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Original Article

EFFECTS OF COCONUT OIL ASSOCIATED WITH A PHYSICAL EXERCISES PROGRAM ON BODY COMPOSITION AND LIPID PROFILE

EFEITOS DO ÓLEO DE COCO ASSOCIADO COM UM PROGRAMA DE EXERCÍCIOS FÍSICOS SOBRE A COMPOSIÇÃO CORPORAL E PERFIL LIPÍDICO

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RESUMO
O objetivo deste estudo foi avaliar os efeitos da suplementação de óleo de coco associado com um programa de exercícios físicos sobre a composição corporal e perfil lipídico em mulheres eutróficas normolipidicas. A amostra foi composta de 20 mulheres divididas aleatoriamente em 2 grupos, grupo exercício suplementado com 13 mL/dia de óleo de coco (GCO; n=10) e grupo exercício não suplementado com óleo de coco (GSO; n=10). Foram avaliados medidas perimétricas de adiposidade central, gordura (%), massa gorda, massa magra, níveis séricos de colesterol total, LDL-c, HDL-c e triglicérides no início e no final de 12 semanas de intervenção. Para as comparações intragrupos e entre os grupos foi utilizado o teste T para amostras dependentes e independentes. Os resultados mostraram que 12 semanas de intervenção modificou a adiposidade central no grupo GCO, diminuindo 2,6% a circunferência da cintura comparado ao grupo GSO ($p<0,05$). A gordura (%), massa gorda e massa magra não se modificaram após 12 semanas de intervenção nos grupos GCO e GSO ($p<0,05$). Na comparação do perfil lipídico entre os grupos, o grupo GCO diminui 3% o LDL-c enquanto que o grupo GSO aumentou 13,7% o colesterol total e 14,2% o LDL-c ($p<0,05$). Em conclusão, o óleo de coco associado com um programa de exercício físico aeróbico não modifica a composição corporal e atenua as alterações no perfil lipídico em mulheres eutróficas normolipidicas.
Palavras-chave: Óleo de coco. Exercício. Composição corporal. Lipídeos. Mulheres.

ABSTRACT
The aim of this study was to evalute the effects of supplementation of coconut oil associated with a physical exercise program on body composition and lipid profile in normolipid eutrophic women. The sample was composed of 20 women randomized divided into two groups, supplemented exercise group with 13 mL/day of coconut oil (GES, n= 10) and unsuppemented exercie group with coconut oil (GEU), n= 10). Perimeters measurements of central adiposity, fat (%), fat mass, lean mass, total cholesterol, low-density lipoprotein cholesterol (LDL-c), high-density lipoprotein cholesterol (HDL-c) and triglycerides concentrations were evaluated in the beginning and in the final of 12 weeks of intervention. For intragroup and intergroup comparisons was used dependentes and independentes sample t-test. The results showed that 12 weeks of intervention modified the central adiposity in the GES group, decreased 2,6% the waist cincunference compared to GEU group ($p<0.05$). The fat (%), fat mass and lean mass did not change after 12 weeks of intervention between GES and GEU groups ($p>0.05$). In the comparation of lipid profile between groups, GES group decreased 3% the LDL-c while the GEU group increased 13.7% the total cholesterol and 14.2% the LDL-c concentration ($p<0.05$). In conclusion, coconut oil associated with a physical exercise program did not modify the body composition and attenuate the changes in the lipid profile in normolipid eutrophic women.
Keywords: Coconut oil. Exercise. Body composition. Lipids. Women.

Introduction

Coconut oil is a food supplement of plant origin derived from the *Cocos nucifera* species, family *Arecaceae* and subfamily *Cocoideae*[1]. Such a supplement consists basically of saturated fatty acids (92%), that is, lauric acid, myristic acid and palmitic acid as the main ones [2].

These fatty acids do not require transport by the chylomicrons to reach the tissues, in addition to not depending on the action of carnitine palmitoyltransferase-1 (CPT-1)[3]. For this reason, coconut oil has the capacity to be oxidized immediately by the mitochondria, helping in energy supply and avoiding the stock in adipose tissue[4,5].

