Association of Subclinical Hypothyroidism and Dyslipidemia in Children and Adolescents

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Abstract

Background: Correlation of higher levels of TSH and dyslipidemia in children is controversial. This study was designed to assess the relation between lipid profile components and TSH levels in children.

Method: This cross-sectional study was performed in a growth assessment clinic in Shiraz. Children aged between 2 to 18 years that came to the clinic from January till April 2018 were considered. TSH levels equal or above 5 and lower than 10 mIU/L with normal FT4 were considered as subclinical hypothyroidism.

Results: 666 children were euthyroid while 181 had subclinical hypothyroidism. Mean total cholesterol in euthyroid children was 160.50 ± 29.070 mg/dl and in SH group 161.39 ± 28.694 mg/dl (P=0.713). Mean LDL-C in euthyroid children was 90.96 ± 24.996 mg/dl and in SH group 89.10 ± 23.852 mg/dl (P=0.369). Mean HDL-C in euthyroid children was 47.94 ± 10.560 mg/dl and in SH group 49.04 ± 10.361 mg/dl. (P=0.211). Mean non-HDL-C in euthyroid children was 112.56 ± 27.696 mg/dl and in SH group 112.35 ± 28.136 mg/dl. (P=0.929). Mean triglyceride in euthyroid children was 104.98 ± 54.934 mg/dl and in SH group 113.83 ± 91.342 mg/dl (P=0.215). There was no significant difference in mean serum total cholesterol, LDL, HDL, non-HDL and triglyceride levels between euthyroid and subclinical hypothyroid. Adjusted correlation was not significant between TSH levels and any lipid profile component.

Conclusion: By comparing the results of this study with other studies, it is evident that lipid disorder in subclinical hypothyroid children does not have a specific pattern.

Introduction

Subclinical hypothyroidism is defined as elevated TSH levels while T4 or FT4 levels are normal.[1] It is a common disorder with a prevalence of 1 to 10% in Adult Community, [2,
while in the pediatrics population subclinical hypothyroidism is slightly lower than 2%. [2, 4] Elevated TSH levels are linked with obesity[5], and they are found to be reversible after weight loss, whether being attained through bariatric surgery or diet.[6, 7] Subclinical hypothyroidism in adults has been linked to higher chances of cardiac disease, [8–14] insulin resistance and neuromuscular and neurobehavioral alteration.[10, 15–18] Several studies have correlated subclinical hypothyroidism in adults with higher levels of total cholesterol, LDL, non-HDL, TG and lower levels of HDL.[19–21] However in study by Meisinger et al only higher triglyceride was correlated with higher levels of TSH in male participants. Higher levels of total cholesterol and LDL-C was only true for female participants.[22]

Correlation of higher levels of TSH and dyslipidemia in children is controversial. Some studies have showed higher levels of TC, LDL and TG with increase in TSH.[23–27] Conversely another study showed higher levels of TG as the only positive correlation with increase in TSH.[28]

Studies about the association of dyslipidemia and subclinical hypothyroidism in children show different results. This cross sectional prospective study was designed to compare lipid profiles including TG, Total Cholesterol, LDL-c and HDL-c in euthyroid vs. subclinical hypothyroid children.

Methods

This study was conducted as part of a larger project on serum lipid and thyroid profile in southern Iranian children and adolescents; details of which are available in another research paper.[29] In short, children with an age of 2 to 18 years that came to a growth assessment clinic in the city of Shiraz for routine growth follow up from January till April 2018 were selected for the study. After consent from their parents, they were checked for serum Total cholesterol, LDL-c, HDL-c, Non-HDL-c, TG, TSH and FT4 levels simultaneously.
in a non-fast state. For this study, inclusion criteria were: 1- age of 2–18 years; 2- presence of normal free T4 (0.8–1.8 ng/dL); 3- TSH between 0.3 and < 10 mIU/L. Exclusion criteria were 1- Those children who were on levothyroxine therapy at the time of assessment; 2- Ongoing use of medications that may interfere with thyroid function test or lipid profile such as anti-thyroid medications, corticosteroids, oral contraceptives, thiazides; 3- Familial Hyperlipidemia; 4- Diseases that may affect lipid profile such as DM, kidney disease, rheumatologic disease, other endocrine disease.

