Original Article

Effects of aerobic and resistance training on the high-density lipoprotein cholesterol concentration in women with hypothyroidism

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Published online: June 30, 2020

(Accepted for publication: June 22, 2020)

DOI:10.7752/jpes.2020.04245

Abstract

Background. Hypothyroidism is caused by an increase in the concentration of thyroid hormone caused by the smaller production or exogenous administration of the hormone. Physical training improves the endothelial function in hypothyroidism, which indicates the disordered physiology of several endothelium-derived vasoactive factors, e.g., nitric oxide. Physical exercise affects the obesity reduction process, which is characteristic for hypothyroidism, because thyroid hormones are responsible for controlling metabolism. In addition, physical exercise increases blood HDL concentration during aerobic exercise and resistance training and improve the quality of life. Thus, the purpose of this study was to investigate the effect of aerobic and resistance training on the high-density lipoprotein cholesterol concentration in women with hypothyroidism.

Materials and methods. The sample consisted of 31 women with the hormonal rate stabilized by hormonal therapies for at least three months through the administration of a synthetic hormone levothyroxine sodium; the women were diagnosed with chronic hypothyroidism, but their thyroid-stimulating hormone (TSH) and T₄ levels were stabilized (TSH level of 0.3–4.5 mU/L and free T₄ level of 0.7–1.8 ng/dL). The sample was divided into the following three groups: aerobic training group (ATG, n = 10), resistance training group (RTG, n = 11), and control group (CG, n = 10); the women were selected at random from the Macapá city. The comparison of HDL concentrations between the sessions on week zero (T1) and on the 20th week (T2) between the three groups (CG, ATG, and RTG) was performed by one-way analysis of variance ANOVA, and the post-hoc Bonferroni correction test was applied when significant differences were observed.

Results. For T1, the values of HDL concentrations in different groups were 46.2 ± 12.2 mg/dL (CG), 50.1 ± 6.7 mg/dL (ATG), and 48.2 ± 8.0 mg/dL (RTG) and did not show any statistically significant difference (p = 0.64); for T2, the recorded HDL concentrations for different groups were 48.1 ± 8.9 mg/dL (CG), 59.1 ± 10.5 mg/dL (ATG), and 61.4 ± 12.7 mg/dL (RTG); the values showed a statistically significant difference (p = 0.03) especially for RTG compared to CG with the mean difference of 12.26 mg/dL or 25.4% (p = 0.04).

Conclusion. It can be concluded that physical exercise may have altered the HDL concentration profile in women with hypothyroidism compared to the control; the effect after 20 weeks of resistance training was especially significant.

Key Words: Hypothyroidism, Physical exercise, Resistance training, Aerobic training.

Introduction

Hypothyroidism is characterized by the dysregulation of the body's endocrine system. Hypothyroidism causes functional imbalance owing to thyroid dysregulation, which affects the production of hormones Triiodothyronine (T₃) and tetraiodothyronine (T₄) (Taylor et al., 2018; Bhat et al., 2016) result in an increase in TSH levels (>5mU / L); 95% of cases of clinical hypothyroidism correspond to the primary type (Knudsen et al., 2000). This deregulation leads to cellular and metabolic complications, which impair the physical capacity of those affected by the disease (Taylor et al., 2018; Koromilas et al., 2010).

The clinical manifestation showed the prevalence of 1% for thyroiditis (a type of hypothyroidism), 0.4% for hyperthyroidism or Graves's disease (Biondi et al., 2015), and subclinical hypothyroidism has been reported to be between 4% and 20% in the population (Peeters, 2017); the highest prevalence is observed in women, elderly, and Caucasians (Stott et al., 2017; Ghetti et al., 2014).

Western countries have the prevalence of 2–5% of thyroid diseases (Raffaelli et al., 2010). In Brazil, the incidence of hypothyroidism may reach 20% in certain populations (Sgarbi et al., 2013). Owing to the multifactorial origin, with the lack of active iodine minerals in diet as a predominant factor, chronic hypothyroidism is related to genetic predisposition, environmental factors [e.g., radiation and absorption of heavy metals (Sgarbi et al., 2013)], nutrition [owing to the high absorption of iodine present in cooking salt and

dietary deficiency of minerals and vitamins such as iron, selenium, and vitamin D (Hu & Rayman, 2017)], and obesity (Sanyal & Raychaudhuri, 2016).

Physical training improves the endothelial function in hypothyroidism, which indicates the disordered physiology of several endothelium-derived vasoactive factors, in particular nitric oxide (Guang-da Xiang et al., 2009). However, the possible benefits of physical training on the functional capacity of these patients [i.e., effect on high-density lipoprotein cholesterol (HDL) concentration] remains unknown (Bassi et al., 2012; Werneck et al., 2012; Cakmak et al., 2007).

