Triiodothyronine is Independently Associated with Metabolic Syndrome in Euthyroid Middle-aged Subjects

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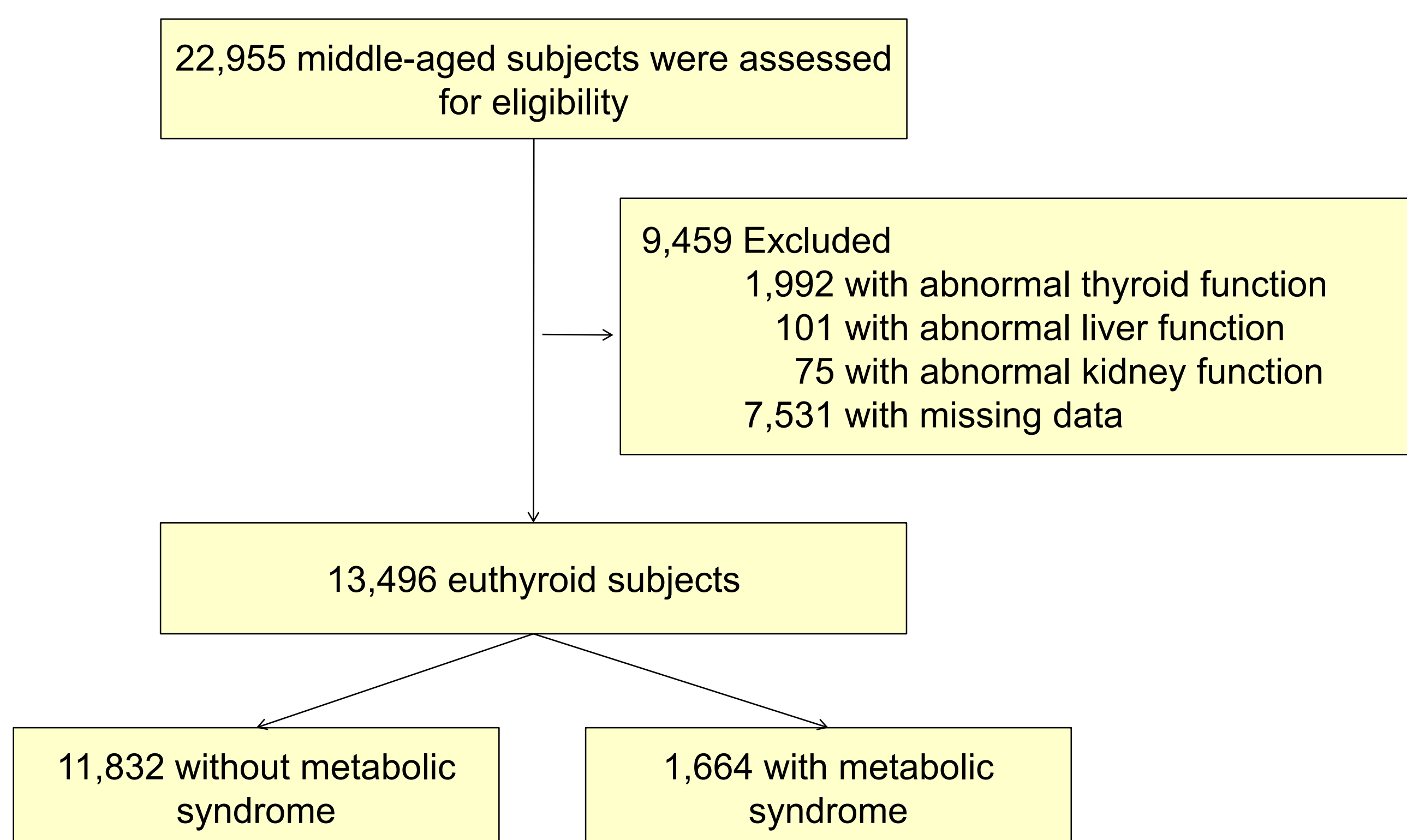[2]Division of Endocrinology and Metabolism, Department of Medicine, Samsung Medical Center, Sungkyunkwan University School of Medicine

INTRODUCTION

Recent studies have shown associations of thyroid hormone levels with metabolic syndrome (MetS) among euthyroid individuals though there have been some inconsistencies. We evaluated the relationships between thyroid hormones and MetS components in euthyroid middle-aged subjects in a large cohort.

