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OPEN ARAŞTIRMA MAKALESİ / RESEARCH ARTICLE

Evaluation of The Relationship Between Metabolic Parameters and Vitamin D Levels in Children with Insulin-Dependent Diabetes Mellitus

İnsülin Bağımlı Diabetes Mellituslu Çocuklarda Metabolik Parametreler ile Vitamin D Seviyesi Arasındaki İlişkinin Değerlendirilmesi

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ÖZET

Amaç: D vitamini hiperlipidemi, kardiyovasküler hastalık riski ve glikoz/insülin metabolizmasında önemli bir rol oynar. Bu çalışmanın amacı; tip 1 diyabetes mellituslu çocukların metabolik profilleri, aterojenik indeks ve kardiyovasküler hastalık riski ile serum vitamin D düzeyleri arasındaki ilişkiyi araştırmaktır.

Gereçler ve Yöntem: Çalışmaya 307 tip 1 diyabetes mellituslu hasta dahil edildi. Antropometrik ve klinik ölçümler, biyokimyasal parametreler, aterojenik plazma indeksi (AIP) değerleri ve serum vitamin D düzeyleri değerlendirildi.

Bulgular: Çalışmaya yaş ortalaması 11.5 ±3.87 olan, 152'si (%49.5) kız, 155'i (%50.5) erkek olmak üzere 307 diyabet hastası dahil edildi. Hastalarımızın büyük çoğunluğunda Vitamin D eksikliği (%77.5; (n=193)) tespit edildi. Vitamin D düzeyi düşük hastaların günlük ortalama insülin dozu 0.91±0.31 U/kg/gün; ortalama hemoglobin A1C (HbA1C) seviyesi %11.77; vitamin D düzeyi normal olanlarda ise ortalama insülin dozu 0.94±0.28 U/kg/gün; HbA1C seviyesi %12.19 olarak bulundu (p> 0.05). Kızlarda ortalama aterojenik plazma indeksi düzeyi 0.28±0.33 iken; erkeklerde 0.25±0.31 idi (p > 0.05). Vitamin D eksikliği olan vakaların aterojenik plazma indeksi ortalaması 0.29±0.31 iken, vitamin D eksikliği olmayanlarda aterojenik plazma indeksi ortalaması ise 0.13±0.28 olarak bulundu (p< 0.001).

Sonuç: Aterojenik plazma indeksi; vitamin D eksikliği olan hastalarda daha yüksek bulunmuştur. Çalışma sonucunda elde edilen verilere göre; Vitamin D düşüklüğü ve aterojenik plazma indeksi yüksekliği kardiyovasküler komplikasyonları öngörmede önemli belirteçlerdir. Tip 1 diyabetes mellituslu çocuklarda bu parametrelerin yakın takibinin uzun dönem morbiditeyi önlemede yol gösterici olacağı düşünülmektedir.

Anahtar Kelimeler: Tip 1 Diabetes Mellitus, Aterojenik İndeks, D Vitamini

ABSTRACT

Objective: Vitamin D play an important role in hyperlipidemia, cardiovascular disease risk, and glucose/insulin metabolism. The aim of this study is; To investigate the relationship between serum vitamin D levels and metabolic profiles of children with type 1 diabetes mellitus (T1DM), atherogenic index, and cardiovascular disease risk.

Materials and Methods: Anthropometric and clinical measurements, biochemical parameters, atherogenic plasma index (AIP) values and serum vitamin D levels were evaluated.

Results: The study included 307 diabetic patients, 152 (49.5%) females and 155 (50.5%) males, with a mean age of 11.5±3.87. Vitamin D deficiency (77.5%; (n=193)) was detected in the majority of our patients. The mean daily insulin dose of patients with low vitamin D levels was 0.91±0.31 U/kg/day; mean hemoglobin A1C (HbA1C) level 11.77%; in those with normal vitamin D levels, the mean insulin dose is 0.94±0.28 U/kg/day; the HbA1C level was found to be 12.19% (p>0.05). While the mean atherogenic plasma index level in females was 0.28±0.33; it was 0.25±0.31 in males (p>0.05). While the mean atherogenic plasma index of cases with vitamin D deficiency was 0.29±0.31, the mean of atherogenic plasma index in those without vitamin D deficiency was found to be 0.13±0.28 (p<0.001).

