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# TSH Levels in Turkish Adults: Prevalences and Associations With Serum Lipids, Coronary Heart Disease and Metabolic Syndrome

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**Abstract:** Overt hypothyroidism is implicated in atherosclerosis through dyslipidemia, hypertension, and hyperhomoscysteinemia. Epidemiological data related to the role of thyroid hormones in the risk of coronary heart disease (CHD) and metabolic syndrome (MS) in Turkish adults are lacking. Thyroid stimulating hormone (TSH) was measured in the 2004 follow-up of the Turkish Adult Risk Factor Study, with the aim of investigating thyroid hormone status as a possible risk factor in CHD and MS in the population sample. To this end, a subgroup of the cohort (512 men and women: mean age 52 ± 11.4) in whom the prevalences for CHD, MS and diabetes (DM) were 8.2%, 42.4% and 10.7%, respectively, were screened for TSH. The cohort was classified as hypo-, hyper- or euthyroid according to cutoffs of 4.2 and 0.3 μU/ml for TSH, respectively. No distinction was made between overt and subclinical thyroid states.

Total and LDL-cholesterol was lowest, but waist circumference unexpectedly highest in the hyperthyroid group. Women (1.3 μU/ml) had significantly higher ($P < 0.001$) TSH levels than men (0.95 μU/ml). The prevalence of hypo- and hyperthyoidism in men and women were 1.7%/7% and 4.4%/5%, respectively, and women overwhelmingly predominated the hypothyroid cases. TSH values did not significantly differ among groups diagnosed as or not CHD, MS, or DM. Log TSH was significantly correlated with total and LDL-cholesterol and, inversely, with alcohol usage. Multivariate linear regression analysis revealed total cholesterol as the sole independent covariate of TSH levels in men and both sexes combined. An increase by approximately one-third of the physiological TSH levels was associated with a 40 mg/dl-increase in total cholesterol concentrations. Age- and sex-adjusted TSH did not contribute to the risk of CHD, hypercholesterolemia, MS, or DM in logistic regression analyses.

To conclude, TSH levels were independently associated with total cholesterol concentrations but did not appear to be a risk factor for CHD or MS in the cohort studied. Following up the group prospectively may give a better understanding concerning the thyroid status and CHD risk in Turkish adults.

**Key Words:** Coronary disease risk; serum TSH; thyroid status

## Introduction

Hypothyroidisim is associated with cardiovascular risk (1,2). Log linear relation between free thyroxine (fT4) and thyroid stimulating hormone (TSH) makes TSH the first choice for diagnosis of thyroid dysfunction (3). Subclinical excess or deficiency of thyroid hormones can be diagnosed only by serum levels of TSH. Hypothyroidism prevalence is reported as 1-10% in adults (4) and can reach 20% (5) in the elderly, especially women. Subclinical dysthyroidism is defined by abnormal circulating TSH values in face of normal free thyroid hormone levels (5). Subclinical hypothyroidism,

characterized by modifications in cardiovascular and neuromuscular functions and lipid metabolism, may be the first phase or beginning of a progressive disease state (6,7). Small changes in thyroid function tests within the reference range influence the severity of atherosclerosis (1). In thyroid defiency, hypertension together with dyslipidemia accelerate atherosclerosis (8). Both hypothyroidism and subclinal hypothyoidsm are associated with hyperhomocyteinemia, endothelial dysfunction, left ventricular dysfunction and mild inflammation characterized by elevated C-reactive proten (CRP) levels, and defective coagulation (9,10). The similarities in cardiovascular anomaly pattern in HT and SCHT imply that even small deficiencies in thyroid hormones may have effects on the cardiovascular system. Studies also exist (11-13) that found no associations between SCTH and cardiovacular events and lipid profiles. The basic reason for conflicting results is the gradual decline in TSH upper reference limit over the last two decades from ~ 10 to ~4.0-4.5 μU/ml.

Low TSH levels also have effects on the cardiovascular system (14). Even a single measurement of low TSH in individuals aged 60 or older was associated with mortality from all causes and, particularly, cardiovascular disease (15).

We aim in this paper to report in a limited population sample of just over half of Turkey's population a) the prevalences of surrogates of hypo- or hyperthyroidism, b) the associations of TSH levels with cardiovascular risk factors as well as with coronary heart disease (CHD) and metabolic syndrome (MS).

