

Article

Profiles of Thyroid Hormones in the Overweight Boys of District Rawalpindi, Punjab, Pakistan

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ABSTRACT: We must understand hormonal pathways to solve the global problem of overweight children and adolescents. This study examines the relationship between thyroid hormone levels and body weight in Rawalpindi boys, where childhood obesity/BMI is more prevalent. Thyroid function and body weight have been linked in a few studies. In this case-control study, we recruited 166 boys (both normal and Obese) aged 5-15 from hospitals in District Rawalpindi, Pakistan. Heparinized syringes collected 1.5 ml antecubital blood samples from each subject. Blood plasma was immediately centrifuged following standard procedures and frozen at -20 °C. ELISA measured T3, T4, and TSH levels. A family history of Obesity or other endocrine or chronic diseases disqualified participants. Overweight boys had lower tri-iodothyronine (T3) levels than normal-weight boys ($p < 0.05$). Ordinary boys' T3 levels rose from 5 to 10 years old. Overweight boys had lower T3 levels than normal-weight 9–15-year-olds ($p < 0.05$). From 5 to 7, 9 to 11, and 15 years old, overweight boys had lower tetra iodothyronine (T4) levels than normal-weight males ($p < 0.05$). Chubby boys had higher TSH levels at 9, 11, and 13–15 than normal-weight males ($p < 0.05$). TSH correlated positively with body weight, while T3 and T4 correlated negatively. TSH linked with BMI, while T3 and T4 did not. This profile may explain overweight etiology. These findings can inform future research and interventions to address this serious public health concern in Rawalpindi and beyond.

Keywords: Thyroid disorders, Thyroid hormones, Overweight children, Obesity

Introduction:

Obesity and overweight status are significant concerns of medical science nowadays. Previous studies established an association of inappropriate weight gain with various interoceptive (genome, hormonal imbalance, age, etc.) and exteroceptive (diet, physical activities, etc.) factors. In this regard, disorders of the thyroid hormones are also suspected of having implications in overweight (hypothyroidism) or underweight (hyperthyroidism) in rodents, adult human beings, and children [1]–[5]. Researchers reported that subclinical hypothyroidism is prevalent in obese adults and children (3.2–23%) [6].

The levels of thyroid hormones, i.e., thyroxine (T₄) and triiodothyronine (T₃), maintain the regular metabolic rate of the body [7], [8] by regulating the oxidation of lipids and carbohydrates, and appetite. Therefore, normal levels of thyroid hormones are necessary to maintain average body weight and composition [9]. Obesity has become a worldwide

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epidemic, and many complications are associated with it. Slight differences in thyroid functions leading to a risk of gaining weight and becoming obese have substantial implications [1]. Thyroid hormones increase weight in overweight children and adolescents, leading to cardiovascular, pulmonary, and puberty issues if not properly managed.

Extensive research has been conducted on adult subjects to uncover the elements contributing to weight increase. Still, implications of thyroid hormones malfunctioning have scarcely been studied in children at or before puberty. Therefore, we designed this study by hypothesizing that thyroid disorders are among the significant risk factors for weight gain in children and adolescents. The main objective of this study was to estimate profiles of thyroid hormones in normal and overweight children and adolescents and the effects on weight gain in overweight children and adolescents.

Materials and Methods:

The present case-control study included 166 (80 normal-weight and 86 overweight) boys of 5-15 years recruited from various hospitals in Rawalpindi, Pakistan, after approval.

Inclusion and exclusion criteria:

The boys included belonged to the same socioeconomic status and eating habits. Excluded from the study were participants with a history of Obesity in their family and those who suffered from any chronic diseases or endocrine disorders. The study included 86 participants who were overweight (their BMI was greater than 25 kg/m²) but had no other ailments simultaneously. The standard weight (BMI<25 kg/m²) of children and adolescents from the same population was taken as control.

Data and sample collection:

After the informed consent of the subject and guardian, the data on socioeconomic, general health, and lifestyle aspects were collected in a predefined questionnaire specially developed for the purpose. A portable Harpenden Stadiometer was utilized to measure standing height, and a digital weight scale was used to do the calculation necessary to determine BMI. A single blood sample (1.5ml) was collected from the antecubital vein of each of the subjects by using a heparinized syringe.

Hormonal analysis:

The blood samples were immediately transported in an icebox to the Endocrinology Laboratory in the Department of Zoology, Pir Mehr Ali Shah, Arid Agriculture University Rawalpindi. The plasma was separated by centrifugation and frozen at -20 °C. T3, T4, and TSH plasma concentrations were measured by direct Enzyme-Linked Immunosorbent Assay (ELISA) for each hormone (Amgenix, USA).