847 children including 366 (43.2%) boys and 481 (56.8%) girls had full inclusion criteria and were selected for this study. For precise calculation of BMI, SDS-BMI and BMI percentile, UptoDate calculators, which are based on CDC growth charts, were used. Serum TSH and lipid profile were measured using Cobas e411 Analyzer (Mannheim, Germany) with electrochemiluminescence immunoassay (ECLIA) method and Dirui CS-T240 Auto chemistry Analyzer (Changchun, China) using Pars Azmoon kits (Iran) respectively. Assay performance was controlled using Elecsys PreciControl Universal for serum thyroid profile and TrueLab N and TruLab P for lipid profile. Auto Analyser was calibrated using Elecsys TSH CalSet and TruCal U. Inter-assay coefficients of variation (CVs) for TSH are 1.56% for 1.37 mIU/L and 0.08% for 8.62 mIU/L respectively while inter and intra assay coefficient of variations were 3.2 and 2.29% for total cholesterol and 1.6 and 1.49% for triglyceride respectively.

Signed informed consent was obtained from all participants and or their parents. The study was approved by the Kazeroon Azad University of Medical Sciences research ethics committee. (reference 1398.125)

Abnormal lipid profile cutoffs are based on the 2011 statement of the National Heart, Lung, and Blood Institute's (NHLBI) Expert Panel on Integrated Guidelines for Cardiovascular Health and Risk Reduction in Children and Adolescents and the 2008
American Academy of Pediatrics' (AAP) policy statement. (Table 1)

TSH levels equal or above 5 were considered abnormal. All participants with high TSH levels were considered for a second remeasurement. For these participants, second TSH levels were considered for the study.

For analysis, the study group was divided into two age groups: 2–9 and 10–18 each representing before start of puberty and after start of puberty respectively. Participants with TSH levels equal or above 5 mIU/L and lower than 10 mIU/L with normal free T4 levels were categorized as Subclinical Hypothyroid children. Relation between serum TSH and each lipid profile component (dependent variable) was evaluated using partial variable correlation, adjusted for age, gender and BMI Z-score. Comparisons were performed by using chi_squared test for categorical variables in table 4 and by Student t-test for continuous variables in table 3. A value of p < 0.05 was considered statistically significant in all comparisons with confidence interval of 95%. All statistical analysis were performed using SPSS software version 25.0 (SPSS, Chicago, IL, USA).

Results

Based on Table 2, of the 847 children in this study, 666 had TSH levels between 0.3–4.9 IU/ml and were considered as euthyroid while 181 who had TSH levels of 5–9.9 mIU/L and were considered as subclinical hypothyroid participants. There was no significant statistical difference in mean age between euthyroid and subclinical hypothyroid participants. (9.96 ± 3.40 years vs. 9.98 ± 3.28, P = 0.945) 42.8% of euthyroid and 44.8% of subclinical hypothyroid were male. (p = 0.637) Overall, subclinical hypothyroid children had higher BMI Z-scores than euthyroid children. (p = 0.012) (Table 2)

Table 3 shows mean levels of lipid profile components in euthyroid and subclinical hypothyroid children and the subgroups of 2–10 and 10–18 years of age participants. Overall, there was no significant statistical difference in any of the lipid profile
components between euthyroid and subclinical hypothyroid children and in the subsequent age related subgroups. (Table 3)

Table 4 shows the prevalence of dyslipidemia in each of the lipid profile components in euthyroid and subclinical hypothyroid children and their respective age groups. Overall, there was no significant statistical difference in prevalence of any of the lipid profile dyslipidemias between euthyroid and subclinical hypothyroid children and in the subsequent age related subgroups. (Table 4)

Table 5 shows the association of TSH levels and each of the lipid profile components based on partial correlation method adjusted for age, gender and BMI Z-score. No correlation was seen between TSH levels and any of the lipid profile components. Use of logistic regression was forgoed due to the results of this study. (Table 5)

Discussion

Based on our study, we found no correlation between TSH levels and lipid profile components. We also found no difference in mean levels of serum lipid levels between euthyroid and subclinical hypothyroid patients.