METHODS

Retrospective analysis of 13,496 euthyroid middle-aged subjects who participated in comprehensive health examinations was performed.

22,955 middle-aged subjects were assessed for eligibility

9,459 Excluded
1,992 with abnormal thyroid function
101 with abnormal liver function
75 with abnormal kidney function
7,531 with missing data

13,496 euthyroid subjects

11,832 without metabolic syndrome

1,664 with metabolic syndrome

RESULTS

Baseline characteristics of study subjects.

Variables	Metabolic syndrome No (n=11,832)	Metabolic syndrome Yes (n=1,664)	p value	Overall (N=13,496)
Male	6,852 (58%)	1,316 (79%)	<0.001	8,168 (61%)
Age (years)	50.5 ± 6.6	52.3 ± 6.5	<0.001	50.7 ± 6.6
Smoking (current/former/never) (%)	17/29/54	27/37/36	<0.001	19/30/51
BMI (kg/m^2)	23.4 ± 2.6	26.5 ± 2.4	<0.001	23.8 ± 2.7
Overweight (25≤BMI<30)	2,784 (24%)	1,258 (76%)	<0.001	4,042 (30%)
Obesity (BMI≥30)	134 (1%)	109 (7%)	<0.001	243 (2%)
Body fat (%)	23.3 ± 6.1	25.7 ± 5.7	0.004	23.6 ± 6.1
Male	20.2 ± 4.4	23.8 ± 4.1	<0.001	20.8 ± 4.5
Female	27.7 ± 5.4	33.1 ± 4.9	<0.001	28.0 ± 5.5
Abdominal fat (%)	0.88 ± 0.06	0.93 ± 0.06	<0.001	0.88 ± 0.06
Male	0.89 ± 0.06	0.93 ± 0.05	<0.001	0.90 ± 0.06
Female	0.85 ± 0.06	0.91 ± 0.06	<0.001	0.86 ± 0.06
Systolic BP (mmHg)	109.9 ± 14.2	121.0 ± 15.3	<0.001	111.3 ± 14.8
Diastolic BP (mmHg)	67.7 ± 9.8	74.4 ± 10.0	<0.001	68.5 ± 10.0
Total cholesterol (mg/dL)	188.0 ± 30.7	191.9 ± 33.2	<0.001	188.5 ± 31.0
LDL cholesterol (mg/dL)	122.8 ± 27.9	125.4 ± 29.9	0.001	123.1 ± 28.2
HDL cholesterol (mg/dL)	59.4 ± 13.5	47.3 ± 10.9	<0.001	57.9 ± 13.8
Male	55.5 ± 11.9	47.2 ± 11.3	<0.001	54.2 ± 12.2
Female	64.8 ± 13.8	47.7 ± 9.2	<0.001	63.6 ± 14.2
Triglycerides (mg/dL)	114.7 ± 63.9	214.0 ± 102.5	<0.001	126.9 ± 77.1
Fasting glucose (mg/dL)	87.5 ± 12.9	103.7 ± 23.8	<0.001	89.5 ± 15.6
HbA1c (%)	5.3 ± 0.5	5.9 ± 0.9	<0.001	5.4 ± 0.6
HOMA-IR	1.9 ± 0.9	2.9 ± 1.5	<0.001	2.1 ± 1.1
TSH (mU/L)	2.4 ± 1.3	2.3 ± 1.3	0.017	2.3 ± 1.3
T3 (nmol/L)	1.72 ± 0.28	1.78 ± 0.29	<0.001	1.72 ± 0.28
T4 (nmol/L)	108.6 ± 17.9	108.3 ± 18.4	0.521	108.6 ± 17.9
T3 to T4 ratio	0.016 ± 0.003	0.017 ± 0.003	<0.001	0.016 ± 0.003

BMI, body mass index; BP, blood pressure; HDL, high-density lipoprotein; LDL, low-density lipoprotein; HOMA-IR, homeostasis model assessment of insulin resistance.

