

Evaluation of Vitamin D Levels in Obese and Morbid Obese Children

Orkide Donma, Mustafa M. Donma

Abstract—Obesity may lead to growing serious health problems throughout the world. Vitamin D appears to play a role in cardiovascular and metabolic health. Vitamin D deficiency may add to derangements in human metabolic systems, particularly those of children. Childhood obesity is associated with an increased risk of chronic and sophisticated diseases. The aim of this study is to investigate associations as well as possible differences related to parameters affected by obesity and their relations with vitamin D status in obese (OB) and morbid obese (MO) children. This study included a total of 78 children. Of them, 41 and 37 were OB and MO, respectively. WHO BMI-for age percentiles were used for the classification of obesity. The values above 99 percentile were defined as MO. Those between 95 and 99 percentiles were included into OB group. Anthropometric measurements were recorded. Basal metabolic rates (BMRs) were measured. Vitamin D status is determined by the measurement of 25-hydroxy cholecalciferol [25-hydroxyvitamin D₃, 25(OH)D] using high-performance liquid chromatography. Vitamin D status was evaluated as deficient, insufficient and sufficient. Values < 20.0 ng/ml, values between 20-30 ng/ml and values > 30.0 ng/ml were defined as vitamin D deficient, insufficient and sufficient, respectively. Optimal 25(OH)D level was defined as ≥ 30 ng/ml. SPSSx statistical package program was used for the evaluation of the data. The statistical significance degree was accepted as $p < 0.05$. Mean ages did not differ between the groups. Significantly increased body mass index (BMI), waist circumference (C) and neck C as well as significantly decreased fasting blood glucose (FBG) and vitamin D values were observed in MO group ($p < 0.05$). In OB group, 37.5% of the children were vitamin D deficient, and in MO group the corresponding value was 53.6%. No difference between the groups in terms of lipid profile, systolic blood pressure (SBP), diastolic blood pressure (DBP) and insulin values was noted. There was a severe statistical significance between FBG values of the groups ($p < 0.001$). Important correlations between BMI, waist C, hip C, neck C and both SBP as well as DBP were found in OB group. In MO group, correlations only with SBP were obtained. In a similar manner, in OB group, correlations were detected between SBP-BMR and DBP-BMR. However, in MO children, BMR correlated only with SBP. The associations of vitamin D with anthropometric indices as well as some lipid parameters were defined. In OB group BMI, waist C, hip C and triglycerides (TRG) were negatively correlated with vitamin D concentrations whereas none of them were detected in MO group. Vitamin D deficiency may contribute to the complications associated with childhood obesity. Loss of correlations between obesity indices-DBP, vitamin D-TRG, as well as relatively lower FBG values, observed in MO group point out that the emergence of MetS components starts during obesity state just before the transition to morbid obesity. Aside from its deficiency state, associations of

vitamin D with anthropometric measurements, blood pressures and TRG should also be evaluated before the development of morbid obesity.

Keywords—Children, morbid obesity, obesity, vitamin D.

I. INTRODUCTION

OBESITY and particularly morbid obesity are associated with severe health problems. Both are reaching to epidemic proportion. Obesity is associated with an altered hormonal profile including vitamin D [1].

Vitamin D deficiency is prevalent in children and adults throughout the world, particularly in OB individuals [2]-[7]. Both low vitamin D status and obesity have concomitantly reached epidemic levels worldwide [6]. Vitamin D deficiency is prevalent also among patients with metabolic syndrome (MetS) [8].

Vitamin D is a micronutrient, which is essential for bone metabolism. It exhibits important functions also in immune system. Due to its fat-soluble property, it is distributed into fat tissue. There is evidence related to the association of 25-hydroxy cholecalciferol [25-hydroxy vitamin D, 25(OH)D] with adiposity and cardiometabolic risk factors. Some recent findings suggest the differential effect of vitamin D on cardiovascular risk factors such as oxidative stress and insulin resistance (IR) [9]-[12]. Also some connections among low vitamin D status, air pollution and obesity were reported [5]. Low socioeconomic status is a newly identified independent risk factor for poor vitamin D status [13].