In this context, the nutraceutical industry has recommend the use of coconut oil supplementation as a strategy for weight loss, reduction of central adiposity and lipid profile (serum cholesterol, LDL-c, HDL-c and triglycerides)[6]. These effects have been associated with lauric acid, which corresponds to 46% of the fatty acids found in coconut oil[7,8]. Lauric acid is absorbed directly into the portal circulation and transported to the liver for rapid oxidation; however, it does not participate in the biosynthesis or cholesterol transport. This mechanism could increase energy expenditure, decrease fat deposition in adipose tissue, result in faster satiation and improve the lipid profile of individuals[9].

Despite the possible effects of coconut oil supplementation on the reduction of central adiposity[10-12], these same effects are not seen either in the body fat mass or in the body fat percentage of individuals[12-14]. Moreover, research is conflicting with regard to the effects of coconut oil consumption to change the serum levels of total cholesterol, HDL-c, LDL-c, and triglycerides in different groups and age groups[6]. Therefore, other interventions to change body composition and to positively influence the lipid profile should be considered, such as inclusion of physical exercise programs.

Studies have shown that different physical exercise programs can change body composition and improve lipid profile[15,16-18]. Investigations have been carried out with animal models[1,19-21] associating physical exercises with dietary strategies, such as coconut oil supplementation, however, only one study with humans was found [10]. Further research is needed to substantiate the benefits attributed to coconut oil in body composition and lipid parameters in humans. Associating interventions that reduce abdominal and visceral fat mass and improve blood lipid profile is important so as to decrease the risk of cardiovascular disease.

The present study aimed at assessing the effects of coconut oil supplementation associated with a physical exercise program on body composition and lipid profile of normolipid eutrophic women.

Methods

Twenty voluntary women, employees of a Brazilian cooperative so-called *Cooperativa Médica da Unimed* in the municipality of Videira, state of Santa Catarina (SC), participated in the study. As inclusion criteria, all volunteers should be classified according to their Body Mass Index as being eutrophic women[22] (BMI = 18.5 - 24.9 kg/m^2); they should have a blood lipid profile within the desired health values[23], in addition to not having participated in systematized exercises in the past 6 months prior to the start of the research. Moreover, the subjects should not show musculoskeletal or cardiopulmonary diseases. All the volunteers signed a Free Informed Consent Form (FICF) and the study was approved by the Research Ethics Committee of the university referred to as *Universidade do Meio Oeste de Santa Catarina* (UNOESC), under opinion number 2.189.975.

Initially, the women were randomly divided into 2 groups: 1) exercise group supplemented with coconut oil (COG; n = 10); 2) coconut oil non-supplemented group (CONSG; n = 10). Soon after, in the first week, the volunteers were submitted to the following evaluations: Day 1: anthropometry, Day 2: body composition and Day 3: blood biochemistry analysis. Both groups started the physical exercise program on the second week, and at the end of the 12-week experiment period they were re-evaluated. The participants were recommended not to change their diets and not to use any medication during the intervention.

The body mass and height anthropometric measurements were performed according to the procedures recommended by Gultekin et al[24] in a private room at the *Cooperativa Médica da Unimed* in the municipality of Videira (SC). The body mass was evaluated with the women wearing light clothes and without shoes by using an Omron calibrated digital scale (Model HBF-514) with a maximum capacity of 150 kg and precision of 0.1 kg. For assessing height, the volunteers were standing with the body as elongated as possible and the head positioned under FRANKFURT plane. A Compact Trena Type Sanny Stadiometer was used with a precision of 0.1 cm for measurement. The Body Mass Index (BMI) was calculated by applying the following equation: BMI = body mass (kg)/height^2(m)[25].