Statistical analysis:

The mean and standard errors (S.E.) were calculated and presented as tables and figures. Normal and overweight groups' hormonal data were compared using Student's t-test. Analysis of Variance (ANOVA) and then Duncan's Multiple Range Test (DMRT) were utilized to directly compare the hormone levels found in the various age groups. Pearson correlation and linear regression were also applied to parametric data. Every one of the tests used a two-way split-sample design, and the level of statistical significance was set at $p < 0.05$ [10].

Results:

The following results were documented in this investigation.

Characteristics of the study population:

The mean body weight of normal boys was 28.02 ± 1.01 kg, while 33.25 ± 0.21 kg in overweight boys. The body mass index (BMI) was 22.02 ± 0.28 kg/m² and 28.65 ± 0.70 kg/m² in the normal and overweight boys, respectively. Compared to boys of normal weight, those who were overweight showed significantly reduced mean concentrations of triiodothyronine (T₃) but not T₄. On the other hand, the mean concentrations of thyroid stimulating hormone (TSH) were not substantially ($p > 0.05$) lower in boys who had a normal weight as compared to those who were overweight. (Table 1).

Table 1. Characteristics of boys (Mean $\pm$ S.E.) included in the study

	Normal (n=80)	Overweight (n=86)
T ₃ (ng/ml)	$3.57 \pm 0.15^*$	2.21 ± 0.35
T ₄ (μ g/dl)	5.79 ± 0.30	5.29 ± 0.16
TSH (μ U/ml)	2.45 ± 0.46	2.92 ± 0.27
Weight (kg)	$28.02 \pm 1.01^*$	33.25 ± 0.21
BMI (kg/m ²)	$22.02 \pm 0.28^*$	28.65 ± 0.70

T₃: triiodothyronine; T₄: tetraiodothyronine; TSH: thyroid stimulating hormones.

*Values are significantly different at $\alpha=0.05$

Age-related thyroid hormone plasma concentrations in overweight and normal-weight boys:

According to the findings, the levels of T₃ in normally developing boys rose steadily at age five and continued to grow until they reached their highest point at age 10. A similar increasing pattern of T₃ levels was observed in overweight boys, but the peak levels were achieved at 15 (Fig. 1).

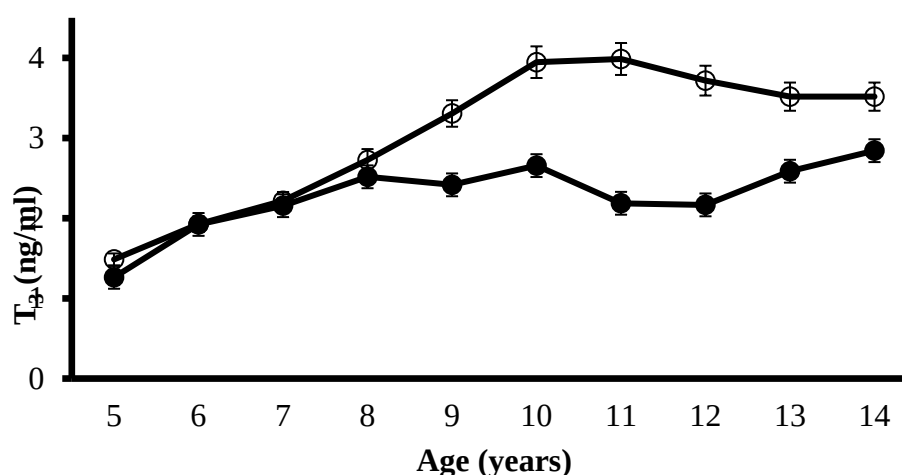


Fig. 1: Changes in plasma mean concentrations of T₃ associated with aging, compared with normal weight and overweight boys. (Open markers: normal weight boys; closed markers: over-weight boys).

Although the levels of T_3 were statistically ($p>0.05$) similar from 5 to 8 years of boys in both groups, T_3 levels were significantly ($p<0.05$) lower in overweight boys as compared to normal-weight boys at the age of 9 to 15 years. Similarly, Fig. 2 shows that T_4 levels were significantly ($p<0.05$) lower in overweight boys compared to normal-weight boys from 5 to 7, 9 to 11, and 15 years of age. However, the levels of TSH were slightly ($p>0.05$) decreasing from 6 years to 10 years only in normal-weight boys. The TSH levels were significantly ($p<0.05$) higher in overweight boys as compared to normal-weight boys at 9, 11, and 13 to 15 years of age (Fig. 3).