Body's vitamin D status is tested by assessing serum 25(OH)D concentrations. Some foods rich in vitamin D are not sufficient to meet the need for this vitamin. Vitamin D can be synthesized in the skin upon exposure to sunlight. This is an important source of this micronutrient.

It was reported that serum 25(OH)D declines with puberty-onset. Children with the combined condition of central obesity and suboptimal 25(OH)D (<30 ng/ml) before puberty-onset have higher IR during puberty. It suggested that there is a need of ensuring adequate – 25(OH)D status before pubertal-onset, particularly in OB children [14].

The populations living in countries at high latitudes are simply at risk of developing vitamin D deficiency however, it is interesting to note that adults and children living in countries quite close to equator were also under the threatening of deficient vitamin D status [2], [3], [7], [15], [16]. Turkey is located in between these two different geographic areas. Therefore, it is a matter of wonder.

The aim of this study is to determine vitamin D status of

O. D., Prof. Dr., is with the Istanbul University, Cerrahpasa Medical Faculty, Department of Medical Biochemistry, Istanbul, Turkey ((corresponding author to provide phone: 00-90-532-371-72-07; fax: 00-90-212-632-00-50; e-mail: odonma@gmail.com).

M. M. D., Prof. Dr., is with the Namik Kemal University, Faculty of Medicine, Department of Pediatrics, Tekirdag, Turkey (e-mail: mdonma@gmail.com).

Turkish children, associations between vitamin D and some physiological as well as biochemical parameters such as basal metabolic rate (BMR), blood pressures, lipid and glucose profiles in both OB and MO groups.

II. PATIENTS AND METHODS

A. Patients

This study comprised a total of 78 children (41 OB and 37 MO) between 6 and 18 years old. Informed consent forms were taken from the participants and their parents. Ethical Committee approval was obtained.

B. Obesity Classification, Measurements and Ratios

Children were divided into two groups depending upon their BMI-for age and sex percentiles prepared by WHO for the classification of obesity. Children, whose values are greater than 99th percentiles were included into MO group. Those with the values within 95th and 99th percentiles were considered as OB group. Anthropometric measurements and calculations of ratios using weight, height, waist C, hip C, head C and neck C were performed.

C. Laboratory Methods

BMRs were measured. Routine biochemical analyses were performed. Vitamin D analyses were performed by the determination of 25(OH)D using high performance liquid chromatography. Optimal 25(OH)D level was defined as ≥ 30 ng/ml. Children were grouped based upon their vitamin D status, as deficient, insufficient and sufficient. Values <20.0 ng/ml were considered as vitamin D deficient, values between 20-30 ng/ml were described as insufficient, and values >30.0 ng/ml were defined as sufficient.

D. Statistical Evaluations

SPSS was used for data evaluation. Data were analyzed in terms of mean \pm SD and percentages. Differences between groups were tested. Correlation analyses were performed. p values smaller than 0.05 was considered as statistically significant.

III. RESULTS

Mean age \pm SD value of OB group was 12.0 ± 2.9 years. The corresponding value for MO group was 11.2 ± 3.6 years ($p>0.05$). Significantly increased BMI (24.5 ± 3.3 kg/m² vs 29.6 ± 7.8 kg/m²), waist C (83.0 ± 11.1 cm vs 91.7 ± 18.6 cm), and neck C (32.5 ± 3.2 cm vs 34.8 ± 5.0 cm) as well as significantly decreased FBG (93.7 ± 7.7 mg/dl vs 88.3 ± 5.2 mg/dl) and vitamin D (26.0 ± 16.7 ng/ml vs 18.8 ± 8.7 ng/ml) values were observed in MO group ($p<0.05$). In OB and MO groups, 37.5% and 53.6% of the children were vitamin D deficient (Fig. 1). There was a severe statistical significance between FBG values of the groups ($p<0.001$). The members of lipid profile (total cholesterol, TRG, high density lipoprotein cholesterol, low density lipoprotein cholesterol), SBP, DBP and insulin values did not differ between the groups.

Important correlations between BMI, WC, hip C, neck C and both SBP as well as DBP were found in OB group. In

MO group, correlations only with SBP were obtained.