In a study by Unal E et al on 38 subclinical hypothyroid children in comparison to a control group, Subclinical hypothyroidism lead to an increased dyslipidemia (increased TC and LDL)[23] and in a study by Witte T et al showed that there is significant positive association between TSH and all non-HDL parameters (total cholesterol, LDL-C, and triglycerides) in children.[24] Another study by Cerbone M showed that triglyceride to high-density lipoprotein-cholesterol ratio (P = 0.01), and high-density lipoprotein-cholesterol were significantly lower (P = 0.003) in SH subjects compared with controls.[25] In the study by Paoli-Valeri M et al on 17 children with subclinical hypothyroidism, subjects with subclinical hypothyroidism had significantly lower HDL-C levels.[26]. In the latest study by Dahl AR, et al on 228 children with subclinical hypothyroidism showed that
Mild SCH in children and adolescents was associated with higher rates of elevated total cholesterol and elevated non-HDL cholesterol.[27].

Meanwhile, Nader NS et al argued that in euthyroid children without a history of hypo- or hyperthyroidism, increasing levels of TSH and decreasing levels of free T4 are associated with higher triglyceride levels[28] and Gönül Çatlı et al, in a study on 27 subclinical hypothyroid children comparing to a control group, showed that there is similar Serum lipoprotein levels and dyslipidemia frequency between the two groups.[30].

According to our results there is no relation between mean TC, LDL-C, HDL-C, non HDL-C and TG levels in euthyroid and subclinical hypothyroid children. The same results is found in the subsequent 2–10 and 10–18 year old age groups.

There is no statistical difference between the percentage of children who have high TC, LDL-C, Non-HDL-c and TG in euthyroid and subclinical hypothyroid children. No statistical difference was also shown in percentage of children with low HDL-c between euthyroid and subclinical hypothyroid children.

According to Berenson GS, et al, in the Bogalusa Heart study, atherosclerosis will start at childhood and the effect of multiple risk factors on the extent of atherosclerosis was quite evident. One of the major risk factors in atherosclerosis is hyperlipidemia.[31]

Although L-T4 treatment exerts some beneficial effects, there is no available data regarding the impact of therapy on metabolic outcomes in SH children.[25, 30]

The mechanism of how thyroid hormones can affect lipid profile is not completely clear, but thyroid hormones reduce apoB lipoproteins via a non-LDLR pathway that leads to decreased liver apoB production.[32]

Although it is generally believed that thyroid hormones and their synthetic derivatives known as thyromimetics, can reduce serum cholesterol by their ability to increase LDLRs but recent study showed that TH and thyroid hormone receptor-β selective agonists GC-1
and KB2115 are able to reduce serum cholesterol by inducing Cyp7a1 expression and stimulating the conversion and excretion of cholesterol as bile acids.[33].

The advantage of our study relative to other studies is that a large number of subclinical hypothyroid children are included and also this is a cross sectional prospective study. Most of the other studies on relation of TSH and serum lipid concentration are case control studies spanning several years.

**Conclusion**

From this study, it can be concluded that that high TG is the most common lipid disorder in SCH patient, followed by high non HDL-C. In addition, by comparing the results of this study with other studies, it is evident that lipid disorder in SCH children does not have a specific pattern.

**Abbreviations**

TC, total cholesterol; LDL-C, low-density lipoprotein cholesterol; HDL-C, high-density lipoprotein cholesterol; Non-HDL-C, non-low-density lipoprotein cholesterol; TG, triglycerides; BMI, body mass index; TSH, thyroid stimulating hormone; FT4, free T4; CI, confidence interval; CDC, center for disease control and prevention.

**Declarations**

**Availability of data and materials:** The datasets used during the current study are available from the corresponding author on reasonable request.

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Contributions

AshH: Collected the data, performed data analysis, interpreted the data and wrote the manuscript AsaH: Designed the study, Involved in critical revision of the manuscript. All authors read and approved the final version of the manuscript.

Corresponding author: Correspondence to Asadollah Habib.