There is a relationship between lipid metabolism and thyroid hormones because thyroid hormones physiologically stimulate synthesis by inducing the enzyme HMGCo-A reductase, which regulates HDL concentration and is associated with hypothyroidism (Zhang et al., 2015). Therefore, important association has been identified among hypercholesterolemia and certain newer risk factors for atherosclerosis in individuals with overt hypothyroidism and, in some cases, subclinical hypothyroidism (Cappola & Ladenson, 2003).

Physical exercise affects the obesity reduction process, which is characteristic of hypothyroidism because thyroid hormones are responsible for controlling metabolism. Physical exercise raises blood HDL concentration during aerobic exercises (Fikenzer et al., 2018; Othman & Temur, 2018) and resistance training (Wood et al., 2019; Costa et al., 2019; Ihalainen et al., 2019; Krčmářová et al., 2018), which improves the quality of life (Reuters et al., 2006).

There are few studies on exercise tolerance in patients that are being treated for hypothyroidism; in addition, there are not enough studies on the effect of physical training programs (Lankhaar et al., 2014); thus, this field remains open for investigation. Therefore, the purpose of this study was to investigate the effect of aerobic and resistance training on the high-density lipoprotein cholesterol concentration in women with hypothyroidism

Materials and methods

The study protocol was approved by the local Ethical Human Research Committee of Universidade Federal do Amapá (protocol: 1.886.643), and an informed written consent was obtained from all subjects. This study was conducted in accordance with the instructions of the Helsinki Declaration of 2008 and resolution 466 of December 12, 2012, edited by the National Health Council.

Participants

The sample consisted of 31 women (25–60 years old) who were diagnosed with chronic hypothyroidism; their hormonal rate was stabilized by hormonal therapies for at least three months through the administration of a synthetic hormone levothyroxine sodium; their TSH and T₄ levels were stabilized (the TSH level was 0.3–4.5 mU/L, and the free T₄ level was 0.7–1.8 ng/dL) (Sgarbi et al., 2013). The sample was divided into the following three groups: aerobic training group (ATG, n = 10), resistance training group (RTG, n = 11), and control group (CG, n = 10). The participants were selected at random from the Macapá city in the state of Amapá, which is located northwest of the North Region of Brazil and is also known as the Amazon Region. All subjects were nonsmokers, with no history of cardiopulmonary disease, and none were taking medication.

Procedure

The data were obtained through periodic assessments during 12 weeks of training. The data were collected one week before the beginning of the research [i.e., week 0 (T₁)] and one week after the end of the twelfth week of training (T₂).

The AT group was submitted to the protocol of running three times per week at constant intensity at 60% and 80% of heart rate, which was measured by manual palpation of the pulse for 30 s; the total training time varied between 40 min and 60 min per day. RT was submitted to the protocol that included training three times a week, in 3 sets of 10 repetitions, working nine muscle groups per day (large muscles and altered by segments). The strength index was measured with the 1RM test, by extracting 60% of the maximum load for the training.

The tests were conducted in a quiet room with temperature maintained at 22°C. All subjects were instructed to avoid strenuous activity during 24 h prior to each testing session and avoid alcohol, caffeine, and consumption of large meals for at least 3 h prior to testing.

Anthropometric Measurements

During an orientation session, the testing procedures and time commitment required for participation in this study were verbally explained to potential volunteers. Clinical examinations were performed through anthropometric evaluations with protocols validated, suggested, and recommended by WHO (2010) in the *Technical Report Series 854*. The height was measured in centimeters using an *Altuxata*[®] portable measuring stadiometer. The body mass was measured to the nearest 0.1 kg using a *Balmak*[®] mechanical scale model 111. The body mass index (BMI) was calculated as the quotient ratio of weight over squared height (kg/m²).

Laboratory Analysis

Laboratory tests were carried out in the same laboratory located in the central region of the city of Macapá, including the HDL concentration hormonal dosing exams. A mean amount of 4–5 mL of blood was withdrawn; all procedures were performed according to the standards of separation and transport of biological samples (Brenta et al., 2013).

Statistical Analysis

Descriptive statistical analyses of the data were expressed as the mean $\pm$ standard deviation. The Kolmogorov–Smirnov test was used to determine the normality of distribution, when the normality of distribution was confirmed. The difference between groups in anthropometric characteristics was tested by one-way analysis of variance ANOVA, and the post-hoc Bonferroni correction test was applied when significant differences occurred. The comparison of HDL concentration between sessions on week zero (T1) and on the 20th week (T2) between the three groups (CG, ATG, and RTG) was tested by one-way analysis of variance ANOVA, and the post-hoc Bonferroni correction test was applied when significant differences occurred. An alpha level less than or equal to 0.05 was required for statistical significance. All data were entered in the Matlab version 2019.b (Mathworks, EUA).