Conclusion: Atherogenic plasma index was higher in patients with vitamin D deficiency. According to the data obtained as a result of the study; low vitamin D and high atherogenic plasma index levels are important predictors of cardiovascular complications. It is thought that close monitoring of these parameters will be a guide in preventing long-term morbidity in children with type 1 diabetes mellitus.

Keywords: Type 1 Diabetes Mellitus, Atherogenic Index, Vitamin D

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INTRODUCTION

Type 1 Diabetes Mellitus (T1DM) is one of the most common chronic diseases of childhood and is caused by partial or absolute insulin deficiency due to the destruction of the beta cells of the pancreas (1). It has been reported in epidemiological studies that there is a high prevalence of vitamin D deficiency in children and adolescents with T1DM and a relationship between both (2). Studies have shown that 25(OH)D levels of T1DM patients are lower than the control groups, and vitamin D supplementation in early infancy reduces the risk of T1DM by approximately 30% (3). Vitamin D has anti-inflammatory and immunomodulatory effects that may affect the autoimmune pathology of T1DM (4). Epidemiological studies suggest an inverse relationship between circulating 25(OH)D levels and coronary vascular disease risk biomarkers, including the atherogenic lipid profile (5). It has been suggested that Vitamin D has both direct and indirect effects in changing lipid profile by increasing lipoprotein lipase activity in adipose tissue and decreasing serum levels of triglycerides (TG) (6).

MATERIALS AND METHODS

A total of 307 T1DM patients who were followed up in the pediatric endocrinology outpatient clinic, 249 and 58 who were not checked for vitamin D levels were retrospectively included in the study. While 193 of the patients had vitamin D deficiency, this level was found to be normal in 56 patients. Vitamin D levels were considered deficient in those below 20 ng/mL (7). Inclusion criteria were determined as being in the 0-18 age range and having a diagnosis of insulin-dependent diabetes mellitus. Non-insulin dependent diabetes mellitus patients, history of drug use that impairs vitamin D metabolism and those with disease were determined as exclusion criteria.

The body weights of the children and adolescents included in the study were measured in kilograms (kg) by using a NAN brand mechanical weighing device and their height was measured with a standard type stable Holtain Limited height measuring device (sensitive to 1 millimeter) and recorded in centimeters (cm). Measurements were made in-room clothes, on an empty stomach, and standing. Body mass index (BMI) was calculated using the formula (Bodyweight (kg)/height (m2)). Body weights, heights, and body mass indices were evaluated with the Standard Deviation Score (SDS). SDSs were calculated using an appropriate computer program prepared according to age and gender (8). Patients with BMI-SDS≥+2 are obese, those between +1.5, +1.99 are overweight; those between -2, +1.5 are normal weight; those with <-2 were considered to be underweight (9).

Tanner staging was used for puberty classification (10,11). Patients with Tanner stage 2 and above were evaluated as pubertal, and those with stage 1 were evaluated as prepubertal (12). After resting all patients for 10 minutes, blood pressure was measured with a mercury sphygmomanometer in a sitting position using a cuff suitable for their age. The value at which the first Korotkoff sound was heard was recorded as systolic blood pressure, and the value at which the sound disappeared was recorded as diastolic blood pressure. Systolic and diastolic blood pressure limits were analyzed from tables determined according to height percentile and age. Those with a blood pressure level above the 95th percentile were considered hypertensive (13).

HbA1C, lipid profile (Total cholesterol, TG, low-density lipoprotein (LDL), high-density lipoprotein (HDL)), and vitamin D levels were recorded at the first admission and follow-up of patients with type 1 diabetes mellitus. Each patient gave examinations in the morning, after 8-12 hours of fasting, in the form of venous blood samples. Biochemical parameters were determined by routine methods using the Abbot Architect c 8000 brand device. A Siemens Centaur device was used to measure the 25OHD level.

The Atherogenic Index (AIP) was calculated as log (TG/HDL-C). Those with AIP ratios of 0.11 and below were considered at low risk; those >0.11 and ≤0.21 at medium risk and AIP >0.21 at high risk (14). The study was conducted retrospectively. So there was no need for patient informed consent form. The study was conducted as a medical specialization thesis. Ethics committee approval was received.

Statistical Analysis

The data obtained in this study were evaluated with the SPPS 25 program. The Chi-square test was used for comparing the differences between categorical variables. In cases where independent numerical variables were not normally distributed, the Mann-Whitney U test was used. In statistical analysis, the significance level was taken into account as <0.05 (p-value).