Ethics declarations

Ethics approval and consent to participate: Signed informed consent was obtained from all participants and or their parents. The study was approved by the Kazeroon Azad University of Medical Sciences research ethics committee. (reference 1398.125)

Consent for publication: Not applicable.

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References

1. Salerno M, Capalbo D, Cerbone M, De Luca F. Subclinical hypothyroidism in childhood — Current knowledge and open issues. Nat. Rev. 2016; 12: 734-46.

2. Canaris GJ, Manowitz NR, Mayor G, Ridgway EC 2000 The Colorado thyroid disease prevalence study. Arch Intern Med 160:526-534

3. Biondi B & Cooper DS. The clinical significance of subclinical thyroid disfunction. Endocrine Reviews 2008 29 76-131. (doi:10.1210/er.2006-0043)
4. Paoli-valeri M, Mamán-alvarado D, Jiménez-lópe V, Arias-ferreira A, Bianchi G, Aratabellabarba G. [Frequency of subclinical hypothyroidism among healthy children and those with neurological conditions in the state of Mérida, Venezuela]. Invest Clin. 2003;44(3):209-18.

5. Marras V, Casini MR, Pilia S et al. Thyroid function in obese children and adolescents. Horm. Res. Paediatr. 2010; 73: 193-7.

6. Reinehr T. Thyroid function in the nutritionally obese child and adolescent. Current Opinion in Pediatrics 2011 23 415-420.(doi:10.1097/MOP.0b013e328344c393)

7. Reinehr T, de Sousa G & Andler W. Hyperthyrotropinemia in obese children is reversible after weight loss and is not related to lipids. Journal of Clinical Endocrinology and Metabolism 2006 913088-3091. (doi:10.1210/jc.2006-0095)

8. McQuade C, Skugor M, Brennan DM, Hoar B, Stevenson C, Hoogwerf BJ. Hypothyroidism and moderate subclinical hypothyroidism are associated with increased all-cause mortality independent of coronary heart disease risk factors: a PreCIS database study. Thyroid : official journal of the American Thyroid Association. 2011;21(8):837-843.

9. Lervasi G, Molinaro S, Landi P, et al. Association between increased mortality and mild thyroid dysfunction in cardiac patients. Arch Intern Med. 2007;167(14):1526-1532.

10. Althaus BU, Staub JJ, Ryff-De Lèche A, Oberhänsli A, StähelinHB. LDL/HDL-changes in subclinical hypothyroidism: possible risk factors for coronary heart disease. Clin Endocrinol (Oxf) 1988;28:157-163.

11. Arem R, Rokey R, Kiefe C, Escalante DA, Rodriguez A. Cardiac systolic and diastolic function at rest and exercise in subclinical hypothyroidism: effect of thyroid hormone
12. Arinc H, Gunduz H, Tamer A, Seyfeli E, Kanat M, Ozhan H, Akdemir R, Uyan C. Tissue Doppler echocardiography in evaluation of cardiac effects of subclinical hypothyroidism. Int J Cardiovasc Imaging 2006;22:177-186. Epub 2005 Nov 2

13. Chen X, Zhang N, Cai Y, Shi J. Evaluation of left ventricular diastolic function using tissue Doppler echocardiography and conventional doppler echocardiography in patients with subclinical hypothyroidism aged <60 years: a meta-analysis. J Cardiol 2013;61:8-15. Epub 2012 Oct 18

14. Ochs N, Auer R, Bauer DC, Nanchen D, Gussekloo J, Cornuz J, Rodondi N 2008 Meta-analysis: subclinical thyroid dysfunction and the risk for coronary heart disease and mortality. Ann Intern Med 148:832–845.

15. Wu T, Flowers JW, Tudiver F, Wilson JL, Punyasavatsut N. Subclinical thyroid disorders and cognitive performance among adolescents in the United States. BMC Pediatr 2006;6:12.

16. Monzani F, Caraccio N, Siciliano G, Manca L, Murri L, Ferrannini E. Clinical and biochemical features of muscle dysfunction in subclinical hypothyroidism. J Clin Endocrinol Metab 1997;82:3315-3318.

17. Monzani F, Del guerra P, Caraccio N, et al. Subclinical hypothyroidism: neurobehavioral features and beneficial effect of L-thyroxine treatment. Clin Investig. 1993;71(5):367-71.

