Ann Mil Health Sci Res. 2017 September; 15(3):e66745. doi: 10.5812/amh.66745 .

Published online 2017 September 24. **Original Article**

Evaluating the Effects of Supplementation with Calcium, Vitamin D, or Their Combination on Lipid Profile and Body Weight in Overweight Military Personnel

Shahnaz Tofangchiha,[1,*] Banafshe Dormanesh,[2] and Peyman Rezaie[3]

[1]Department of Internal Medicine, AJA University of Medical Sciences, Tehran, Iran
[2]Department of Pediatric Nephrology, AJA University of Medical Sciences, Tehran, Iran
[3]Biochemistry and Nutrition Department, School of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran

[*]*Corresponding author*: Dr Shahnaz Tofangchiha, Department of Internal Medicine, AJA University of Medical Sciences, Tehran, Iran. Tel: +98-9123068225, E-mail: stofangchiha05@gmail.com

Received 2017 July 10; **Revised** 2017 August 15; **Accepted** 2017 September 07.

Abstract

Background and Objectives: Obesity is a major public health problem worldwide and it has been reported that the prevalence of overweightness and dyslipidemia increases in military personnel. This study was designed to evaluate the independent or combined effect of calcium and vitamin D supplementation on blood lipid profile and body weight in overweight military male personnel.

Methods: Overall, 120 overweight males were allocated to 4 groups, including 1, Calcium supplementation (2 tablets per day; each containing 500 mg of calcium carbonate); 2, vitamin D supplementation (2 tablets per day; each containing 200 IU of vitamin D3); 3, Ca + Vit D supplementation (2 tablets per day; each containing 500 mg calcium carbonate plus 200 IU vitamin D3); and 4, Placebo (2 tablets per day, containing micro-cellulose). In all groups, blood lipid, body weight, and anthropometric indices were measured at baseline and after 6 weeks. Changes of lipid profile and body weight following intervention were calculated as before minus after the intervention. Data was analyzed by one-way analysis of variance (ANOVA) followed by Tukey's post hoc test.

Results: Serum triglycerides and total cholesterol significantly decreased in the calcium-treated group more than the other groups ($P < 0.05$). Furthermore, LDL and body weight significantly decreased in Ca + Vit D treated group more than the other groups ($P < 0.05$).

Conclusions: It seems that Ca or Ca plus Vit D supplements decrease triglycerides, total Cholesterol, LDL, and body weight in overweight patients.

Keywords: Calcium, Vitamin D, Lipid Profile, Body Weight, Military Personnel, Overweight Men

1. Background

Obesity is a major public health problem worldwide (1). In addition, dyslipidemia is often associated with obesity. Obesity-related dyslipidemia is recognized by decreased high density lipoprotein (HDL), elevated very low-density lipoprotein (VLDL), triglycerides (TG), and low density lipoprotein (LDL) particles. Dyslipidemia contributes to the increased risk of atherosclerosis and, by extension, the risk of heart disease and stroke (2, 3). In developed countries, most dyslipidemias are hyperlipidemias; that is, an increase in blood lipids. Blood lipid disorders are frequently because of improper diet and lifestyle (4). Military studies indicate that the combined prevalence of overweightness and obesity in military personnel in the US increased to an all-time high in 2005 (60.5%) with higher prevalence of obesity in 2005 compared to 2002 (5).

Cardiovascular disease (CVD) in its various types is the main reason of death worldwide, ranking first in both developing and developed nations (6, 7). It is estimated that by 2030, nearly 23.6 million people will die from CVD (7). According to the role of dyslipidemia as an independent risk factor for CVD, extraordinary effort has been devoted to the role of dietary intervention on lipid profile, especially from nutritional studies.

Recently, it has been shown that low serum 25-hydroxyvitamin D (25(OH) D), a measure of vitamin D status, is associated with an increased risk of CVD (8, 9), also hypovitaminosis D has been linked with increased total serum cholesterol concentration (10). There is an explanation that intake of vitamin D improves insulin sensitivity and reduces parathyroid hormone, therefore vitamin D might have a role in improving the parameters of

lipid profile regarding the decreasing effect of insulin on biosynthesis of cholesterol through increasing activity of the rate-controlling enzyme (b-hydroxy-b-methylglutaryl coenzyme A reductase) of the metabolic pathway that produces cholesterol (7, 11).