Approval of research protocols by institutional committee was taken with the number 2020/2549.

RESULTS

In our study, there were 307 diabetic patients, 152 (49.5%) females and 155 (50.5%) males, whose ages ranged from 2.1 to 18 (Mean = 11.52±3.87). Examining the distribution of diabetic patients by puberty, 114 (37.1%) patients were prepubertal and 193 (62.9%) patients were pubertal. The mean doses of insulin usage of our patients were calculated as 0.90±0.30 U/kg/g. HbA1C levels in the first year of diagnosis (11.9%) were found to be significantly higher than the third (10%) and fifth years (10.2%) (respectively; t(225)=9.56, p<0.001;150)=5.74, p<0.001). There was no significant difference between the HbA1C levels in the third and fifth years (p>0.05).

When the BMI of the cases with and without vitamin D deficiency was examined, the mean BMI of the cases with vitamin D deficiency was 19.50±5.74 kg/m^2, while the cases without vitamin D deficiency were calculated as 18.57±8.12 kg/m^2. It was observed that there was no significant difference between the means of the groups (p>0.05). In our study, while 77.5% (n=193) of the patients whose vitamin D level was checked had vitamin D deficiency, this level was normal in 22.5% (n=56). In patients with low vitamin D levels, the mean insulin dose was 0.91±0.31 U/kg/day, and the mean HbA1C level was 11.7%; In normal cases, it was 0.94±0.28 U/kg/day, and the mean HbA1C level was 12.1%. When the insulin use dose and the mean HbA1C value are compared in cases with low and normal vitamin D levels, it is seen that there is no significant difference ($p>0.05$).

When the AIP levels of the patients were classified according to puberty and gender, a significant difference was found in AIP levels in the prepubertal and pubertal groups ($\chi^2(2)=10.34$, $p<0.01$). While the mean AIP value of prepubertal patients is 0.18±0.33, it is 0.31±0.30 in pubertal patients. On the contrary, there is no significant difference in the AIP levels of males and females ($p>0.05$). While the mean AIP value in females is 0.28±0.33, the mean AIP value in males is 0.25±0.31. Table 1can be examined for detailed information. The results obtained when comparing the HbA1C value of the patients with high atherogenic index in the first year and those of the patients with normal and low AIP show that there is a significant difference ($F(2,250)=3.87$, $p<0.05$). It is observed that the mean HbA1C value of the patients with low AIP levels in the first year is significantly lower than that of the patients with high AIP levels. Table 2 can be examined for detailed information. When the mean AIP values of the cases with and without vitamin D deficiency were examined, the mean AIP of the cases with vitamin D deficiency was 0.29±0.31, while this rate was calculated as 0.13±0.28 in those with normal vitamin D deficiency. The results obtained show that there is a significant difference between the two groups ($p<0.001$).

When the mean systolic and diastolic blood pressure of the cases with and without Vitamin D deficiency were examined, the mean systolic-diastolic blood pressure of the vitamin D deficient cases was 103.94±11.24/65.31±8.91 mmHg; in cases without vitamin D deficiency, mean systolic-diastolic blood pressure was calculated as 104.11±10.62/64.64±9.53 mmHg. The results show that there is no significant difference in the mean systolic and diastolic blood pressure of the cases with and without vitamin D deficiency ($p>0.05$).

When the mean of TG, cholesterol, HDL, and LDL values of the cases with and without vitamin D deficiency was examined, it was observed that the TG levels of the cases with vitamin D deficiency were significantly higher ($t(236)=-4.09$, $p<0.001$). However, there was no significant difference between the groups in terms of cholesterol, HDL, and LDL means ($p>0.05$). Table 3 can be examined for detailed information.