18. Monzani F, Pruneti CA, De negri F, et al. [Preclinical hypothyroidism: early involvement of memory function, behavioral responsiveness and myocardial contractility]. Minerva Endocrinol. 1991;16(3):113-8.

19. Pallas D, Koutras DA, Adamopoulos P, Marafelia P, Souvatzoglou A, Piperingos G, Moulopoulos SD 1991 Increased mean serum thyrotropin in apparently euthyroid
hypercholesterolemic patients: does it mean occult hypothyroidism? J Endocrinol Invest 14:743-746.6.

20. Asvold BO, Vatten LJ, Nilsen TIL, Bjoro T 2007 The association between TSH within the reference range and serum lipid concentrations in a population-based study. The HUNT Study. Eur J Endocrinol 156:181-186.

21. Bakker SJ, Ter maaten JC, Popp-snijders C, Slaets JP, Heine RJ, Gans RO. The relationship between thyrotropin and low density lipoprotein cholesterol is modified by insulin sensitivity in healthy euthyroid subjects. J Clin Endocrinol Metab. 2001;86(3):1206-11.

22. Meisinger C, Ittermann T, Tiller D, et al. Sex-specific associations between thyrotropin and serum lipid profiles. Thyroid. 2014;24:424-432.

23. Unal E, Akın A, Yıldırım R, Demir V, Yildiz İ, Haspolat YK. Association of Subclinical Hypothyroidism with Dyslipidemia and Increased Carotid Intima-Media Thickness in Children. J Clin Res Pediatr Endocrinol. 2017;9(2):144-149.

24. Witte T, Ittermann T, Thamm M, Riblet NB, Völzke H. Association between serum thyroid-stimulating hormone levels and serum lipids in children and adolescents: a population-based study of german youth. J Clin Endocrinol Metab. 2015;100(5):2090-7.

25. Cerbone M, Capalbo D, Wasniewska M, et al. Cardiovascular risk factors in children with long-standing untreated idiopathic subclinical hypothyroidism. J Clin Endocrinol Metab. 2014;99(8):2697-703.

26. Paoli-valeri M, Guzmán M, Jiménez-lópez V, Arias-ferreira A, Briceño-fernández M, Arata-bellabarba G. [Atherogenic lipid profile in children with subclinical hypothyroidism]. An Pediatr (Barc). 2005;62(2):128-34.

27. Dahl AR, Iqbal AM, Lteif AN, Pittock ST, Tebben PJ, Kumar S. Mild subclinical
hypothyroidism is associated with paediatric dyslipidaemia. Clin Endocrinol (Oxf). 2018;89(3):330-335.

28. Nader NS, Bahn RS, Johnson MD, Weaver AL, Singh R, Kumar S. Relationships between thyroid function and lipid status or insulin resistance in a pediatric population. *Thyroid: official journal of the American Thyroid Association*. 2010;20(12):1333-1339.

29. Habib A, Molayemat M, Habib A. Association of lipid profile and BMI Z-score in southern Iranian children and adolescents. *J Pediatr Endocrinol Metab*. 2019;32(8):827-835.

30. Çatlı G, Anık A, Ünver tuhan H, Böber E, Abacı A. The effect of L-thyroxine treatment on hypothyroid symptom scores and lipid profile in children with subclinical hypothyroidism. *J Clin Res Pediatr Endocrinol*. 2014;6(4):238-44.

31. Webber LS, Srinivasan SR, Wattigney WA, Berenson GS. Tracking of serum lipids and lipoproteins from childhood to adulthood. The Bogalusa Heart Study. *Am J Epidemiol*. 1991;133(9):884–99.

32. Goldberg IJ, Huang LS, Huggins LA, et al. Thyroid hormone reduces cholesterol via a non-LDL receptor-mediated pathway. *Endocrinology*. 2012;153(11):5143-9.

33. Lin JZ, Martagón AJ, Hsueh WA, et al. Thyroid hormone receptor agonists reduce serum cholesterol independent of the LDL receptor. *Endocrinology*. 2012;153(12):6136-44.