Results

The anthropometric characteristics of the subjects were similar between groups with low values of standard deviation (Table 1); the values were expressed as the mean $\pm$ standard deviation and showed no significant differences.

Table 1. Descriptive characteristics of participants

Variables	ATG	RTG	CG	P value
Age, year	38.8 $\pm$ 11.0	38.8 $\pm$ 9.9	42.0 $\pm$ 10.4	0.75
Weight, kg	70.2 $\pm$ 8.7	65.8 $\pm$ 10.8	73.0 $\pm$ 11.8	0.37
Height, cm	160.3 $\pm$ 6.6	158.5 $\pm$ 5.0	159.2 $\pm$ 7.6	0.84
Body mass index, kg/m ²	27.4 $\pm$ 3.7	26.2 $\pm$ 4.3	29.0 $\pm$ 5.4	0.45

ATG is the aerobic training group; RTG is the resistance training group; CG is the control group.

The values of HDL concentration for different groups for T1 were 46.2 $\pm$ 12.2 mg/dL (CG), 50.1 $\pm$ 6.7 mg/dL (ATG), and 48.2 $\pm$ 8.0 mg/dL (RTG) and did not show statistically significant difference ($p = 0.64$); for T2, the values of HDL concentrations for different groups were 48.1 $\pm$ 8.9 mg/dL (CG), 59.1 $\pm$ 10.5 mg/dL (ATG), and 61.4 $\pm$ 12.7 mg/dL (RTG) and showed statistically significant difference ($p = 0.03$). Then, Bonferroni adjustment reported a significant difference between HDL concentrations in different groups in T2 pairwise comparisons (Table 2).

Table 2. Bonferroni correction test for HDL concentration in different groups in T2 pairwise comparisons

Factors		Mean Difference	P value	95% Confidence Interval
CG	AGT	−11.00	0.10	−23.46 to 1.46
	RTG	−12.26	0.04	−24.44 to −0.08
AGT	CG	11.00	0.10	−1.46 to 23.46
	RGT	−1.26	1.00	−13.44 to 10.91
RGT	CG	12.26	0.04	0.08 to 24.44
	AGT	1.26	1.00	−10.91 to 13.44

Discussion

Hypothyroidism is caused by an increase in the concentration of thyroid hormone owing to its smaller production or exogenous administration of the hormone. The results of this study confirmed an increase in HDL concentration after physical exercise in women with hypothyroidism compared to GC, especially after 20 weeks of resistance training.

For HDL cholesterol, previous studies have reported that regular physical training promotes an increase in its plasma concentration (Wood et al., 2019; Costa et al., 2019; Ihalainen et al., 2019; Fikenzer et al., 2018; Othman & Temur, 2018; Krčmárová et al., 2018), which reflects the disordered physiology of several endothelium-derived vasoactive factors, in particular nitric oxide (Guang-da Xiang et al., 2009).

Previous studies have reported that aerobic training induces an increase in HDL (Fikenzer et al., 2018; Othman & Temur, 2018), which indirectly improves the quality of life (Reuters et al., 2006) of subjects with hypothyroidism compared to weight loss factors and prevention of associated diseases (Mohammadi et al., 2019; Liu et al., 2017), especially cardiorespiratory diseases (Bassi et al., 2012; Werneck et al., 2012; Cakmak et al., 2007). However, there were no significant differences observed. Although not statistically significant, it is worth noting that when aerobic training was applied to women with hyperthyroidism, the HDL concentration values were similar to those of women in the resistance training group.

Wood et al. (2019) have determined that high intensity exercises are more effective at increasing HDL in subjects with chronic non-communicable diseases compared to aerobic training. Therefore, the results of this study confirmed the tendency of plasma HDL concentration to increase after resistance training in women with hypothyroidism compared to that for GC with the mean difference of 12.26 mg/dL or 25.4% ($p = 0.04$) after 20 weeks of training.

To our knowledge, this study is the first to investigate the effect of aerobic and resistance training on the high-density lipoprotein cholesterol concentration in women with hypothyroidism. This study was performed on a homogeneous sample of women (25–60 years old), who were diagnosed with hypothyroidism.

Conclusions

It can be concluded that physical exercise may have altered the HDL concentration profile in women with hypothyroidism compared to that in the control, especially after 20 weeks of resistance training.

Conflict of interests

The authors declare that this research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Author contributions

Rodrigo Coutinho Santos and Wollner Materko were the principal investigators, who contributed to the study design, data collection, data analyses and writing of the manuscript. Demilto Yamaguchi da Pureza and Daianne Freires Fernandes contributed to the study design, data analyses, and wrote the manuscript. All authors read and approved the final version of the manuscript and are accountable for all aspects of the work.

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