## Material and Methods

### Population sample

TSH was measured in 512 men and women within the cohort of the 2004 follow-up of the *Turkish Adult Risk Factor Study* conducted in the Aegean, Mediterranean, East and Southeast Anatolia and Black Sea regions. Participants were 34 years of age or older. The survey was representatively stratified for sex, age, geographical regions and for rural-urban distribution. Informed consent was obtained from each individual, and the survey conformed to the principles embodied in the Declaration of Helsinki. Data were obtained by history of the past years via a questionnaire, physical examination of the cardiovascular system and recording of a resting electrocardiogram (ECG) (16).

Identification of MS conformed to the definition used by the NCEP guidelines (17), namely when 3 or more of the following 5 risk determinants were present: waist circumference (men >102 cm, women >88 cm), triglycerides ≥150 mg/dl, HDL-cholesterol (men <40, women <50 mg/dl), blood pressure (≥130/≥85 mmHg), and fasting glucose ≥110 mg/dl.

### Measurement of risk factors and validation

Blood pressure was measured twice in the sitting position on the right arm using a sphygmomanometer (Erka), after at least 5 minutes of rest. Readings were recorded to the nearest even number, and the mean of two recordings 3 min apart was computed. Waist circumference was measured - with the subject standing and wearing only underwear, at the level midway between the lower rib margin and the iliac crest, while that of the hip was measured at the level of the great trochanters. Body mass index (BMI) was calculated by the computer as weight divided by height squared ($kg/m^2$). In regard to cigarette smoking, nonsmokers, past smokers and current smokers formed the categories.

Plasma concentrations of cholesterol, fasting triglycerides, HDL-cholesterol (HDL-C) and glucose were determined by the enzymatic Roche kits, uric acid by Infinity kits, γ-glutamyl transferase (GGT) by Thermo Trace kinetic kit, and phospholipids by WAKO phosholipid B kit using Hitachi 902 autoanalyzer. TSH and insulin were measured by chemiluminescence immunoassay "ECLIA" method utilising Elecsys 1010 immunautoanalyzer. Concentrations of apo A-I, apo B, hs-CRP and complement C3 were measured by means of particle-enhanced immunonephelometry with the Behring nephelometer method using N Latex CRP mono reagent (Behring Diagnostics). Within run and day to day CV for TSH were 3.4/3.2% and 5.0/4.2%, respectively, and <1.7 and 2.4% for biochemistry parameters on Hitachi, < 3.1 and 4.4% for the blood proteins measured with the nephelometer, respectively, for the two-level control sera. The laboratory was a member of an external quality control program. Mean values given for concentrations of TSH, GGT and CRP are geometric means calculated from the log-transformed distribution.

Individuals with diabetes mellitus or impaired fasting glucose were identified by self report or by adhering to the criteria of the American Diabetes Association (18). LDL-cholesterol values were computed according to the Friedewald formula (19).

TSH reference limits were taken as 0.3 and 4.2 μU/ml, as provided by the manufacturing firm. Values within the limits were evaluated as euthroid whereas those above 4.2 μU/ml as hypothyroid, and below 0.3 μU/ml as hyperthyroid. Becuase fT4 levels were not measured, we made no distinction between subclinical and overt thyroid dysfunction. Participants were questioned about acute or chronic diseases and medications. None reported having used medications (glucocorticoids or dopamine) that decreased or (amiodarone or lithium) increased TSH (3).

*Diagnosis of* CHD was based on the presence of angina pectoris, a history of myocardial infarction with or without accompanying Minnesota codes of the ECG (20), or a history of myocardial revascularization. Retrosternal or precordial distress coming on exertion, lasting 2-15 minutes and relieved by rest was designated as typical angina, while in the absence of the last feature this was considered as atypical angina. Among women typical angina before 45 years and atypical angina at any age precluded the diagnosis. Isolated typical angina in women and atypical angina in men were considered as suspect diagnosis. These criteria resulted in the fact that ECG changes of "ischemic type" of greater than minor degree (Codes 1.1-2, 4.1-2, 5.1-2, 7.1) were associated in over three-fifths of all patients. A cerebrovascular accident (CVA) was diagnosed when a new stroke occurred, or when death followed such an event.

Anyone consuming alcohol once a month or more were evaluated as alcohol users. Smokers were classified as nonsmokers, past or current smokers. Physical activity was classified as 1. white collar worker, sewing or knitting, 1 km daily walk 2-repair worker 1-2 km daily walk , 3-carpenter, floor and window cleaning, truck driving, 4 km daily walk, 4- heavy work, farming and regular sports activity .