Tables
Table 1. Definition of lipid levels in children from the 2011 Expert Panel Integrated Guidelines for Cardiovascular Health and Risk reduction in Children and Adolescents

| Category | Acceptable mg/dL (mmol/L) | Borderline mg/dL (mmol/L) | High |
|----------|---------------------------|---------------------------|------|
| TC       | <170 (4.4)                | 170 to 199 (4.4 to 5.2)   | ≥200 (5.2) |
| LDL-C    | <110 (2.8)                | 110 to 129 (2.8 to 3.3)   | ≥130 (3.4) |
| Non-HDL-C| <120 (3.1)                | 120 to 144 (3.1 to 3.7)   | ≥145 (3.8) |
| TG       | <75 (0.8)                 | 75 to 99 (0.8 to 1.1)     | ≥100 (1.1) |

• Age 0 to 9 years
- Sex: Male (137 ± 27.3)
- Female (136 ± 25.7)

• Age 10 to 19 years
- Sex: Male (137 ± 27.3)
- Female (136 ± 25.7)

Abbreviations: TC, total cholesterol; LDL-C, low-density lipoprotein cholesterol; HDL-C, high-density lipoprotein cholesterol; Non-HDL-C, non-low-density lipoprotein cholesterol; TG, triglycerides

Table 2. Anthropometric characteristics of the study subjects.

| Category          | Euthyroid (666) | Subclinical Hypothyroid (181) | P value |
|-------------------|-----------------|------------------------------|---------|
| Age               | 9.96 ± 3.40     | 9.98 ± 3.28                  | 0.945   |
| Gender (Male)     | 42.8%           | 44.8%                        | 0.637   |
| Height (cm)       | 135.20 ± 19.48  | 137.16 ± 18.37               | 0.226   |
| Weight (kg)       | 38.66 ± 20.22   | 41.31 ± 19.44                | 0.116   |
| TSH (mIU/L)       | 2.52 ± 1.16     | 6.90 ± 1.52                  | <0.001* |
| FT4 (ng/dl)       | 1.40 ± 0.25     | 1.43 ± 0.26                  | 0.242   |
| BMI Z score       | 0.16 ± 1.84     | 0.55 ± 1.80                  | 0.012*  |
| BMI               | 19.76 ± 6.14    | 20.98 ± 7.39                 | 0.024*  |

Abbreviations: BMI, body mass index; TSH, thyroid stimulating hormone; FT4, free T4.

Table 3. Mean serum lipid profile components based on the subjects’ thyroid status.

| Category  | Total (847) | Age 2-10 (421) | Age 10-18 (426) |
|-----------|-------------|----------------|-----------------|
| TChol     | Euthyroid (666) | Subclinical Hypothyroid (181) | P |
| LDL-chol  | 160.50 ± 29.070 | 161.39 ± 28.694 | 0.713 | 161.66 ± 29.842 | 160.73 ± 26.664 | 0.782 | 159.38 ± 28.314 | 162.14 ± 30.971 | 0.431 |
| HDL-chol  | 90.96 ± 24.996 | 89.10 ± 23.852 | 0.369 | 92.54 ± 25.514 | 88.06 ± 21.540 | 0.119 | 89.46 ± 24.436 | 90.27 ± 26.302 | 0.788 |
| Non-HDL-chol | 47.94 ± 10.560 | 49.04 ± 10.361 | 0.211 | 48.62 ± 11.077 | 50.09 ± 10.910 | 0.253 | 47.29 ± 10.016 | 47.86 ± 9.630 | 0.637 |
| TG        | 112.35 ± 27.696 | 112.35 ± 28.136 | 0.929 | 113.04 ± 28.081 | 110.64 ± 27.266 | 0.459 | 112.09 ± 27.358 | 114.28 ± 29.107 | 0.515 |

Abbreviations: TChol, total cholesterol; LDL-c, low-density lipoprotein cholesterol; HDL-c, high-density lipoprotein cholesterol; Non-HDL-c, non-low-density lipoprotein cholesterol; TG, triglycerides
### Table 4. Distribution of lipid profile abnormality based on thyroid status and age.