Table 1. Classification of Atherogenic Index Levels of Patients According to Puberty and Gender

		Atherogenic Index Level			
		Low	**Medium**	**High**	**Total**
Prepubertal	n	43	15	38	96
	%	44.8	15.6	39.6	
Pubertal	n	47	37	98	182
	%	25.8	20.3	53.8	
Total	n	90	52	136	278
	%	32.4	18.7	48.9	
Female	n	42	27	64	133
	%	31.6	20.3	48.1	
Male	n	48	25	72	145
	%	33.1	17.2	49.7	
Total	n	90	52	136	278
	%	32.4	18.7	48.9	

Table 2. First-Year HbA1C Values of Cases with High Atherogenic Index, Medium and Low Risk

				95% Confidence Interval	
Level	**Mean**	**S**	**n**	**Lowest**	**Highest**
Low	11.34	2.81	82	10.72	11.95
Medium	11.94	3.18	47	11.13	12.76
High	12.46	2.73	124	11.96	12.96
Total	12.00	2.88	253	-	-

Table 3. TG, Cholesterol HDL and LDL Values of Cases with and without Vitamin D Deficiency

Vitamin D Level	Variables	n	Lowest Value	Highest Value	Mean	S
Low	TG(mmol/L)	185	1.27	54	6.66	5.18
	Cholesterol(mmol/L)	185	4.94	20.2	9.41	2.37
	HDL(mmol/L)	183	0.85	5.98	2.95	0.75
	LDL(mmol/L)	183	0.99	11.7	5	1.82
Normal	TG(mmol/L)	53	1.55	12.4	4.55	2.27
	Cholesterol(mmol/L)	53	5.66	14.11	9.1	1.95
	HDL(mmol/L)	52	1.41	7.33	3.16	0.91
	LDL(mmol/L)	52	1.78	8.25	5	1.5

DISCUSSION

It has been suggested that vitamin D has both direct and indirect effects in changing lipid profile by increasing lipoprotein lipase activity in adipose tissue and decreasing serum levels of TG (6). There is no study in the literature on the evaluation of vitamin D levels of pediatric patients with T1DM diagnosis by atherogenic index. In our study, the mean AIP of cases with vitamin D deficiency was 0.29±0.31, while the mean AIP of those without vitamin D deficiency was found to be 0.13±0.28 ($p<0.001$). The fact that the mean value of AIP is above 0.21 in T1DM patients with vitamin D deficiency is an indication that vitamin D deficiency poses a high risk for cardiovascular diseases in these patients

The age at which T1DM occurs in childhood has a bimodal distribution, with a peak at four to six years of age and a second in early adolescence (ages 10 to 14) (15). In the study conducted by Al-Shaikh et al in Saudi Arabia in 2016, the mean age of the patients was 13.9±3.8 years (13.86±3.88 for males and 14.06±3.86 for females) (16). In our study, the mean age of the patients was found to be 11.52±3.87 (11.74 for males and 11.3 for females). In a study conducted in Egypt by Hafez et al in 2019, 48% of the patients were found prepubertal and 52% pubertal (17). In our study, it is seen that 37.1% patients were prepubertal and 62.9% were pubertal, and it contains similar findings with the studies in the literature.

Treatment of type 1 diabetes mellitus requires lifelong administration of exogenous insulin (18). According to ISPAD; At the onset of T1DM, typically 0.5-0.75 U/kg/day total insulin doses are selected, and then these doses are adjusted daily to reach the target glycemia (19). In our study, the mean daily insulin dose of the patients was found to be 0.90±0.30 U/kg/day. Hemoglobin A1C reflects the mean blood sugar level of 2-3 months and is used to predict the risk of developing diabetes complications. Although there are different approaches regarding the HbA1C level of T1DM patients in the pediatric population in the literature, the mean value is expected to be below 7.5% (20). In our study, it was found that the HbA1C level in the first year of diagnosis was 11.90%.

In a study conducted in Egypt by Hafez et al in 2017, the insulin dose of T1DM patients with vitamin D deficiency was 1.2±0.38 U/kg/day; In those with normal levels of vitamin D; 0.99±0.16 U/kg/day was found. HbA1C levels were 9.38±1.99% for patients with vitamin D deficiency; For those with normal vitamin D levels, it was found to be 8.56±0.49% (21). In our study, the mean daily insulin dose of patients with low vitamin D levels was 0.91±0.31 U/kg/day; The HbA1C level was found to be 11.77%. In patients with normal vitamin D levels, the mean insulin dose was 0.94±0.28 U/kg/day; The HbA1C level was found to be 12.19%. In the studies in the literature, no significant difference was found in the insulin use dose and HbA1C level in patients with vitamin D deficiency and normal. We think that this is since the vitamin D level of our patients was not regularly checked at the time of diagnosis and during the period when the HbA1C level was checked.