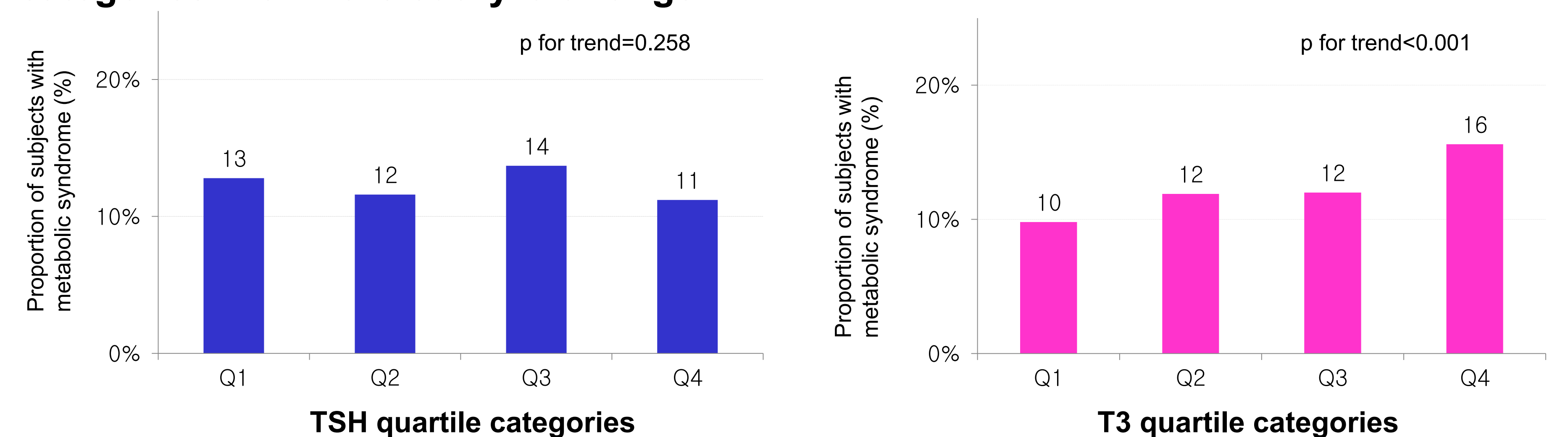### Means for thyroid hormone levels by select metabolic syndrome components.

Variables	n (%)	Thyroid hormones TSH (mU/L)	T3 (nmol/L)	T4 (nmol/L)	T3 to T4 ratio
BMI (kg/m^2)					
Underweight (<18.5)	219 (2%)	2.6 ± 1.3*a	1.67 ± 0.28*a	109.7 ± 17.4‡*a	0.015 ± 0.003*a
Normal (18.5-24.9)	8,992 (66%)	2.4 ± 1.3*a	1.71 ± 0.28*b	108.8 ± 17.9‡a,b	0.016 ± 0.003*b
Overweight (25-29.9)	4,042 (30%)	2.2 ± 1.2*b	1.75 ± 0.28*c	108.0 ± 17.9‡a,c	0.017 ± 0.003*c
Obesity (≥30)	243 (2%)	2.2 ± 1.2*b	1.79 ± 0.26*d	110.9 ± 20.0‡a,b	0.017 ± 0.003*c
Systolic BP (mmHg)					
<130	10,272 (76%)	2.3 ± 1.3	1.71 ± 0.28*	108.3 ± 17.8*	0.016 ± 0.003†
≥130	3,224 (24%)	2.3 ± 1.3	1.76 ± 0.29*	109.7 ± 18.3*	0.017 ± 0.003†
Diastolic BP (mmHg)					
<85	10,756 (80%)	2.3 ± 1.3	1.71 ± 0.28*	108.3 ± 17.8*	0.016 ± 0.003‡
≥85	2,739 (20%)	2.3 ± 1.3	1.76 ± 0.29*	109.9 ± 18.5*	0.017 ± 0.003‡
HDL cholesterol (mg/dL)					
low	1,555 (12%)	2.5 ± 1.3*	1.68 ± 0.28*	108.8 ± 17.7	0.016 ± 0.003*
high	11,941 (88%)	2.3 ± 1.3*	1.73 ± 0.28*	108.6 ± 17.9	0.017 ± 0.003*
Triglycerides (mg/dL)					
<150	9,966 (74%)	2.3 ± 1.3	1.70 ± 0.28*	108.8 ± 17.9	0.016 ± 0.003*
≥150	3,530 (26%)	2.4 ± 1.3	1.80 ± 0.28*	108.1 ± 18.1	0.017 ± 0.003*
Fasting glucose (mg/dL)					
<100	11,484 (85%)	2.4 ± 1.3*	1.72 ± 0.28*	108.6 ± 17.8	0.016 ± 0.003*
≥100	2,012 (15%)	2.2 ± 1.2*	1.75 ± 0.29*	108.6 ± 18.6	0.017 ± 0.003*
HbA1c (%)					
<5.7	10,636 (79%)	2.4 ± 1.3‡a,b	1.72 ± 0.28*a	108.5 ± 17.8†a	0.016 ± 0.003*a
5.7-6.4	1,992 (15%)	2.3 ± 1.3‡a,b	1.75 ± 0.29*b	108.6 ± 17.8†a	0.017 ± 0.003*b
≥6.5	868 (6%)	2.2 ± 1.3‡b,c	1.73 ± 0.30*a	110.4 ± 19.6†b	0.016 ± 0.003*a