Furthermore, there are mixed results regarding the effect of Ca supplementation on lipid profile. Some studies reported the favorable (12-15) or insignificant (16, 17) effect of Ca supplementation on lipid profile. It has been suggested that calcium has a decreasing role in fatty acid absorption through the formation of insoluble calcium-fatty complexes; consequently, serum levels of total and LDL cholesterol will be decreased (18, 19). Increasing calcium absorption from the intestine is the main role of vitamin D in calcium homeostasis (20).

Therefore, according to the contradictory outcomes and increasing prevalence of obesity and dyslipidemia in military personnel, worldwide (21, 22), this study was designed to evaluate the impacts of supplementation with calcium, vitamin D, or their combination on lipid profile and weight in overweight military male personnel.

2. Methods

2.1. The Study Population

Overall, 120 military male personnel (aged 18 to 50 years) agreed to participate in this study. This study was conducted from April to June 2016 in Shiraz, Iran. Subjects were selected from Iranian army personnel.

Inclusion criteria were male gender, age between 18 and 50 years old, body mass index (BMI) of over 25 kg/m^2, not having any cancer or severe endocrine, mental, hepatic, renal, gastrointestinal, cardiovascular, neurologic, rheumatologic, hematologic, skeletal, and eating disorders, not taking any medication, nutritional supplements or herbal preparations, which could affect body weight, calcium and/or vitamin D status during the last 12 weeks, not reporting any history of adverse reaction to the study supplements, consuming less than 3 servings of dairy per day, not being a regular smoker or consuming alcohol, not being a participant in other trials over the last 6 months, and stable body weight (body weight changes of less than 3 kg in the last 3 months). This study excluded participants with development of serious adverse events during the study period or lack of adherence to the study protocol. Participants, who took less than 80% of the supplements were excluded from final analysis.

2.2. Experimental Design

Participants were allocated to one of the 4 groups as follow: 1, calcium supplemented group (taking 2 tablets per day, each containing 500 mg of calcium carbonate); 2, vitamin D supplemented group (taking 2 tablets per day, each containing 200 IU of vitamin D3); 3, calcium-vitamin D supplemented group (taking 2 tablets per day, each containing 500 mg of calcium carbonate plus 200 IU vitamin D3); 4, placebo group (taking 2 tablets per day, each containing micro cellulose). Supplements were purchased from Iran Drau company, Tehran, Iran. Daily energy requirements were estimated using EER equations (23). Afterwards, specific diets (55% carbohydrate, 18% protein, and 27% fat) were designed for each participant by a trained nutritionist. All of the participants received a diet sheet containing a standard recipe and diet recommendations and a portion-size booklet of common foods and were asked not to change their physical activity during the study.

Participants received their supplements every 2 weeks and were followed for compliance with dietary regimens and supplements intake. They were asked to return the bottle of supplements on the next visit, and their compliance was assessed by counting the remaining supplements.

2.3. Dietary Intake Assessment

Dietary intakes were assessed at baseline and on week 6 by using 24-hour food record method (2 week days and 1 weekend).

2.4. Biochemical Assays

A 5-cc venous blood sample was obtained from each participant between 7:00 to 9:00 AM after an overnight fast at baseline and after 6 weeks. The whole blood was centrifuged. Serum 25(OH) D was measured by enzyme immunoassay (EIA) (Immunodiagnostic Systems Ltd, Boldon, UK) using the IDS 25-hydroxy vitamin D EIA kit. Plasma lipids (Cholesterol, TG, HDL, and LDL) were measured using enzymatic methods.

2.5. Ethical Consideration

The study aims and methods were described to the participants and written consent was obtained. The study was approved by the ethics committee of Iran Army University of Medical Sciences.

2.6. Statistical Analysis

Data were analyzed using the SPSS software (version 19; SPSS Inc., Chicago, IL). Normal distribution of variables was tested by the Kolmogorov-Smirnov test. Paired sample t-test was used to estimate the effect of intervention in each group. Mean differences of blood lipids and weight among the groups were assessed using one-way analysis of variance (ANOVA). P values of less than 0.05 were considered statistically significant.