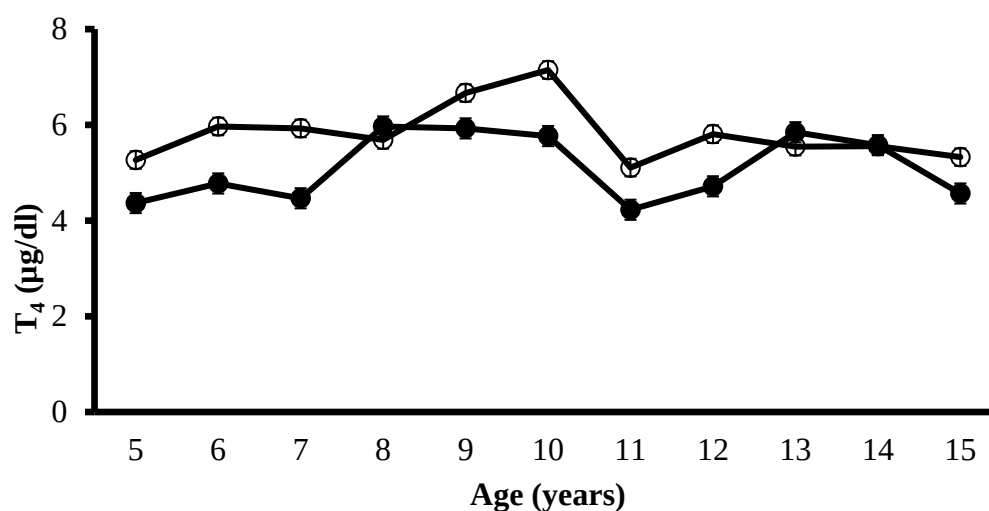


Fig. 2: Age-related changes in plasma concentrations of T_4 normal weight and overweight boys. (Open markers: normal weight boys; closed markers: over-weight boys).

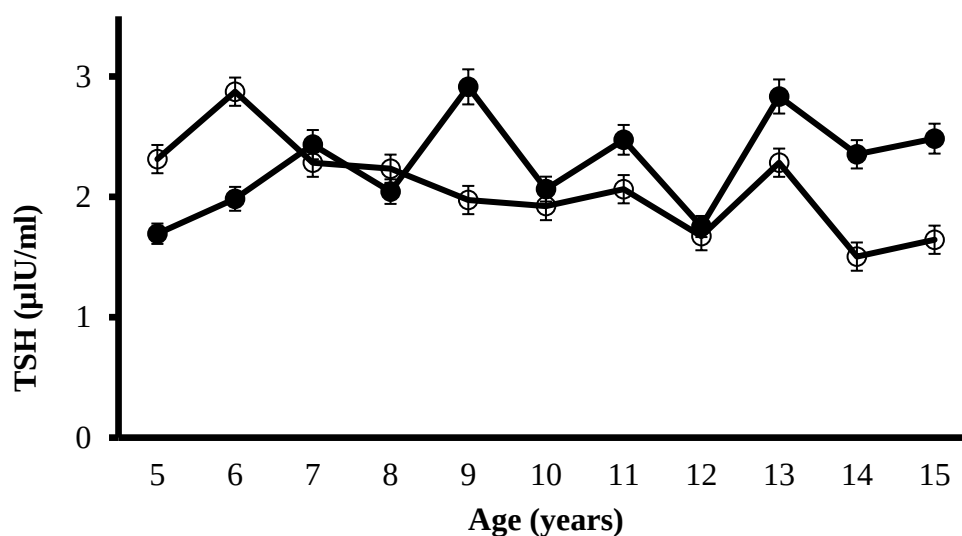


Fig. 3: Age-related changes in plasma mean concentrations of TSH in normal-weight and overweight boys. (Open markers: normal weight boys; closed markers: over-weight boys).

Correlation of body weight, BMI, and thyroid hormones:

The data in Table 2 illustrates the connections between thyroid hormones, age, body weight, and BMI. There was a substantial ($p < 0.05$) inverse connection between T3 and T4 and body weight ($r = -0.33$ and $r = -0.32$, respectively), although there was a significant ($p < 0.05$) positive association between TSH and body weight ($r = 0.56$). TSH had a substantial ($p < 0.05$) positive association ($r = 0.43$) with BMI, whereas T3 and T4 had a significant ($p < 0.05$) negative connection ($r = -0.45$ and $r = -0.24$, respectively). The T3 and T4 had statistically significant ($p < 0.05$) negative correlation with TSH ($r = -0.36$ & $r = -0.68$, respectively). Furthermore, age had a significant ($p < 0.05$) positive correlation ($r = -0.72$) with body weight.

Table 2. Correlation between age, weight, BMI and thyroid hormones in boys.