BMI, body mass index; BP, blood pressure; HDL, high-density lipoprotein.

*p<0.001, †0.001≤p<0.01, ‡0.01≤p<0.05.

a,b,c,dThe same letters indicate non-significant difference between groups based on Tukey's multiple comparison test.

The proportion of subjects with metabolic syndrome by thyroid hormone quartile categories within the euthyroid range.

Risk of metabolic syndrome in euthyroid subjects according to hormone quartiles.

Thyroid hormone categories	Metabolic syndrome/ Total n (%)	OR (95% CI) Model 1	Model 2	Model 3
TSH quartiles				
0.4-1.4 mU/L	481/3,744 (13%)	1.000	1.000	1.000
1.5-2.1 mU/L	395/3,414 (12%)	0.888 (0.747-1.055)	0.919 (0.772-1.095)	0.926 (0.727-1.178)
2.2-3.0 mU/L	423/3,085 (14%)	1.078 (0.909-1.279)	1.170 (0.983-1.391)	1.245 (0.982-1.577)
3.1-5.0 mU/L	365/3,253 (11%)	0.857 (0.719-1.023)	1.016 (0.848-1.217)	1.134 (0.887-1.452)
T3 quartiles				
1.10-1.51 nmol/L	323/3,307 (10%)	1.000	1.000	1.000
1.52-1.69 nmol/L	403/3,373 (12%)	1.254 (1.074-1.464)†	1.217 (1.040-1.424)‡	1.025 (0.829-1.268)
1.70-1.89 nmol/L	415/3,470 (12%)	1.255 (1.076-1.464)†	1.169 (1.001-1.366)‡	1.000 (0.809-1.235)
1.90-2.90 nmol/L	523/3,346 (16%)	1.712 (1.476-1.984)*	1.570 (1.351-1.824)*	1.249 (1.020-1.529)†
T4 quartiles				
64.0-96.0 nmol/L	481/3,631 (13%)	1.000	1.000	1.000
96.1-107.0 nmol/L	390/3,387 (12%)	0.852 (0.716-1.014)	0.870 (0.730-1.038)	0.867 (0.685-1.097)
107.1-119.5 nmol/L	354/3,153 (11%)	0.828 (0.693-0.990)†	0.814 (0.680-0.975)†	0.746 (0.582-0.956)†
119.6-155.0 nmol/L	439/3,325 (13%)	0.996 (0.841-1.180)	0.942 (0.794-1.119)	0.890 (0.706-1.121)
T3 to T4 ratio quartiles				
0.0060-0.0140	333/3,379 (10%)	1.000	1.000	1.000
0.0141-0.0159	375/3,406 (11%)	1.132 (0.936-1.368)	1.132 (0.934-1.371)	1.097 (0.843-1.428)
0.0160-0.0179	428/3,329 (13%)	1.350 (1.122-1.624)*	1.358 (1.126-1.638)*	1.275 (0.988-1.646)
0.0180-0.0565	528/3,382 (16%)	1.692 (1.416-2.022)*	1.616 (1.349-1.936)*	1.458 (1.141-1.863)*

Model 1, unadjusted; Model 2, adjusted for sex and age;
Model 3, adjusted for sex, age, body fat percentage, smoking and HOMA-IR.
*p<0.001, †0.001≤p<0.01, ‡0.01≤p<0.05.

CONCLUSION

Serum T3 levels are independently associated with MetS in euthyroid middle-aged subjects.

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