|                  | Euthyroid (689) | Subclinical Hypothyroid (184) | Euthyroid (338) | Subclinical Hypothyroid (100) | Euthyroid (351) | Subclinical Hypothyroid (84) | P    |
|------------------|-----------------|-------------------------------|-----------------|-------------------------------|-----------------|-------------------------------|------|
| **TChol (mg/dL)**|                 |                               |                 |                               |                 |                               |      |
| Acceptable (<170)| 66.4%           | 65.7%                         | 0.915           | 63.7%                         | 65.6%           | 0.933                         | 0.672|
| Borderline-high (170-199) | 24.2%           | 23.8%                         | 0.882           | 27.1%                         | 26.0%           | 0.933                         | 0.636|
| High (>=200)     | 9.5%            | 10.5%                         | 0.923           | 9.2%                          | 8.3%            | 0.977                         | 0.56  |
| **LDL-cholesterol (mg/dL)** |              |                               |                 |                               |                 |                               |      |
| Acceptable (<110) | 81.2%           | 83.4%                         | 0.682           | 77.8%                         | 85.4%           | 0.268                         | 0.657|
| Borderline-high (110-129) | 12.3%           | 9.9%                          | 0.791           | 14.8%                         | 9.4%            | 0.031                         | 0.657|
| High (>=130)     | 6.5%            | 6.6%                          | 0.703           | 7.4%                          | 5.2%            | 0.031                         | 0.657|
| **HDL-cholesterol (mg/dL)** |              |                               |                 |                               |                 |                               |      |
| Acceptable (>45) | 56.9%           | 61.9%                         | 0.266           | 58.8%                         | 63.5%           | 0.205                         | 0.720|
| Borderline-low (40-45) | 19.8%           | 20.4%                         | 0.093           | 17.2%                         | 20.8%           | 0.223                         | 0.06  |
| Low (<40)        | 23.3%           | 17.7%                         | 0.138           | 24.0%                         | 15.6%           | 0.226                         | 0.06  |
| **Non-HDL-cholesterol (mg/dL)** |              |                               |                 |                               |                 |                               |      |
| Acceptable (<120) | 64.0%           | 62.4%                         | 0.661           | 64.6%                         | 63.5%           | 0.857                         | 0.213|
| Borderline-high (120-144) | 24.2%           | 23.2%                         | 0.215           | 21.5%                         | 24.0%           | 0.267                         | 0.224|
| High (>=145)     | 11.9%           | 14.4%                         | 0.103           | 13.8%                         | 12.5%           | 0.103                         | 0.165|
| **TG (mg/dL)**   |                 |                               |                 |                               |                 |                               |      |
| Acceptable (<75/90) | 41.0%           | 44.2%                         | 0.522           | 38.2%                         | 39.6%           | 0.967                         | 0.400|
| Borderline-high (75-99/90-129) | 26.7%           | 22.7%                         | 0.477           | 23.7%                         | 22.9%           | 0.296                         | 0.224|
| High (>=100/130) | 32.3%           | 33.1%                         | 0.682           | 38.2%                         | 37.5%           | 0.672                         | 0.400|

**Abbreviations:** TChol, total cholesterol; LDL-c, low-density lipoprotein cholesterol; HDL-c, high-density lipoprotein cholesterol; Non-HDL-c, non-low-density lipoprotein cholesterol; TG, triglycerides

### Table 5. Correlation of lipid profile components with serum TSH levels.

| Lipid Profile components | Correlation coefficient (r) | P value |
|--------------------------|-----------------------------|---------|
| TChol                    | 0.033                       | 0.331   |
| LDL-c                    | 0.015                       | 0.657   |
| HDL-c                    | 0.039                       | 0.257   |
| Non-HDL-c                | 0.020                       | 0.554   |
| TG                        | 0.019                       | 0.584   |

**Notes:** Data are given in r and P values. Correlation coefficient was assessed by partial correlation method. Adjusted for age, sex and BMI Z-score.

**Abbreviations:** TChol, total cholesterol; LDL-c, low-density lipoprotein cholesterol; HDL-c, high-density lipoprotein cholesterol; Non-HDL-c, non-low-density lipoprotein cholesterol; TG, triglycerides