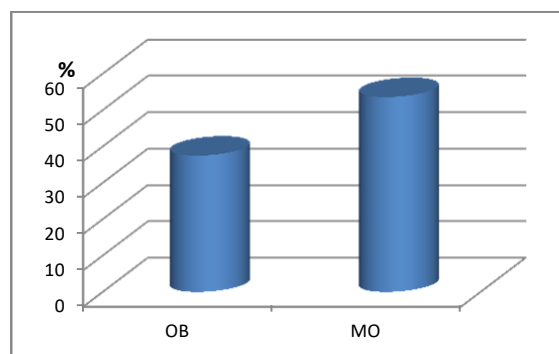


Fig. 1 Comparison of vitamin D deficiency status of the groups

In a similar manner, in OB group, correlations were detected between SBP-BMR ($r= 0.561$, $p<0.05$) and DBP-BMR ($r= 0.406$, $p<0.05$). However, in MO children, BMR correlated only with SBP ($r= 0.583$, $p<0.05$).

The associations of vitamin D with anthropometric indices as well as some lipid parameters were defined. In OB group BMI ($r= -0.321$, $p<0.05$), WC ($r= -0.281$, $p<0.05$), hip C ($r= -0.311$, $p<0.05$) and TRG ($r= -0.261$, $p<0.05$) were negatively correlated with vitamin D concentrations whereas none of them were detected in MO group.

IV. DISCUSSION

Vitamin D is an important issue, because it is an important micronutrient, located at the center of calcium-phosphorus metabolisms, and in close association with many hormones. By this way, it affects metabolic parameters such as glucose and BMR. Due to it is storage site, it is also expected to be closely associated with obesity indices.

Low levels of serum vitamin D have been reported in school children in Kuwait [2]. In a school-based survey targeting Saudi students, prevalence of vitamin D deficiency was found as 49.5% [16]. A study aimed to assess the vitamin D status of Canadian children reported that, of all children, 5.6% were vitamin D deficient [15]. In Spanish children, prevalences of hypovitaminosis D were 58.1% in normal, 55% in overweight, 68.2% in OB and 81.1% in severely OB children [7].

In our study, we have investigated prevalence of vitamin D deficiency in two groups with varying degree of obesity. In OB group, percentage of vitamin D deficient children was 37.5%, however, much more increased percentage was calculated in MO group (53.6%).

There is some general information about the relationships among vitamin D, blood pressure, BMI (Fig. 2).

Vitamin D decreases the activity of renin-angiotensin-aldosterone system and lowers renin synthesis to reduce blood pressure [17]. Vitamin D deficiency was highly prevalent in patients with hypertension as well as type 2 diabetes and was associated with higher systolic ambulatory blood pressure monitoring [18]. Vitamin D levels did not show any significant correlation with BMI, waist or body fat [19].

However, there is at least suggestive evidence that good vitamin D status may have a favorable impact on insulin sensitivity, blood pressure and BMI. Down-regulation of parathyroid hormone secretion is a likely explanation for this phenomenon.

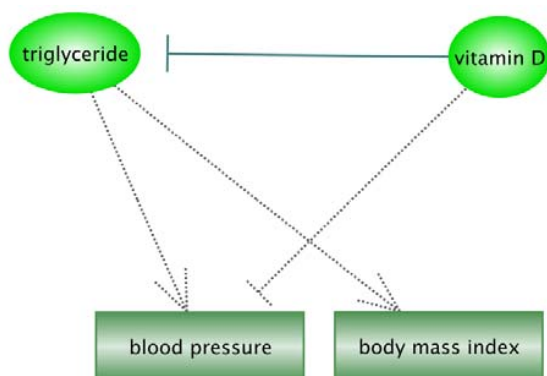


Fig. 2 Relations among vitamin D, TRG, blood pressure and BMI

Typically, more attention is given to SBP as a major risk factor for cardiovascular disease for people over 50. In most people, SBP rises steadily with age due to the increasing stiffness of large arteries, long-term build-up of plaque and an increased incidence of cardiac and vascular disease [20].

In a study, performed on OB women, it was reported that the relationships between SBP and heart rate, muscle endurance, power, and agility are stronger than the relationships between DBP and these variables [21]. In our study, different correlations have existed in terms of SBP and DBP between OB and MO groups. Our findings concerning SBP are quite interesting because they are confined to the pediatric population.