3. Results

Overall, 120 individuals completed the study (calcium supplemented group: 30 persons; vitamin D supplemented group: 30 persons; calcium-vitamin D supplemented group: 30 persons; and placebo group: 30 persons).

Table 1 illustrates no significant differences in age, vitamin D3 serum, and dietary intake of participants among the 4 groups at baseline.

Table 2 shows lipid profile and body weight before and after the intervention and their changes following the intervention among the 4 groups.

As presented in Table 2, serum triglycerides and total cholesterol change significantly differed among groups. They were significantly decreased in the calcium-treated group more than the other groups ($P < 0.05$). Furthermore, LDL and body weight changes significantly differed among groups. They significantly decreased in the calcium plus vitamin D-treated group more than the other groups ($P < 0.05$). There was no significant difference in serum HDL changes among groups.

4. Discussion

This was a placebo-controlled, parallel group trial that evaluated the effects of supplementation with calcium, vitamin D, or their combination on lipid profile and body weight in overweight military male personnel. The main finding of this study was that changes of total cholesterol and triglycerides were significant in the calcium-treated group with meaningful LDL and body weight changes in the Ca-Vit D supplemented group.

The results of interventional studies in this field are contradictory (7, 11). Zemel et al. performed a randomized, placebo-controlled trial on 32 obese adults to evaluate the effects of Ca-vitamin D supplementation on lipid profile (24). They reported no significant effects on LDL, HDL and triglycerides. However, other investigations indicated the favorable impacts of these supplements on lipid profile (12, 25, 26). One explanation for the dissimilarity in these results could be the different amounts of calcium given to participants in these studies. Total daily calcium intake of participants was 1200 to 1300 mg in the study of Zemel et al., while, in the current study, supplementation consisted of 1000 mg Ca/d that was added to the diet of the subjects, who formerly had an average intake of 600 mg Ca/d. Major et al. (12) indicated that greater daily calcium consumption in comparison with dietary reference intakes (27) is necessary for individuals with typical inadequate calcium intake to obtain a decrease in parameters of lipid profile.

There is some evidence of an inverse relationship between calcium intake and body weight. A systematic review found that among overweight or obese individuals, calcium supplementation compared to placebo produced a mean body weight loss of 0.7 kg (28-30).

Several effects attributed to calcium intake, including reduction in fatty acid absorption and an increase in fecal fatty acid content, consequently formation of insoluble calcium-fatty soaps in the gut may justify the observed decrease in total cholesterol and triglycerides in the current study (12, 31). Moreover, increase cholesterol excretion due to the increasing effect of calcium intake on conversion of cholesterol to bile acids may be another explanation (32). However, some insignificant changes in the current study could be justified according to the short duration of the current study in comparison with other conducted surveys (12, 24).

Observational studies have revealed that high serum (25(OH) D) levels are linked with a favorable lipid profile (7, 33), and one study on military personnel showed significant correlation between vitamin D and HDL (34). In addition, it has been indicated that there are significant positive relationships between serum 25(OH) D and total cholesterol, HDL and LDL levels as well as meaningful negative associations between serum 25(OH) D and both LDL-C/HDLC ratio and TG (35, 36). Although an insignificant effect of vitamin D supplementation on lipid profile was seen in some investigations, which are in accordance with the current findings (7, 37, 38), yet Heikkinenet al. suggested that vitamin D supplementation may have unfavorable effects on lipids and could be associated with increased serum LDL cholesterol (39).

One explanation is that improved insulin sensitivity and parathyroid hormone reduction after vitamin D intake might have a role in improving the parameters of lipid profile due to decreasing effect of insulin on biosynthesis of cholesterol via increased b-hydroxy-b-methylglutaryl coenzyme A reductase (HMG- CoA reductase) activity, which is a rate-controlling enzyme in the pathway of producing cholesterol (7, 11, 40).

Performing a study in different scientific fields has its own limits, similarly, there are limitations in the current study. Approving the usefulness of calcium and vitamin D supplementation on improvement of lipid profile and body weight may need a longer period of intervention.

4.1. Conclusion

It seems that Ca or Ca plus Vit D supplements decrease triglycerides, total Cholesterol, LDL, and body weight in overweight patients.