Venous blood was centrifuged at 3000 rpm for 15 minutes to separate within one hour from its cells to obtain sera. Sera were sent to İstanbul on ice packs and kept at -80° C until the day of measurements. Measurements were made at Yildiz Technical University Medical Center Laboratory.

### Data analysis

The independent associations between risk variables and CVD were evaluated by logistic regression. Relative risk estimates and 95% confidence intervals were obtained. Regression models were adjusted for confounding variables (age, sex, etc.). Due to the skewed distribution of TSH, CRP, fasting insulin and GGT values, these parameters were log-transformed for calculations. Two-sided t-tests and Pearson's chi-square tests were used to analyze the differences in proportions between groups at the last follow-up examination. A value of $P < 0.05$ was considered statistically significant. Univariate correlation analyses were performed according to Pearson. Multiple regression analyses of the data were carried out using SPSS-10 for Windows package.

## Results

Mean TSH values for genders and age groups are shown in Table 1. Median values (and interquartile intervals) for men were 1.05 (0.68-1.62) and for women 1.40 (0.84-2.22) μU/ml, respectively. Geometric mean TSH value for women (1.3 μU/ml) was significantly ($P < 0.001$) higher than that of men (0.95 μU/ml). Mean TSH values were not different either across geographic regions or between those younger or older than 60 years. Low, normal and high TSH prevalences in our cohort were 4.7%, 91%, and 4.4%, respectively. Women constituted 82.6 % of the hypothyroids. Seven percent of women, as contrasted to only 1.7% of men, were hypothyroid. In the high TSH group (hypothyroid, Group III) distribution of genders were significantly different ($P < 0.015$).

General characteristics of the low, normal, and high TSH groups are given in Table 2. Three groups were first compared with Kruskal Wallis analysis and then with Mann Whitney U test two by two, whenever a significant difference was found with the former. The only significantly different parameters were high waist-to-hip ratio and low total cholesterol and HDL-phospholipid in the low TSH (Group I) compared to the normal TSH group (II).

CHD, MS and DM were diagnosed in 42 ( 8.2%), 217 (42.4 %), 55 (10.7%) of the participants in this study (Table 3). Neither the TSH mean values, nor the prevalences of low or high TSH were significantly different in those who were diagnosed as CHD, MS, and DM or not. Smoking frequency was 13, 12.5, and 26% in the high, low, and normal TSH groups.

Correlations between the risk parameters and TSH were found in men only with total cholesterol ($r = 0.21$),

Table 1. TSH geometric mean values by gender and age groups in 512 Turkish adults (μU/ml)

| | Men | | | Women | | |
|---|---|---|---|---|---|---|
| Age groups | n | mean | SD | n | mean | SD |
| 34-49 | 107 | 0.95 | 2.31 | 133 | 1.37 | 2.4 |
| 50-59 | 61 | 1.08 | 1.91 | 67 | 1.42 | 2.86 |
| 60-69 | 43 | 0.76 | 4.36 | 49 | 1.14 | 3.2 |
| >70 | 28 | 1.01 | 2.65 | 24 | 1 | 3.43 |
| Total | 239 | 0.95 | 2.61 | 273 | 1.3 | 2.74 |

Table 2. General characteristics of the groups with low, normal, and high TSH levels