In a study conducted in Saudi Arabia in 2016 by Al-Shaikh et al. the mean systolic-diastolic blood pressure measurement was 113.2±11.2/67.8±9.0 mmHg in those with insufficient vitamin D, and 111.9±12.8/67.9±8.5 mmHg in those with normal levels. Again in this study, the BMI of those with vitamin D deficiency was 21.6±4.5 kg/m^2; the BMI of normal ones was found to be 20.1±3.9 kg/m^2 (16). In our study, the mean systolic blood pressure of cases with vitamin D deficiency was 103.94±11.24 mmHg; the mean diastolic blood pressure was calculated as 65.31±8.91 mmHg. Besides, the mean systolic blood pressure of cases without vitamin D deficiency was 104.11±10.62 mmHg; Mean diastolic blood pressure was found to be 64.64±9.53 mmHg, and no significant difference was found in those with deficient and normal vitamin D levels ($p>0.05$). While the mean BMI of our patients with vitamin D deficiency was 19.50±5.74 kg/m^2, the mean BMI of cases without vitamin D deficiency was calculated as 18.57±8.12 kg/m^2. It was observed that there was no significant difference between the means of both groups ($p>0.05$). Our study contains findings similar to the literature.

In a study conducted by Sapunar et al in 2018 with 208 children in Chile, the AIP value in males was 0.25±0.31; 0.26±0.23 in females; it was found to be 0.25±0.30 in prepubertal children and 0.26±0.21 in pubertal children (22). In a study conducted by Nogay on 400 children in our country in 2017, the AIP value in females in pubertal patients was –0.15±0.22; It was found to be –0.15±0.25 in males. AIP rate in females in prepubertal patients was –0.04±0.20; It was found to be –0.24±0.31 in males (23). In the results obtained from our study, while the mean AIP value in females was 0.28±0.33; the mean AIP value in males is 0.25±0.31. However, the mean AIP value in prepubertal cases was found to be 0.18±0.33, while it was 0.31±0.30 in pubertal patients. In the studies in the literature, we think that there is a difference in the mean of AIP since the cases are not diagnosed with T1DM. Again, we believe that this difference between pubertal and prepubertal cases is due to the malnutrition in patients and the increase in blood glucose regulation during adolescence.

In a study conducted by Zabeen et al (2018) in Bangladesh, 65% of 576 T1DM patients have dyslipidemia. It was found that 50% of the patients had a high TG level, 66% had a high LDL level, and 48% had a low HDL level. A higher mean HbA1C (9.8%[8.4-11.8] versus 7.9%[9.3-10.5]) was found in patients with dyslipidemia compared to those without (24). In our study, in the comparison of the relationship between AIP and HbA1C levels, the mean HbA1C level in the first year of patients with high AIP values was 12.4%; those with low risk were found to be 11.34%. No study was found in the literature on the comparison of the relationship between AIP and HbA1C in T1DM patients; It was also found in our study that dyslipidemia affects the increase of HbA1C.

In conclusion Blood sugar regulation must be ensured in patients with type 1 diabetes mellitus and optimal vitamin D support should be given importance in patients with diabetes mellitus.