Table 1. Age, Serum Vitamin (Vit) D3, and Dietary Intake of the Participants in the Four Groups at Baseline[a]

Variables	Placebo Treated	Calcium Treated	Vit D Treated	Calcium-Vit D Treated	P Value
Age, y	40.26 ± 5.92	42.4 ± 7.61	39.30 ± 5.92	38.3 ± 6.12	0.95
Serum D3, nm/L	31.58 ± 8.52	29.56 ± 7.28	27.27 ± 13.19	32.52 ± 15.80	0.38
Energy, kcal/day	1790.4 ± 770.2	1710.4 ± 500	1880.2 ± 34.4	1910.6 ± 345.2	0.82
Carbohydrate, % of energy	26.5 ± 11.5	52.1 ± 7.3	57.8 ± 6.5	57.0 ± 11.2	0.36
Fat, %of energy	33.12 ± 19.36	31.19 ± 8.3	30.45 ± 5.41	31.51 ± 5.84	0.48
Protein, %of energy	17.63 ± 2.53	7.36 ± 6.70	16.11 ± 2.31	15.6 ± 2.67	0.52

[a] Data are expressed as mean ± SD and statistically analysedby One-way ANOVA.

Table 2. Comparison of Lipid Profile and Body Weight Changes Among the Four Groups After Six Weeks of Intervention[a]

Variables	Placebo Treated	Calcium Treated	Vit D Treated	Calcium-Vit D Treated	$F_{(3,116)}$	P Value[b]
TG, mg/dL						
Before	144.0 ± 1.2	144.8 ± 2.6	140.2 ± 2.5	140.0 ± 2.7	1.116	0.345
After	142.8 ± 1.7	136.8 ± 2.4	140.1 ± 2.2	137.0 ± 2.5	1.651	0.182
Changes	-1.17 ± 1.54	-8.00 ± 1.50*	-0.03 ± 0.74#	-3.07 ± 1.79#	5.88	0.001
TC, mg/dL						
Before	181.6 ± 3.2	184.7 ± 2.9	179.3 ± 3.2	172.6 ± 3.9	2.445	0.067
After	181.5 ± 3.2	178.0 ± 2.4	178.4 ± 3.4	170.8 ± 3.8	1.966	0.123
Changes	-0.07 ± 1.15	-6.73 ± 1.42*	0.90 ± 1.76#	-1.83 ± 1.24#	4.504	0.005
LDL, mg/dL						
Before	95.5 ± 2.3	98.1 ± 2.3	94.6 ± 2.6	98.4 ± 2.5	0.592	0.621
After	95.9 ± 2.1	98.5 ± 1.8	96.2 ± 2.6	88.8 ± 2.0*#†	3.881	0.011
Changes	0.43 ± 1.07	0.43 ± 1.26	1.57 ± 1.51	-9.57 ± 1.26*#†	16.475	0.000
HDL, mg/dL						
Before	44.2 ± 1.0	43.5 ± 1.1	45.0 ± 1.0	39.1 ± 1.2*#†	6.009	0.001
After	43.5 ± 1.1	43.6 ± 1.0	42.5 ± 1.2	39.5 ± 1.1	2.885	0.039
Changes	-0.73 ± 0.84	0.10 ± 0.34	-2.53 ± 1.34	0.43 ± 0.60	2.370	0.074
Body weight, kg						
Before	85.6 ± 1.1	86.9 ± 1.0	85.8 ± 1.1	89.0 ± 0.7	2.487	0.064
After	85.8 ± 1.0	87.2 ± 1.0	86.0 ± 1.0	86.3 ± 0.9	0.390	0.761
Changes	0.18 ± 0.25	0.30 ± 0.19	0.22 ± 0.29	-2.74 ± 0.26*#†	35.142	0.000

Abbreviations: HDL, High Density Lipoprotein; LDL, Low Density Lipoprotein; TC, Total Cholesterol; TG, Triglycerides.
[a] Data are expressed as mean ± SEM and statistically analyzed by One-way ANOVA followed Tukey's as post hoc test.
[b] *, #, † Indicate significant differences between placebo treated group ,calcium treated group, vitamin D treated group and calcium-vitamin D treated group, respectively.

Acknowledgments

The authors acknowledge and appreciate Dr Iraj Mirzaii Dizgah for providing support.

Footnote

Conflict of Interest: None of the authors had conflicts of interest.