| | Group I<br>TSH<0.3 μU/ml<br>n = 24 | Group II<br>TSH:0.3-4.19 μU/ml<br>n = 465 | Group III<br>TSH:>4.2 μU/ml<br>n = 23 |
|---|---|---|---|
| Gender: women (%) | 12 (50) | 242 (52.0) | 19 (82.6) |
| Age (years) | 55.6 ± 11.7 | 51.9 ± 11.5 | 50.1 ± 10.1 |
| TSH* μU/ml | 0.06 ± 4.3 | 1.12 ± 1.8 | 7.54 ± 1.6 |
| Waist circumference (cm) | 100.1 ± 12.2 * | 95.4 ± 10.5 | 93.0 ± 10.5 |
| Waist/hip ratio | 0.98 ± 0.06*** | 0.94 ± 0.09 | 0.93 ± 0.07 |
| Body mass index (kg/m$^2$) | 30.7 ± 6.1 | 29.3 ± 4.5 | 29.0 ± 4.2 |
| Systolic BP (mmHg) | 130.1 ± 24.7 | 126.5 ± 20.6 | 121.6 ± 23.8 |
| Diastolic BP (mmHg) | 83.4 ± 12.3 | 80.9 ± 10.9 | 78.8 ± 13.2 |
| Total cholesterol (mg/dl) | 173.5 ± 39.0 * | 195.0 ± 44.5 | 197.2 ± 40.9 |
| HDL-cholesterol (mg/dl) | 41.2 ± 9.2 | 44.1 ± 12.2 | 44.8 ± 11.5 |
| LDL-cholesterol (mg/dl) | 101.3 ± 31.5 # | 113.7 ± 37.7 | 118.0 ± 34.7 |
| Triglycerides (mg/dl) | 134.6 ± 71.4 | 170.4 ± 109.6 | 160.0 ± 98.7 |
| Glucose (mg/dl) | 100.1 ± 22.4 | 103.8 ± 41.31 | 101.8 ± 27.21 |
| Uric acid (mg/dl) | 5.37 ± 1.97 | 5.2 ± 1.5 | 4.36 ± 1.36 |
| Gamma GT Ψ (U/l) | 27.7 ± 2.5 | 20.2 ± 1.8 | 18.2 ± 2.0 |
| Total phospholipids (mg/dl) | 200.3 ± 50.5 | 211.1 ± 42.1 | 209.3 ± 36.0 |
| HDL-phospholipids (mg/dl) | 112.2 ± 19.6** | 138.4 ± 35.8 | 146.0 ± 39.1 |
| hs-C-reactive protein (mg/L) | 2.57 ± 3.16 | 2.46 ± 2.88 | 2.46 ± 2.95 |
| Apolipoprotein A-I (mg/dl) | 157.6 ± 43.5 | 137.9 ± 31.4 | 131.7 ± 18.2 |
| Apolipoprotein B (mg/dl) | 106.4 ± 22.2 | 106.1 ± 30.9 | 94.7 ± 25.9 |
| Complement C3 (g/L) | 1.44 ± 0.3 | 1.35 ± 0.33 | 1.36 ± 0.28 |
| Fasting insulin Ψ (μU/ml) | 8.12 ± 1.74 | 8.31 ± 1.95 | 9.12 ± 2.29 |
| Fibrinogen (g/L ) | 3.30 ± 0.54 | 3.36 ± 1.04 | 3.17 ± 0.98 |
| Coronary heart disease (%) | 12.5 | 7.7 | 13.0 |
| Metabolic syndrome (%) | 54.2 | 41.7 | 43.5 |
| Diabetes mellitus (%) | 4.2 | 11.4 | 4.4 |

BP: blood pressure, HDL: high-density lipoprotein, LDL: low-density lipoprotein

Ψ: log transformed values

significant difference between the related group and group II: * ($P < 0.05$), ** ($P < 0.01$), ***($P < 0.001$),

# ($p = 0.086$)

Table 3. TSH geometric means and prevalence rates of low, normal and high TSH in groups with or without coronary heart disease, metabolic syndrome or diabetes

| | N | TSH Mean ± SD | low TSH <0.3 U/L (%) | normal TSH 0.3-<4.2 (%) | high TSH ≥4.2 U/L (%) |
|---|---|---|---|---|---|
| Men | 239 | 0.96 ± 2.61* | 5 | 93.3 | 1.7 |
| Women | 273 | 1.30 ± 2.75 | 4.4 | 88.6 | 7.0 # |
| CHD present | 42 | 1.04 ± 3.38 | 7.2 | 85.7 | 7.1 |
| CHD absent | 470 | 1.13 ± 2.65 | 4.5 | 91.3 | 4.3 |
| MS present | 217 | 1.12 ± 3.17 | 6 | 89.4 | 4.6 |
| MS absent | 295 | 1.13 ± 2.39 | 3.7 | 91.9 | 4.4 |
| Diabetes present | 55 | 1.08 ± 2.28 | 1.8 | 96.4 | 1.8 |
| Diabetes absent | 457 | 1.13 ± 2.77 | 5 | 90.2 | 4.8 |

* P < 0.001 ; with # Chi square test p = 0.015
CHD:coronary heart disease, MS:metabolic syndrome

LDL-cholesterol (r = 0.21) and, inversely, with alcohol usage (r = -0.15) (Table 4). No correlation existed between age or smoking status and log TSH in either gender. Total cholesterol (r = 0.004) and, inversely, alcohol intake status (r = -0.196) were obtained as the only two significant independent predictors of TSH in multivariate linear regression analyses in adults or men (Table 5); no independent covariate of TSH was found for women. Our finding of the multivariate analysis implied that a 40 mg/dl (1 SD of total cholesterol) increase in total cholesterol corresponded to a 0.32 µU/ml-increase (1/3 of the physiological level) in TSH values. A model which included age, waist circumference, diastolic blood pressure, and GGT was also significant but could explain only 3% of the TSH variance.