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REFERENCES

1. Lipton RB, Davul M, Burnet D, et al. Obesity at the onset of diabetes in an ethnically diverse population of children: What does it mean for epidemiologists and clinicians? Pediatrics 2005; 115:e553
2. Svoren BM, Jospe N. Diabetes mellitus in children. In: Kliegman RM, Stanton BF, St Geme JW, Schor NF, Behrman RE, editors. Nelson Textbook of Pediatrics. 20th ed. Philadelphia: Elsevier Saunders; 2016. p. 2760-83.
3. Jacobsen R, Frederiksen P, Heitmann BL. Exposuretosunshineearly in life preventeddevelopment of type 1 diabetes in Danishboys. J Pediatr Endocrinol Metab 2016;29:417–24.
4. Hewison M. Vitamin D and the immune system: new perspectives on an old theme. Endocrinol Metab Clin North Am2010;39:365-79
5. Kim DH, Sabour S, Sagar UN, et al. Prevalence of hypovitaminosis D in cardiovascular diseases (from the National Health and Nutrition Examination Survey 2001 to 2004). Am J Cardiol. 2008;102(11):1540-4.
6. Wang JH, Keisala T, Solakivi T, et al. Serum cholesterol and expression of ApoAI, LXR [beta] and SREBP2 in vitamin D receptor knock-out mice. J Steroid Biochem. 2009;113(3–5): 222-6.
7. Linden MA, Freitas RGBON, Hessel G, et.al. Defınıtıon Of Vıtamın D Defıcıency In Schoolchıldren: Systematıc Revıew Wıth Meta-Analysıs. ArqGastroenterol. 2019;56(4):425-30.
8. Cacciari E, Milani S, Balsamo A, et al . Italian cross-section charts for height, weight and BMI (6–20 y). Eur J Clin Nutr 2002;56(2):171-80.
9. Demiral M, Binay Ç, Şimşek E. Eskişehir ilinde tip 1 diyabetes mellitus tanısı ile izlenen hastaların epidemiyolojik özellikleri. Çocuk Sağlığı ve Hastalıkları Dergisi 2016; 59: 14-20.[Epidemiological characteristics of patients with type 1 diabetes mellitus diagnosis in Eskişehir province. Journal of Child Health and Diseases 2016; 59: 14-20
10. Marshall WA, Tanner JM. Variations in pattern of pubertal changes in girls. Arch Dis Child 1969;44(235):291-303.
11. Marshall WA, Tanner JM. Variations in the pattern of pubertal changes in boys. Arch Dis Child 1970;45(39):13-23.
12. Needlman RD. Puberty. İn: Nelson W. et al (eds). Textbook of Pediatrics, 17th ed. Philapelphia: Elsevier Saunders. Reference ranges chapter 2. 2008.
13. National High Blood Pressure Education Program Working Group on Hypertension Control in Children and Adolescent Pediatrics October 1996;98(4):649-58.
14. Fernández-Macías JC, Ochoa-Martínez AC, Varela-Silva JA, et al. Pérez-Maldonado IN.Atherogenic Index of Plasma: Novel Predictive Biomarker for CardiovascularIllnesses. Arch Med Res. 2019;50(5):285-94.
15. Felner EI, Klitz W, Ham M, et al. Genetic interaction among three genomic regions creates distinct contributions to early- and late-onset type 1 diabetes mellitus. Pediatr Diabetes 2005;6:213.
16. Al Shaikh A, Al Zahrani AM. Impact of Vitamin D Status on Cardiometabolic Complications among Children and Adolescents with Type 1 Diabetes Mellitus. J Clin Res Pediatr Endocrinol. 2016;8(1):48-54.
17. Hafez M, Musa N, Abdel Atty S, et.al. Effect of Vitamin D Supplementation on Lipid Profile in Vitamin D-Deficient Children with Type 1 Diabetes and Dyslipidemia. Horm Res Paediatr. 2019;91(5):311-18
18. Malik FS, Taplin CE. Insulin therapy in children and adolescents with type 1diabetes. Paediatr Drugs. 2014;16(2):141-50.
19. International Society for Pediatric and Adolescent Diabetes. 2011 global IDF/ISPAD guideline for diabetes in childhood and adolescence. ISPAD.org. 2011 [cited 2012Jan9].1–132. https://www.ispad.org/sites/default/files/idfispad_diabetes_in_childhood_and_adolescence_guidelines_2011.pdf
20. Chiang JL, Kirkman MS, Laffel LM, et.al. Type 1 diabetes through the life span: A position statement of the American Diabetes Association. Diabetes Care 2014;37:2034
21. Hafez M, Hassan M, Musa N, et al. Vitamin D status inEgyptian children with type 1 diabetes and the role of vitamin D replacement inglycemic control. J Pediatr Endocrinol Metab. 2017 1;30(4):389-94.
22. Sapunar J, Aguilar-Farías N, Navarro J, et al. Alta prevalencia de dislipidemias y riesgoaterogénico en una población infanto-juvenil [High prevalence of dyslipidemiaand high atherogenic index of plasma in children and adolescents]. Rev Med Chil. 2018;146(10):1112-22.
23. Nogay NH. Assessment of the correlation between the atherogenic index ofplasma and cardiometabolic risk factors in children and adolescents: Might it besuperior to the TG/HDL-C ratio? J Pediatr Endocrinol Metab. 2017; 28;30(9):947-55.
24. Zabeen B, Balsa AM, Islam N, et al. Lipid Profile in Relation to Glycemic Control in Type 1 Diabetes Children and Adolescents in Bangladesh. Indian J Endocrinol Metab. 2018;22(1):89-92.