In order to measure waist and hip circumferences, a metal measuring tape by Sanny®, Sanny, São Bernardo do Campo, Brazil, with an accuracy of 0.1 cm and a maximum length of 2 m was used. Waist circumference (WC) was assessed with the volunteer standing, relaxed abdomen, and arms extended along the body. The measuring tape was placed at the midpoint between the last rib and the iliac crest under a horizontal plane without compressing the tissues[26]. The hip circumference (HC) measurement was performed in the region of greater posterior projection of the glutes[26]. The waist-hip ratio (WHR) was calculated by dividing WC (cm) by HC (cm).

The volunteers were submitted to computerized densitometry test so as to evaluate body composition by using Dual-energy X-ray Absorptiometry (DEXA) with a Hologic instrument model (Discovery Wi, APEX operating system). The volunteers were placed on supine position and remained in this position throughout the examination. Fat percentage (%), fat body mass and lean body mass were evaluated by using DEXA software. All these exams were carried out at *Cooperativa Médica da Unimed*, operated by a specialized professional trained in radiology, strictly following the standard procedures.

The blood biochemical evaluation verified the levels of total cholesterol, LDL-cholesterol, HDL-cholesterol and triglycerides of the volunteers. All analyzes were performed by the clinical analysis laboratory at *Cooperativa Médica da Unimed*. In order to obtain the blood sample, the women remained under fasting from 8 to 12 hours and were recommended not ingest alcoholic beverages, in addition to not consuming too much fat and not to do physical activity for 48 hours before the tests. The blood collection was carried out in the morning (7:00 to 9:00 a.m.). Blood without anticoagulants was collected, and the serum was centrifuged soon after so as to perform the tests. The enzymatic colorimetric method was applied by using 5 ml of serum after centrifugation at 3000 rpm for five minutes. The LDL-C cholesterol fraction was obtained with the formula advocated by Friedewald et al[27]. The dosages were performed by applying the automated method in the Labmax Plenno appliance.

After the first week of initial data collection, the group supplemented with coconut oil (COG) and the coconut oil non-supplemented group (CONSG) started a physical exercise program, supervised by a physical education professional. This program followed the recommendations by the World Health Organization (WHO)[28] and it was divided into warm-up (5 to 10 minutes of stretching), 40 minutes of moderate intensity walking from 60% to 75% of the Maximum Heart Rate (HRmax), returning to calmness (5 to 10 minutes of relaxation exercises), with a frequency of three times a week (Monday, Wednesday and Friday) for 12 weeks. All of them performed the exercises in the morning, before starting the daily workday, at the athletics track of a Brazilian sports complex so-called *Complexo Esportivo Medalhão* in the municipality of Videira (SC), with a total of 180 minutes of physical activity per week.

Coconut oil supplementation of COG was started in the second week of the experiment, after initial data collection. The amount of 13 ml/day extra virgin coconut oil was used daily during the 12 weeks. This same dosage had been used in other studies with humans[6,7]. The extra virgin coconut oil by COPRA brand was made available to the volunteers by the researchers, and every two weeks they received a package with 200 ml of extra virgin coconut oil, totalizing six packages with 200 ml for each volunteer at the end of the research. The volunteers were instructed to consume the coconut oil alone or with fruits.

Data descriptive analysis was carried out and shown as mean and standard deviation (SD). In order to determine the parametric and non-parametric statistics, data normality was verified by applying Shapiro-Wilk and Levene tests so as to assess the homogeneity of the variables. In order to compare the intragroup effects of pre and post-experiment, Student's t test was used for the dependent samples. The same test was applied to compare the variables between the groups for the independent samples. The significance level was set at p <0.05.

Results

Table 1 shows COG and CONSG participants' characteristics at the beginning of the experiments. Considering age, body weight and height variables, no significant difference was seen between groups (p> 0.05).