Age- and gender-adjusted TSH elevations (>4.2 µU/ml) did not contribute to the risk of hypercholesterolemia (>200 mg/dl), CHD, or MS by logistic regression analyses (Table 6).

## Discussion

Lacking population-based data in regard to thyroid function status and its relation with CHD and its risk factors among Turkish adults, thyroid function was assessed by TSH measurement in this cross-sectional study. The TSH method used, having a functional sensitvity of <0.020 µU/ml, was suitable for screening for primary hypo- or hyperthyroidism, whether overt or subclinical (3). Main findings of our study were prevalences of hypo- or hyperthyroidism ranging around 4-5%, a 4-fold higher prevalence of hypothyroidism in women than in men, significant independent associations of TSH with total cholesterol and alcohol abstinence, and lack of association with CHD of (gender- and age-adjusted) high TSH levels.

No distinction was made between subclinical and overt thyroid status in our study group because free T4 was not measured. Adult hypothyroidism overwhelmingly (>99%) stems from primary thyroid insufficiency, a

Table 4. Significant correlations of TSH with risk factors

| | Men + women | | Men | | Women | |
|---|---|---|---|---|---|---|
| | r | p | | p | | p |
| Total cholesterol (mg/dl) | 0.172 | 0.000 | 0.211 | 0.001 | 0.104 | 0.087 |
| LDL-cholesterol (mg/dl) | 0.168 | 0.000 | 0.208 | 0.002 | 0.107 | 0.080 |
| Alcohol usage (0-3) | -0.137 | 0.002 | -0.148 | 0.024 | -0.008 | 0.899 |

Table 5. Determinants of serum TSH by multiple linear regression (n = 456)

| | Adults | | | Men | | | Women | | |
|---|---|---|---|---|---|---|---|---|---|
| | β coeffic. | SE | p | β coeffic. | SE | p | β coeffic. | SE | p |
| Age | - 0.005 | 0.008 | 0.566 | 0.005 | 0.009 | 0.570 | -0.009 | 0.014 | 0.528 |
| Waist circumference (cm) | -0.009 | 0.009 | 0.284 | -0.008 | 0.009 | 0.384 | -0.010 | 0.014 | 0.395 |
| Total cholesterol (mg/dl) | 0.005 | 0.002 | 0.013 | 0.007 | 0.002 | 0.004 | 0.002 | 0.003 | 0.482 |
| DBP (mm Hg) | 0.012 | 0.009 | 0.172 | 0.007 | 0.010 | 0.471 | 0.015 | 0.014 | 0.280 |
| Log gamma GT (U/L) | -0.391 | 0.347 | 0.259 | -0.462 | 0.402 | 0.252 | 0.088 | 0.570 | 0.877 |
| Alcohol usage (0-3) | -0.284 | 0.152 | 0.062 | -0.167 | 0.124 | 0.178 | -0.183 | 0.587 | 0.755 |

Model was significant for adults and men (p = 0.024 and p = 0.047, respectively); explained 6% of variance in men.

Table 6. Odds ratio of age- and gender-adjusted TSH for prevalent coronary heart disease and hypercholesterolemia (compared to normal or low TSH values [n = 510])

| | Coronary heart disease | | | | Hypercholesterolemia | | | |
|---|---|---|---|---|---|---|---|---|
| Adults | β | OR | p | 95% CI | β | OR | p | 95% CI |
| Age (years) | 0.097 | 1.102 | 0.000 | 1.067; 1.14 | 0.029 | 1.029 | 0.000 | 1.013; 1.046 |
| Gender(M) | -0.298 | 0.742 | NS | | 0.625 | 1.867 | 0.001 | 1.29; 2.70 |
| TSH (>4.2 µU/ml) | 1.013 | 2.754 | 0.151 | 0.691; 11.0 | -0.008 | 0.992 | NS | |

Model included 512 men and women and 42 coronary heart disease patients
Model included 512 men and women and 96 hypercholesterolemic (>200 mg/dl) individuals
CI: confidence interval, M: males

disorder which is usually accompanied by above-normal TSH levels (3,4).

The limit for an upper reference range for TSH has declined from ~10 to 20 µU/ml to ~4 µU/ml in the last two decades (3,4). Mean TSH levels in populations with sufficient iodide intake are around 1.5 µU/ml, and the reference range is often given as 0.4-4.0 µU/ml. The American Association of Clinical Endocrinologists, in their 2002 Guidelines, has recommended 0.3-3.0 µU/ml as the target range for TSH levels (12).

