Magnesium (Mg) as the second most plentiful intracellular cation and an important part of bone mineralization has a crucial function in synthesis and metabolism of vitamin D.[15,17]

As hypovitaminosis D is prevalent in the pediatric age group of the MENA region, this study aims to assess the relationship of serum Mg and vitamin D levels in a nationally-representative sample of Iranian adolescents.

METHODS

This national population-based study was performed as a sub-study of the "national survey of school student high risk behaviors", which was conducted as the third survey of the school-based surveillance system entitled Childhood and Adolescence Surveillance and Prevention of Adult Non-communicable disease study. This school-based nationwide health survey was conducted among 5528 students, aged 10-18 years, living in 27 provinces in Iran. Details of data collection and sampling are reported previously[18] and here it is reported in brief.

Participants

The study protocols were reviewed and approved by ethical committees and other relevant national regulatory organizations. After complete explanation of the study objectives and protocols for students and their parents, written informed consent and oral assent were obtained from the parents and the students, respectively.[18] The current survey was done as a sub-study among a randomly selected sample of frozen sera (−70°C) of participants in whom 25-hydroxy vitamin D (25(OH) D) was determined.[19] Sera of two groups of adolescents with or without vitamin D deficiency were randomly selected. The Research and Ethics Committee of Isfahan University of Medical Sciences, Isfahan, Iran, approved the current study.

Serum concentration of 25(OH) D was analyzed quantitatively by direct competitive immunoassay chemiluminescene method applying LIASON® 25 OH vitamin D assay TOTAL (DiaSorin, Inc.), with a coefficient of variation of 9.8%.

25(OH) D level of less than 10 ng/ml was considered as vitamin D deficiency and levels between 10 and 30 ng/ml as vitamin D insufficiency.[20]

Magnesium level was determined by atomic absorption spectrophotometer by using hollow cathode lamps of Mg.

The relationship between serum vitamin D and Mg levels was assessed through linear regression analysis purposing Mg as independent variable and 25(OH) D as dependent. Mean Mg serum level in deficient and normal group was compared by *t*-test analysis. Data were analyzed by SPSS statistical software (version 18.0; SPSS Inc., Chicago, IL, USA); the significance level was set at $P < 0.05$.

RESULTS

The study participants consisted of 330 students consisting of an equal number of participants with and without hypovitaminosis D. The mean age of participants was 14.74 ± 2.587 years, without significant difference between those with hypovitaminosis D and those without it (14.75 ± 2.52 vs. 14.74 ± 2.66 years, respectively, $P > 0.05$). Baseline characteristics of participants are shown in Table 1. The mean 25(OH) D level was 6.34 ± 1.47 ng/ml in the group with hypovitaminosis D and 39.27 ± 6.42 ng/ml in the group without it. The mean Mg level was 0.80 ± 0.23 mg/dl with lower level in the group with hypovitaminosis D than in others

Table 1: Baseline characteristics of participants

Parameters	Normal group	Deficient group
Age	14.74±2.66	14.74±2.52
BMI	19.58±4.56	19.64±5.41
SBP	102.33±12.55	102.55±14.47
DBP	63.87±9.52	65.37±9.90
HDL-C	48.55±14.95	48.69±14.10
LDL-C	82.34±26.49	80.81±29.47
Total cholesterol	148.19±32.22	147.15±30.685
TG	97.46±44.81	95.07±40.20
FBG	87.85±12.26	87.93±12.09
AST	24.51±9.48	23.49±10.39
ALT	18.21±14.10	17.82±9.20

All variables are reported in mean±SD. BMI=Body mass index, SBP=Systolic blood pressure, DBP=Diastolic blood pressure, HDL-C=High density lipoprotein cholesterol, LDL-C=Low density lipoprotein cholesterol, TG=Triglyceride, FBG=Fasting blood glucose, AST=Aspartate aminotransaminase, ALT=Alanine aminotransaminase, SD=Standard deviation

(0.73±0.22mg/dlvs.0.87±0.22mg/dl,respectively), with significant lower levels in the deficient group according to *t*-test analysis (P = 0.0001). The linear regression analysis showed that as one unit increase in Mg level, 25(OH) D level raises 0.276, which shows a significant relationship (P = 0.0001).

DISCUSSION

This study, which to the best of our knowledge is the first of its kind, investigated the association of serum 25(OH) D levels with serum Mg in a large nationally-representative sample of the pediatric population. We found that serum 25(OH) D and Mg concentrations had a positive significant correlation.

It is well-documented that hypovitaminosis D is highly prevalent in children and adolescents and shall be considered a public health priority in many parts of the world.[9,21-30] Vitamin D deficiency is important from different aspects due to key roles of this vitamin in different organs and also mechanisms in body tissues.

Different studies revealed the skeletal[21,29,30] and extra skeletal health effects of this vitamin.[5,8,31] In a triple masked clinical controlled trial among 50 obese children aged 10-16 years, vitamin D supplementation was effective on reducing insulin resistance and cardiometabolic risk factors.[32] Mg, as the second intracellular positive cation may effect on this process. Deng *et al*. in their study surveyed the relationship between Mg and vitamin D status and explored Mg intake alone or its interaction with vitamin D intake may involve in vitamin D status.[15] Furthermore, Vojtková *et al*. found that deficient vitamin D type 1 diabetic children have lower Mg level in their blood levels.[20] This relationship may be the result of the central role of that in mineral homeostasis, regulating parathormone secretion and vitamin D action and activation.[17,33] Sahota *et al*. found that Mg is a crucial contributing factor in patients with established osteoporosis with vitamin D deficiency and blunted parathormone level.[34]

Study limitations and strengths

The main limitation of this study was its cross-sectional nature, so the associations of diverse variables should be considered with caution. The study strengths are its novelty in the pediatric age group and using data of a nationally representative group of adolescents, which would increase the generalizability of the study findings.

CONCLUSIONS

Our study revealed significant associations between serum Mg and 25(OH) D levels. This finding may be of use for interventional actions to prevent and manage the highly prevalent problem of hypovitaminosis D in children and adolescents. Further longitudinal studies are required to find the underlying mechanisms and the clinical significance of this association.

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Source of Support: This study was conducted as a thesis funded by Isfahan University of Medical Sciences, Isfahan, Iran,
Conflict of Interest: None declared.