There are also differences between the BMR values as well as the correlations of the groups. In OB group BMR was correlated with both SBP and DBP, on the other hand, only a correlation between BMR and SBP was detected in MO group.

BMRs are reported to be associated with SBP and DBP [22], [23]. However, as in the case of our study, in an anthropological investigation, BMR was found to be positively correlated with SBP among Siberians and is defined as the strongest predictor of blood pressure [24].

Vitamin D deficiency may contribute to the complications of pediatric obesity. Correlations between obesity indices-DBP, vitamin D-TRG and low FBG found in OB group were not detected in MO group. These findings point out that some MetS components may arise during OB state prior to transition to morbid obesity. Following the determination of vitamin D deficiency prevalence, its associations with anthropometric measurements, blood pressures and TRG should also be evaluated before the development of morbid obesity.

REFERENCES

- [1] E. Lespessailles and H. Toumi, "Vitamin D alteration associated with obesity and bariatric surgery," *Exp Biol Med*, vol.242, no. 10, pp. 1086-1094, May 2017.
- [2] K. O. Alyahya, "Vitamin D levels in schoolchildren: a cross-sectional study in Kuwait," *BMC Pediatrics*, vol.17, Dec.2017.
- [3] L. S. Greene-Finestone, D. Garriguet, S. Brooks, K. Langlois, and S. J. Whiting, "Overweight and obesity are associated with lower vitamin D status in Canadian children and adolescents," *Paediatr Child Health*, vol. 22, no. 8, pp. 438-444, Dec. 2017.
- [4] J. S. Walsh, S. Bowles, and A. L. Evans, "Vitamin D in obesity," *Curr Opin. Endocr. Diabetes Obesity*, vol. 24, no. 6, pp. 389-394, Dec. 2017.
- [5] L. Barrea, S. Savastano, C. Di Somma, M. C. Savanelli, F. Nappi, L. Albanese, F. Orio, and A. Colao, "Low serum vitamin D-status, air pollution and obesity: A dangerous liaison," *Rev Endocr Metab Disorders*, vol. 18, No. 2, pp. 207-214, Jun. 2017.
- [6] S. Savastano, L. Barrea, M. C. Savanelli, F. Nappi, C. Di Somma, F. Orio, A. Colao, "Low vitamin D status and obesity: Role of nutritionist," *Rev Endocr Metab Disorders*, vol. 18, no. 2, pp. 215-225, Jun. 2017.
- [7] T. Dura-Trave, F. Gallinas-Victoriano, M. J. Chueca-Guindulain, and S. Berrade-Zubiri, "Prevalence of hypovitaminosis D and associated factors in obese Spanish children," *Nutr Diabetes*, vol.7, article no. e248, Mar. 2017.
- [8] M. J. Alkhataib, K. K. Abdul-Razzak, L. Q. Khasawneh, and N. A. Saadeh, "High prevalence of vitamin D deficiency and correlation of serum vitamin D with cardiovascular risk in patients with metabolic syndrome," *Metab Syndr Relat Disord*, vol. 15, no.5, pp. 213-219, Jun. 2017.
- [9] A. Mousa, N. Naderpoor, M. P. J. de Courten, R. Scragg, and B. de Courten, "25-hydroxyvitamin D is associated with adiposity and cardiometabolic risk factors in a predominantly vitamin D-deficient and overweight /obese but otherwise healthy cohort," *J Steroid Biochem Mol Biol*, vol.173, pp. 258-264, Oct. 2017.
- [10] A. Gul, S. Ozer, R. Yilmaz, E. Sonmezgoz, T. Kasap, S. Takci, and O. Demir, "Association between vitamin D levels and cardiovascular risk factors in obese children and adolescents," *Nutr Hospital*, vol. 34, no.2, pp. 323-329, Mar.-Apr. 2017.