Table 1. The participants' characteristics (Mean ± SD)

	COG	CONSG	p Value
Age (years)	29,0 ± 8,2	35,2 ± 8,6	0,77
Body weight (kg)	62,8 ± 4,2	59,3 ± 6,3	0,27
Height (cm)	163,2 ± 0,6	167,0 ± 0,6	0,60

Source: The authors

Regarding central adiposity (Table 2), COG significantly decreased the waist circumference (WC) and waist-hip ratio (WHR) by 2.6% and 1.3%, respectively, during pre-post-experiment period (p <0.05). The BMI was not changed in the same period in COG (p> 0.05). CONSG showed no change in the anthropometric variables of central adiposity during pre-post-experiment period (p> 0.05).

When COG and CONSG were compared with regard to central adiposity at the end of the experiment (Table 2), a significant difference occurred in waist circumference only, that is, COG decreased it at 3.2%, whereas CONSG showed an increased waist circumference of 0.4% (p <0,05).

COG had no change with regard to the body composition (Table 2) at the end of the 12 weeks (p> 0,05). Although CONSG increased the fat percentage by 1.7% and fat mass by 15.8% during pre-post-experiment period, there was no significant difference between the periods (p> 0.05). Comparison between GCO and CONSG after the 12-week period (Table 2) showed no statistical difference in body composition.

Table 2. Comparison of central adiposity and body composition between the group supplemented with coconut oil (COG) and the coconut oil non-supplemented group (CONSG) after 12 weeks of intervention (mean ± SD)

Variables	COG		CONSG	
	Pre	Post	Pre	Post
WC (cm)	79,8±6,9	77,2 ± 6,3*[a]	75,2 ± 6,5	75,4 ± 6,2
WHR	0,79±0,05	0,78 ± 0,06*	0,77 ± 0,04	0,77 ± 0,05
BMI (kg/m^2)	23,6±2,6	23,7 ± 2,4	21,2 ± 2,5	21,5 ± 2,4
Fat (%)	35,4±6,0	35,5 ± 6,8	34,4 ± 5,1	35,0 ± 4,3
Fat mass (kg)	21,5±4,4	21,7 ± 4,8	17,7 ± 8,5	20,5± 4,3
Lean mass (kg)	39,0±3,7	38,8 ± 4,2	37,3 ± 1,7	37,5 ± 1,7

P.S.: WC – Waist Circunference; WHR – Waist-Hip Ratio; BMI – Body Mass Index. *p<0,05 – intragroup pre-post treatment comparision; [a]p<0,05 – pre-post treatment comparision between the groups

Source: the authors

At the beginning of the experiment the mean total cholesterol concentration of COG and CONSG was 171.4 ± 19.0 mg/dl and 175.4 ± 20.6 mg/dl, respectively, (Figure 1). After 12 weeks of experiment COG did not change the total cholesterol concentrations (p> 0.05), whereas CONSG increased it at 13.1% (172.2 ± 4.3 mg/dl and 198.4 ± 24, 1 mg/dl, respectively, p <0.05).

Regarding the comparison between the groups at the end of this 12-week experiment (Figure 1), CONSG increased total cholesterol by 13.7% and COG increased it at 0.2%, thus, a significant difference between the groups (p <0.05) was seen.

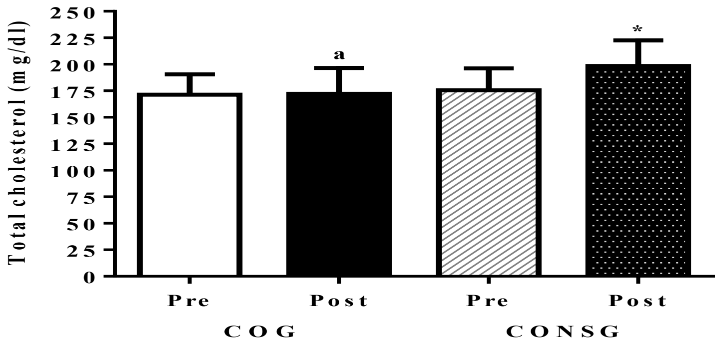

Figure 1. Comparison of total cholesterol between the exercise group supplemented with coconut oil (COG) and the coconut oil non-supplemented exercise group (CONSG) after 12 weeks of intervention (mean ± SD)
Note: *p <0.05 – intragroup pre-post-experiment comparison. *p<0.05 - pre-post-experiment comparison between groups
Source: the authors

Considering triglycerides (Figure 2), at the beginning of the experiment the mean COG and CONSG concentrations were 67.8 ± 24.0 mg/dl and 82.2 ± 34.0 mg/dl, respectively. At the end of 12 weeks of experiment COG increased triglycerides at 27.4% (p <0.05). However, these changes were not seen in the triglycerides of CONSG (p> 0.05).