References

1. Ng M, Fleming T, Robinson M, Thomson B, Graetz N, Margono C, et al. Global, regional, and national prevalence of overweight and obesity in children and adults during 1980-2013: a systematic analysis for

the Global Burden of Disease Study 2013. *Lancet*. 2014;**384**(9945):766–81. doi: 10.1016/S0140-6736(14)60460-8. [PubMed: 24880830].
2. Cabrera M, Sanchez-Chaparro MA, Valdivielso P, Quevedo-Aguado L, Catalina-Romero C, Fernandez-Labandera C, et al. Prevalence of atherogenic dyslipidemia: association with risk factors and cardiovascular risk in Spanish working population. "ICARIA" study. *Atherosclerosis*. 2014;**235**(2):562–9. doi: 10.1016/j.atherosclerosis.2014.05.960. [PubMed: 24956529].
3. Sarikaya H, Ferro J, Arnold M. Stroke prevention–medical and lifestyle measures. *Eur Neurol*. 2015;**73**(3-4):150–7. doi: 10.1159/000367652. [PubMed: 25573327].
4. Koba S, Hirano T. [Dyslipidemia and atherosclerosis]. *Nihon Rinsho*. 2011;**69**(1):138–43. [PubMed: 21226274].
5. Smith TJ, Marriott BP, Dotson L, Bathalon GP, Funderburk L, White A, et al. Overweight and obesity in military personnel: sociodemographic predictors. *Obesity (Silver Spring)*. 2012;**20**(7):1534–8. doi: 10.1038/oby.2012.25. [PubMed: 22314620].
6. Mirzaei M, Truswell AS, Arnett K, Page A, Taylor R, Leeder SR. Cerebrovascular disease in 48 countries: secular trends in mortality 1950-2005. *J Neurol Neurosurg Psychiatry*. 2012;**83**(2):138–45. doi: 10.1136/jnnp-2011-300408. [PubMed: 22019549].
7. Wang H, Xia N, Yang Y, Peng DQ. Influence of vitamin D supplementation on plasma lipid profiles: a meta-analysis of randomized controlled trials. *Lipids Health Dis*. 2012;**11**(42). doi: 10.1186/1476-511X-11-42. [PubMed: 22433171].
8. Canale D, de Braganca AC, Goncalves JG, Shimizu MH, Sanches TR, Andrade L, et al. Vitamin D deficiency aggravates nephrotoxicity, hypertension and dyslipidemia caused by tenofovir: role of oxidative stress and renin-angiotensin system. *PLoS One*. 2014;**9**(7). e103055. doi: 10.1371/journal.pone.0103055. [PubMed: 25048368].
9. Munoz-Aguirre P, Flores M, Macias N, Quezada AD, Denova-Gutierrez E, Salmeron J. The effect of vitamin D supplementation on serum lipids in postmenopausal women with diabetes: A randomized controlled trial. *Clin Nutr*. 2015;**34**(5):799–804. doi: 10.1016/j.clnu.2014.10.002. [PubMed: 25453396].
10. Chiu KC, Chu A, Go VL, Saad MF. Hypovitaminosis D is associated with insulin resistance and beta cell dysfunction. *Am J Clin Nutr*. 2004;**79**(5):820–5. [PubMed: 15113720].
11. Asemi Z, Hashemi T, Karamali M, Samimi M, Esmaillzadeh A. Effects of vitamin D supplementation on glucose metabolism, lipid concentrations, inflammation, and oxidative stress in gestational diabetes: a double-blind randomized controlled clinical trial. *Am J Clin Nutr*. 2013;**98**(6):1425–32. doi: 10.3945/ajcn.113.072785. [PubMed: 24132976].
12. Major GC, Alarie F, Dore J, Phouttama S, Tremblay A. Supplementation with calcium + vitamin D enhances the beneficial effect of weight loss on plasma lipid and lipoprotein concentrations. *Am J Clin Nutr*. 2007;**85**(1):54–9. [PubMed: 17209177].
13. Militaru C, Donoiu I, Craciun A, Scorei ID, Bulearca AM, Scorei RI. Oral resveratrol and calcium fructoborate supplementation in subjects with stable angina pectoris: effects on lipid profiles, inflammation markers, and quality of life. *Nutrition*. 2013;**29**(1):178–83. doi: 10.1016/j.nut.2012.07.006. [PubMed: 23153742].
14. Nikooyeh B, Neyestani TR, Farvid M, Alavi-Majd H, Houshiarrad A, Kalayi A, et al. Daily consumption of vitamin D- or vitamin D + calcium-fortified yogurt drink improved glycemic control in patients with type 2 diabetes: a randomized clinical trial. *Am J Clin Nutr*. 2011;**93**(4):764–71. doi: 10.3945/ajcn.110.007336. [PubMed: 21289226].
15. Soerensen KV, Thorning TK, Astrup A, Kristensen M, Lorenzen JK. Effect of dairy calcium from cheese and milk on fecal fat excretion, blood lipids, and appetite in young men. *Am J Clin Nutr*. 2014;**99**(5):984–91. doi: 10.3945/ajcn.113.077735. [PubMed: 24622806].