Different reference ranges accepted in different studies have led to conflicting findings and prevalence data (21-23). Hypothyroidism is a common disorder with a prevalence ranging from 1 to 10% of the adult population with increasing frequency in women and the elderly, while that of subclinical hypothyroidism reaches 20% in persons beyond 60 years of age.

Hypothyroidism accounts for 80% of all thyroid dysfunctions. In our cohort, it was 4 times more prevalent in women than in men. This is in agreement with the knowledge that the likelihood of a diagnosis of thyroid dysfunction is 3-10 times higher in women (5).

Although 43% of the hypothyroid group was hypercholesterolemic (>200 mg/dl), the prevalence of hypothyroidism was not different in the hypercholesterolemic group (4.9%) from that of the whole group. In men, however, total cholesterol increased significantly as TSH levels rose, independently of age and other risk parameters investigated. An increase by approximately one-third of the physiological TSH levels was associated with a 40 mg/dl-increase (about one-fifth) in total cholesterol concentrations, independent of several other risk variables. This is a salient finding of the present study reflecting the dimension of interrelationship between levels of TSH and total cholesterol.

It is known that hypothyroidism can contribute to a 50%-increase in total cholesterol levels (24) and dispose apoE2 allele carriers to a type III dyslipidemia especially in obese hypothyroid individuals (25). Thyroid hormones

affect lipoprotein metabolism through their effects on cholesterol ester transfer protein, hepatic lipase, lipoprotein lipase, and HMG CoA reductase (26). Both fatty acids and LDL oxidation promotes hypothyroidism (27).

In a study conducted on 300 dyslipidemic Turkish men and women, prevalences of SCHT and HT were found as 10.6% and 2.6%, respectively. In combined hiperlipidemia these ratios inreased to 16.2% and 7.5%, respectively (28). Dyslipidemia was detected in 91.4% of the 268 overt hypothroid patients in a study of the Mayo Clinic (29). In SCHT patients, however, no increase in basal total cholesterol was found in a large study with over 1000 SCHT and 5000 euthyroid controls (13). We observed no significant increase in total cholesterol concentrations in the hypothyroid group; by contrast total cholesterol and HDL-phospholipids were significantly lower in the hyperthyroid than in the euthyroid group.

It was reported in the NHANES Phase III survey that total cholesterol (but not LDL-cholesterol) was higher and HDL-cholesterol lower in SCHT patients, compared to euthyroid controls. In this study on 8222 adults past age 40 years, the TSH interval to define SCHT was taken as 6.7-14.9 μU/ml. Yet, after adjustments for age, ethnicity, gender and lipid lowering medication, SCHT was no longer associated with raised total cholesterol or triglycerides (12).

Hypothyroidism has been reported to contribute to CHD via hyperhomocysteinemia and hypercholesterolemia (30,31). Cardiovascular disease was recently reported to be predicted by SCHT in men younger than 50 years of age, in whom elevation in plasma triglycerides and low-grade inflammation were associated; the disease being 3.4 times higher, compared to euthyroid men (32). SCHT may be associated not only with ischemic events but also with all-cause mortality (33).

An inverse correlation of TSH levels with alcohol intake was disclosed in men and in adults as a whole. Despite becoming attenuated in a linear regression model that included age, total cholesterol, waist circumference, diastolic blood pressure and serum GGT, the independent association of alcohol consumption retained a borderline significance ($p = 0.062$), except when gender was also added to the adult model. Evidence was shown for a flattening effect of high-dose alcohol intake on the nocturnal TSH secretion and modification of its circadian rhythm (34). It would be of interest to investigate the effect of alcohol in a larger group in our future surveys.

The lack of associations in this study between smoking status or age and TSH levels may result from a small sample size, since smoking has been noted to be associated with higher TSH levels and lower fT4, and thyroid dysfunction is known to increase with age, especially in women (3).

To conclude, the prevalence of hypothyroidism was 7% in women and 1.7% in men with TSH when an upper reference limit was considered as 4.2 μU/ml. TSH correlated significantly and independently with total cholesterol, and at a borderline significance, inversely, with alcohol intake. TSH did not contribute to CHD, MS, or DM, probably due to a small sample size. TSH measurements do not justify screening for thyroid function with the purpose of preventive action in the general population, but only in individuals at high-risk for hypothyroidism (including those above middle age).

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