When comparing triglycerides between groups (Figure 2), there was no significant difference at the end of 12 weeks of experiment (p> 0.05).

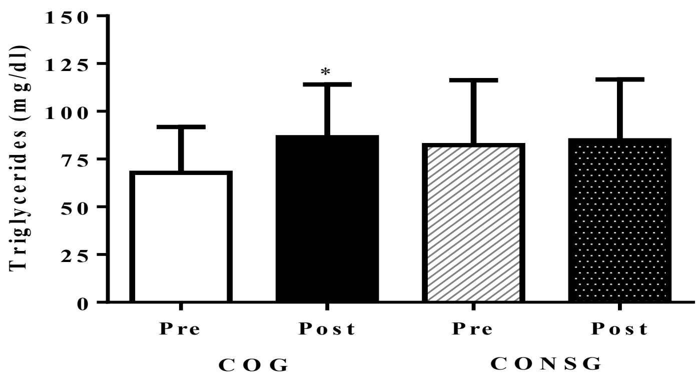

Figure 2. Comparison of triglycerides between the exercise group supplemented with coconut oil (COG) and the coconut oil non-supplemented exercise group (CONSG) after 12 weeks of intervention (mean ± SD)
Note: *p <0.05 – intragroup pre-post-experiment comparison
Source: the authors

The mean LDL-C concentrations in GCO and CONSG at the beginning of the treatment were 97.4 ± 19.3 mg/dl and 92.9 ± 9.7 mg/dl, respectively (Figure 3). At the end of the 12-week experiment, both groups showed no change in LDL-c (p> 0.05).

On the other hand, when the groups were compared at the end of the intervention (Figure 3), CONSG increased LDL-C at 14.2% and COG decreased LDL-c at 3% ($p < 0.05$).

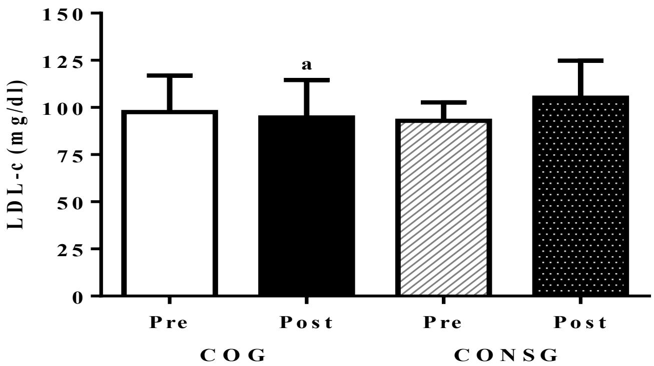

Figure 3. Comparison of LDL-c between the exercise group supplemented with coconut oil (COG) and the exercise coconut oil non-supplemented group (CONSG) after 12 weeks of intervention (mean ± SD)
Note: LDL-c - low-density lipoprotein cholesterol. *p <0.05 - pre-post-experiment comparison between groups
Source: the authors

HDL-c at the start of the experiment in COG and CONSG were 60.4 ± 8.6 mg/dl and 66.0 ± 15.6 mg/dl, respectively, (Figure 4). After 12 weeks of experiment COG did not show any change in HDL-c ($p > 0.05$), whereas the CONSG significantly increased HDL-c at 15.7% ($p < 0.05$).

When comparing the groups (Figure 4), HDL-c was not different at the end of the 12-week period ($p > 0.05$).