16. Rajpathak SN, Xue X, Wassertheil-Smoller S, Van Horn L, Robinson JG, Liu S, et al. Effect of 5 y of calcium plus vitamin D supplementation on change in circulating lipids: results from the Women's Health Initiative. *Am J Clin Nutr*. 2010;**91**(4):894–9. doi: 10.3945/ajcn.2009.28579. [PubMed: 20181812].
17. Reid IR, Horne A, Mason B, Ames R, Bava U, Gamble GD. Effects of calcium supplementation on body weight and blood pressure in normal older women: a randomized controlled trial. *J Clin Endocrinol Metab*. 2005;**90**(7):3824–9. doi: 10.1210/jc.2004-2205. [PubMed: 15827103].
18. Christensen R, Lorenzen JK, Svith CR, Bartels EM, Melanson EL, Saris WH, et al. Effect of calcium from dairy and dietary supplements on faecal fat excretion: a meta-analysis of randomized controlled trials. *Obes Rev*. 2009;**10**(4):475–86. doi: 10.1111/j.1467-789X.2009.00599.x. [PubMed: 19493303].
19. Saedisomeolia A, Taheri E, Djalali M, Moghadam AM, Qorbani M. Association between serum level of vitamin D and lipid profiles in type 2 diabetic patients in Iran. *J Diabetes Metab Disord*. 2014;**13**(1):7. doi: 10.1186/2251-6581-13-7. [PubMed: 24398023].
20. Christakos S, Dhawan P, Porta A, Mady LJ, Seth T. Vitamin D and intestinal calcium absorption. *Mol Cell Endocrinol*. 2011;**347**(1-2):25–9. doi: 10.1016/j.mce.2011.05.038. [PubMed: 21664413].
21. Heydari ST, Khoshdel A, Sabayan B, Abtahi F, Zamirian M, Sedaghat S. Prevalence of cardiovascular risk factors among military personnel in southern Iran. *Int Cardiovasc Res J*. 2010;**4**(1):22–7.
22. McLaughlin R, Wittert G. The obesity epidemic: implications for recruitment and retention of defence force personnel. *Obes Rev*. 2009;**10**(6):693–9. doi: 10.1111/j.1467-789X.2009.00601.x. [PubMed: 19486307].
23. Carole S IJ. Intake: Energy. In: Mahan LK, Escott-Stump S, Raymond JL, editors. *Krause Food and The Nutrition Care Process*. 13 ed. St Louis, Missouri: Elsevier; 2012. p. 19–31.
24. Zemel MB, Thompson W, Milstead A, Morris K, Campbell P. Calcium and dairy acceleration of weight and fat loss during energy restriction in obese adults. *Obes Res*. 2004;**12**(4):582–90. doi: 10.1038/oby.2004.67. [PubMed: 15090625].
25. Martini LA, Wood RJ. Vitamin D status and the metabolic syndrome. *Nutr Rev*. 2006;**64**(11):479–86. doi: 10.1111/j.1753-4887.2006.tb00180.x. [PubMed: 17131943].
26. Reid IR, Mason B, Horne A, Ames R, Clearwater J, Bava U, et al. Effects of calcium supplementation on serum lipid concentrations in normal older women: a randomized controlled trial. *Am J Med*. 2002;**112**(5):343–7. doi: 10.1016/S0002-9343(01)01138-X. [PubMed: 11904107].
27. Institute of Medicine FaNB . *Dietary reference intakes for calcium, phosphorus, magnesium, vitamin D, and fluoride*. Washington, DC: National Academy Press; 1997.
28. Cormick G, Ciapponi A, Minckas N, Althabe F, Belizán JM. Calcium supplementation for weight reduction in overweight or obese people. *Cochrane Database Syst Rev*. 2016. doi: 10.1002/14651858.cd012268.
29. Onakpoya IJ, Perry R, Zhang J, Ernst E. Efficacy of calcium supplementation for management of overweight and obesity: systematic review of randomized clinical trials. *Nutr Rev*. 2011;**69**(6):335–43. doi: 10.1111/j.1753-4887.2011.00397.x. [PubMed: 21631515].
30. Zemel MB. Calcium modulation of hypertension and obesity: mechanisms and implications. *J Am Coll Nutr*. 2001;**20**(5 Suppl):428S–35S. discussion 440S-442S. [PubMed: 11603653].
31. Reid IR. Effects of calcium supplementation on circulating lipids: potential pharmacoeconomic implications. *Drugs Aging*. 2004;**21**(1):7–17. doi: 10.2165/00002512-200421010-00002. [PubMed: 14715041].
32. Vaskonen T, Mervaala E, Sumuvuori V, Seppanen-Laakso T, Karppanen H. Effects of calcium and plant sterols on serum lipids in obese Zucker rats on a low-fat diet. *Br J Nutr*. 2002;**87**(3):239–45. doi: 10.1079/BJNBJN2001508. [PubMed: 12064332].
33. Jorde R, Grimnes G. Vitamin D and metabolic health with special reference to the effect of vitamin D on serum lipids. *Prog Lipid Res*. 2011;**50**(4):303–12. doi: 10.1016/j.plipres.2011.05.001. [PubMed: 21640757].
34. Auwerx J, Bouillon R, Kesteloot H. Relation between 25-hydroxyvitamin D3, apolipoprotein A-I, and high density lipoprotein cholesterol. *Arterioscler Thromb Vasc Biol*. 1992;**12**(6):671–4. doi:

10.1161/01.atv.12.6.671.
35. Jorde R, Figenschau Y, Hutchinson M, Emaus N, Grimnes G. High serum 25-hydroxyvitamin D concentrations are associated with a favorable serum lipid profile. *Eur J Clin Nutr*. 2010;**64**(12):1457–64. doi: 10.1038/ejcn.2010.176. [PubMed: 20823896].
36. Kelishadi R, Farajzadegan Z, Bahreynian M. Association between vitamin D status and lipid profile in children and adolescents: a systematic review and meta-analysis. *Int J Food Sci Nutr*. 2014;**65**(4):404–10. doi: 10.3109/09637486.2014.886186. [PubMed: 24524677].
37. Gannage-Yared MH, Azoury M, Mansour I, Baddoura R, Halaby G, Naaman R. Effects of a short-term calcium and vitamin D treatment on serum cytokines, bone markers, insulin and lipid concentrations in healthy post-menopausal women. *J Endocrinol Invest*. 2003;**26**(8):748–53. doi: 10.1007/BF03347358. [PubMed: 14669830].
38. Wood AD, Secombes KR, Thies F, Aucott L, Black AJ, Mavroeidi A, et al. Vitamin D3 supplementation has no effect on conventional cardiovascular risk factors: a parallel-group, double-blind, placebo-controlled RCT. *J Clin Endocrinol Metab*. 2012;**97**(10):3557–68. doi: 10.1210/jc.2012-2126. [PubMed: 22865902].
39. Heikkinen AM, Tuppurainen MT, Niskanen L, Komulainen M, Penttila I, Saarikoski S. Long-term vitamin D3 supplementation may have adverse effects on serum lipids during postmenopausal hormone replacement therapy. *Eur J Endocrinol*. 1997;**137**(5):495–502. doi: 10.1530/eje.0.1370495. [PubMed: 9405029].
40. Kaplan M, Kerry R, Aviram M, Hayek T. High glucose concentration increases macrophage cholesterol biosynthesis in diabetes through activation of the sterol regulatory element binding protein 1 (SREBP1): inhibitory effect of insulin. *J Cardiovasc Pharmacol*. 2008;**52**(4):324–32. doi: 10.1097/FJC.0b013e3181879d98. [PubMed: 18791464].