Factors	Age	Weight	BMI	T3	T4
Age	1				
Weight	0.72	1			
BMI	0.15	0.59*	1		
T ₃	0.04	-0.33*	-0.45*	1	
T ₄	0.26	-0.32*	-0.24*	0.89*	1
TSH	-0.09	0.56*	0.43*	-0.36*	-0.68*

T₃: triiodothyronine; T₄: tetraiodothyronine; TSH: thyroid stimulating hormones.

*Values are significantly different at $\alpha = 0.05$

Discussion:

The present study showed a comparison between overweight and normal-weight boys in which obese boys had decreased levels of T₃, the most potent thyroid hormone for increasing metabolic rate. Similarly, though non-significant, the levels of T₄ decreased and TSH increased in overweight boys as compared to normal-weight boys [1]–[5], [8].

In our investigation, it is observed that the secretion of TSH from the pituitary is statistically similar in most of the age groups in normal weight and overweight boys, supported by previous studies that TSH remained constant throughout the pubertal development in normal, overweight boys [11]–[13]. According to [14], a surge in prepubertal TSH levels was found between 9.0 and 9.5 years. A temporary increase followed this surge in circulating T3 and T4 and the improved peripheral conversion of tetra-iodothyronine (T₄) to tri-iodothyronine (T₃). A similar prepubertal rise in the levels of TSH was observed in the present study in normal-weight boys at the age of 6 years while in overweight boys at the age of 9 years. It has been hypothesized that an increase in the production of TSH during puberty may be the factor that causes a corresponding expansion in the size of the thyroid gland [15], [16]. A previous study described a higher TSH median value in younger boys (1-9 years) than in older boys (14-15 years). Our findings showed that the levels of TSH were slightly ($p > 0.05$) decreasing from the age of

6 years and onward in normal-weight boys. Our results also support it, as a previous study described a higher TSH median value in younger age groups of 1-9-year-old boys [17]. Similarly, a survey on TSH secretion in adolescents, children, and newborns found that TSH secretion steadily decreases from neonates to teens. The study was conducted on newborns, children, and teenagers [18].

It has been demonstrated that the thyroid function will change its secretion throughout a typical human life span. First, as people get older, their levels of T₃ secretion go up, and then as they get further older, their levels of T₃ secretion go down. Serum T₃ levels are said to be low when a person is born, rise dramatically throughout early infancy, remain high throughout childhood, decline after puberty, remain consistent from late middle age until old age, and finally fall as a person gets older [19]–[21]. We have also demonstrated that the mean plasma concentrations of T₃ increased progressively from the 5-12 years age group in the normal-weight boys. The levels of T₃ gradually declined after 13 years of age. In a recent study, it was discovered that the amount of T₃ secreted from the thyroid gland in boys increases before and around the time puberty first begins. Therefore, the T₃ levels were low in 6- or 7 years old subjects and were higher in subjects with 11.2 or 12 years [22]. In another study, TSH, free T₄, and total T₃ secretion increased in boys from birth to 9 years of age but decreased in teenagers between 15 and 17 years old. This finding was based on the fact that the study measured the secretion of these hormones from day one of life to age 12 [18]. In another study on paediatric reference intervals for T₃, T₃ secretion gradually increases from birth to 8 years. Then it gradually decreases until it reaches its lowest levels at the age of 14 years. These findings were found in children [23]. Likewise, it was discovered that the mean serum T₃ concentrations in children are significantly greater than the mean serum triiodothyronine (T₃) concentrations in adults having good health conditions [24].

Some of the previous researchers found that the secretion of T₄ grew between the ages of 10 and 12 years, even though they reported a steady decline in the secretion of T₄ from the neonatal stage up until 14 years. It was found that the secretion of T₄ increased between these ages [11], [18]. In the same vein, a study that evaluated the levels of free T₄ in children who were otherwise healthy revealed that boys between the ages of 1 and 9 years old had significantly higher T₄ median values when compared to older males between the ages of 15 and 14 years old [17].

Though the present study has limitations and a few ambiguous hormonal patterns (peaks and nadir) due to fewer samples, it depicted that the lower levels of T₃, T₄, and higher levels of TSH than normal may have a role in the overweight in boys. Therefore, it is suggested that a study with a broader scope and a more significant number of samples should be conducted to generalize the results.

Author's Contribution: M.I., Conceived the idea and designed the research work; A.A. acquired data, and made all collections, A.A. & N.A., performed the lab work; A.A., S.H. & F.N. did the statistical work; A.A., S.H., & A.N., wrote the primary draft; A.N. did the language and grammatical edits or Critical revision. A.N. did all the correspondence.

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