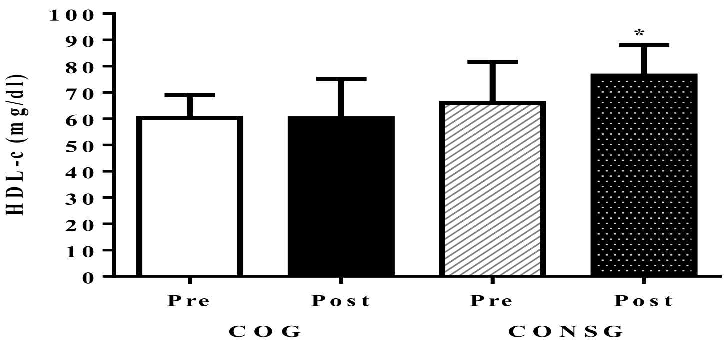

Figure 4. Comparison of HDL-c between the exercise group supplemented with coconut oil (GCO) and the exercise coconut oil non-supplemented group (CONSG) after 12 weeks of intervention (mean ± SD)
Note: HDL-c - high density lipoprotein cholesterol. *p <0.05 – intragroup pre-post-experiment comparison
Source: the authors

Discussion

The findings of the present study showed that after 12 weeks of coconut oil supplementation associated with an aerobic physical exercise program the perimetric measurements of the abdomen region had changed without modifying body fat. In addition, this strategy attenuated changes in the lipid profile throughout the experiment. The potential health benefits of coconut oil have been reported for approximately two decades, mainly with regard to its use by adults with risk factors for cardiovascular diseases[7,10,14,19]. However, according to the best of our knowledge, no study has investigated the effects of coconut oil supplementation associated with physical exercises in eutrophic normolipidic women.

After a 12-week experiment, COG reduced the waist circumference and waist-hip ratio, whereas CONSG did not change any of the perimetric variables of central adiposity (Table 2). Research has shown adverse results with regard to the central adiposity measures with the use of coconut oil. In an experiment with 20 overweight women aged 20-40 years who underwent daily consumption of 30 mL of coconut oil associated with a 50-minute aerobic exercise program 4 times a week for 12 weeks showed that the waist circumference decreased significantly during pre-post-experiment period, corroborating with the findings of the present study[10]. Khaw et al[29] evaluated the effect of daily consumption of 50 g of coconut oil for 4 weeks in a sample of 28 healthy subjects of both sexes. The results showed that coconut oil supplementation did not change the central adiposity at the end of the experiment. Cardoso et al[7] investigated the daily intake of 13 mL of extra virgin coconut oil for 3 months on central adiposity in 92 patients with coronary artery disease. The circumference of the abdomen decreased significantly at the end of the investigation. Another study with 20 obese individuals who consumed 30 mL of coconut oil daily for 6 weeks, showed a significant decreased waist circumference, however the waist-hip ratio did not change at the end of the intervention, corroborating in part with the findings of the present study[12]. The difference between the results of the present investigation and others, regarding central adiposity, may be associated with the characteristics of the samples, time and amount of coconut oil use, the diet control and physical exercise practice.

Studies have shown that medium-chain triglycerides, containing fatty acids with 6 to 10 carbon atoms, such as lauric acid found in coconut oil, can influence metabolism and thermogenesis, modifying body composition in healthy overweight obese adults[9,13.30]. Interestingly, in the present investigation both groups did not change the fat mass, fat percentage or lean mass after the 12-week experiment (Table 2). The present results corroborate with other studies that did not find modifications in these body composition parameters with the coconut oil supplementation[12,14,29]. It can be inferred that no change at the end of the experiment may be related to the lack of a calorie restricted diet or to the physical exercise program that involved only aerobic exercise without strength training. According to Coll-Risco et al[31], changes in body composition, such as weight loss, reduction of fat mass and increase in lean mass are influenced by the association of a caloric-restricted dietary intervention and a physical exercise program that encompasses aerobic activities and strength training.