- [11] M. Erol, O. B. Gayret, S. Hamilcikan, E. Can, O. Yigit, "Vitamin D deficiency and insulin resistance as risk factors for dyslipidemia in obese children," *Arch Argent Ped*, vol. 115, no. 2, pp. 133-138, Apr. 2017.
- [12] T. Grunwald, S. Fadia, B. Bernstein, M. Naliborski, S. F. Wu, and F. De Luca, "Vitamin D supplementation, the metabolic syndrome and oxidative stress in obese children," *J Ped Endocrinol Metab*, vol. 30, no. 4, pp. 383-388, Apr. 2017.
- [13] J. Leger-Guist'hau, C. Domingues-Faria, M. Miolanne, F. Peyrol, L. Gerbaud, B. Pereira, R. Minet-Quinard, V. Sapin, S. Walrand, and Y. Boirie, "Low socio-economic status is a newly identified independent risk factor for poor vitamin D status in severely obese adults," *J Hum Nutr Diet*, vol. 30, no. 2, pp. 203-215, Apr. 2017.
- [14] G. Cediel, C. Corvalan, D. L. de Romana, V. Mericq, and R. Uauy, "Prepubertal adiposity, vitamin D status and insulin resistance," *Pediatrics*, vol. 138, no. 1, e20160076, Apr. 2016.
- [15] L. L. Munasinghe, Y. Yuan, N. D. Willows, E. L. Faught, J. P. Ekwuru, and P. J. Veugelers, "Vitamin D deficiency and sufficiency among Canadian children residing at high latitude following the revision of the RDA of vitamin D intake in 2010," *Br J Nutr*, vol. 117, no. 3, pp. 457-465, Feb. 2017.
- [16] I. M. Kaddam, A. M. Al-Shaikh, B. A. Abaalkhail, K. S. Asseri, Y. M. Al-Saleh, A. A. Al-Qarni, A. M. Al-Shuaibi, W. G. Tamimi, and A. M. Mukhtar, "Prevalence of vitamin D deficiency and its associated factors in three regions of Saudi Arabia A cross-sectional study," *Saudi Med J*, vol. 38, no. 4, pp. 381-390, Apr. 2017.
- [17] C. Legarth, D. Grimm, M. Wehland, J. Bauer, and M. Krüger, "The impact of vitamin D in the treatment of essential hypertension," *Int J Mol Sci*, vol. 19, no. 2, pii. E455, Feb. 2018.
- [18] J. S. R. Moreira, T. P. de Paula, L. F. Sperber, M. E. P. Miller, M. J. Azevedo, and L. V. Viana, "Association of plasma vitamin D status with lifestyle patterns and ambulatory blood pressure monitoring parameters in patients with type 2 diabetes and hypertension," *Diab Res Clin Pract*, vol.139, pp. 139-146, Mar. 2018.
- [19] A. Gupta, M. Aslam, S. Rath, B. K. Mishra, S. Bhardwaj, R. Jhamb, and S. V. Madhu, "Association of vitamin D levels and type 2 diabetes mellitus in Asian Indians is independent of obesity," *Exp Clin Endocrinol Diabetes*, 2018 Mar 20 (Epub ahead of print).
- [20] www.heart.org (Accessed on: 06/10/2016).
- [21] J. Y. Shin, and C. H. Ha, "Relationships between blood pressure and health and fitness-related variables in obese women," *J Phys Ther Sci*,

- vol. 28, pp. 2933-2937, Jul. 2016.
- [22] N. Ali, S. Mahmood, M. Manirujjaman, R. Perveen, A. Al Nahid, S. Ahmed, F. A. Khanum, and M. Rahman, "Hypertension prevalence and influence of basal metabolic rate on blood pressure among adult students in Bangladesh," *BMC Public Health*, vol. 18, pp.58, 2018.
- [23] T. Chen, X. Chu, Y. Zhu, Y. Lan, H. Zhao, and C. Shen, " Basal metabolic rate is correlated with blood pressure among young population," *Int J Clin Exp Med*, vol. 9, no. 6, pp. 12375-12383, 2016.
- [24] J. J. Snodgrass, W. R. Leonard, M. V. Sorensen, L. A. Tarskaia, and M. J. Mosher, " The influence of basal metabolic rate on blood pressure among indigenous Siberians," *Am J Phys Anthropol*, vol. 137, pp. 145-155, Mar.2008.