Regarding lipid profile, in this study COG increased the triglyceride concentration at 27.4% at the end of the 12 weeks (Table 3). These findings are different from others found in the literature. For example, an investigation with 20 overweight women supplemented daily with 30 mL of coconut oil, undergoing 50 minutes of aerobic exercise 4 times a week for 12 weeks, showed no change in the concentration of triglycerides (10). Chinwong et al[6] also found no alterations in triglycerides after 8 weeks of supplementation with 15 mL of coconut oil in 16 healthy subjects aged 18 to 25 years. The study by Cardoso et al[7] with 92 individuals supplemented with 12 mL of coconut oil for 3 months, showed no change in triglyceride concentration. The differences found in the present study in comparison with others obtained previously may be associated with the increase in saturated fat consumption by the participants. The daily diet of 13 mL of coconut oil, which consists of 92% of saturated fatty acids, stimulated the increase of insulin secretion and anabolic processes related to the synthesis of new fatty acids. The synthesis of new fatty acids increases the hepatic production of triglycerides and the secretion of the very-low-density lipoprotein cholesterol (VLDL) in the blood[32].

The other lipid parameters in COG did not change after 12 weeks of intervention (Table 3). Research on the effects of coconut oil on total cholesterol, LDL-c and HDL-c has been inconclusive. The study by Vijayakumar et al[14], evaluated 100 individuals diagnosed with coronary artery disease who received 15% coconut oil in their diet for two years. The results showed that there was no significant change in the levels of total cholesterol, LDL-c or HDL-c after 3 months, 6 months, 1 year and 2 years of supplementation, corroborating with the present study. On the other hand, 29 healthy subjects who received 100gr of coconut oil for three months, showed a significant increase in the LDL-c and HDL-c levels at the end of the experiment, which did not happen in the present investigation. The study by Liau et al[12] with 20 individuals who consumed 30 mL of coconut oil for 6 weeks, found no significant changes in total cholesterol, LDL-c or HDL-c. As previously mentioned, the characteristics of the individuals, time and amount of coconut oil use, the diet control and physical exercise practice can explain the differences of the results between the present study and others.

The practice of aerobic physical exercises without drug or dietary therapies and their effects on blood lipids have comprehensively been evaluated by the literature. Several investigations have shown that aerobic exercises, with intensities between 60% and 85% of VO_{2max}. and weekly frequency of 3 to 5 times a week, have increased serum HDL-c concentrations[15,17,33]. The present results are similar to those of the literature, since CONSG increased HDL-c at the end of the 12-week experiment (Table 3). According to Fraga et al[34] physical exercises improve the enzymatic processes of lecithin-cholesterol-acyltransferase, lipoprotein lipase and reduction of hepatic lipase, which are involved in lipid metabolism. This would result in increases in HDL-c levels. It is worth mentioning that HDL-c exerts a protective effect on the development of atherosclerotic cardiovascular diseases. The antiatherogenic effect of HDL-c is due to its property of transporting lipids, mainly cholesterol esters, from the peripheral tissues to the liver, which is known as reverse cholesterol transport[35].

The group supplemented with coconut oil (COG) throughout the physical exercise program significantly attenuated the increase in total and LDL-c levels compared to the coconut oil non-supplemented exercise group (CONSG) in the present study (Table 3). These effects can be explained by the sum of the stimuli caused by coconut oil supplementation and the increase in energy consumption during physical exercise. The medium-chain fatty acids present in coconut oil are rapidly metabolized in the liver as energy, whereas exercise increases the activity of lipoprotein lipase in aerobic metabolism resulting in increased use of fatty acids, decreasing the synthesis of cholesterol and LDL-c[4,36].

The lack of diet control and eating habits of the participants of the present research throughout the intervention program substantiates the main limitations of this study. The women were recommended not to change their diet during the experiment, however, any change in food consumption with increased energy expenditure provided by the exercises and in the dietary habits with the coconut oil supplementation is unknown.

Conclusions

In conclusion, 12 weeks of coconut oil supplementation associated with an aerobic exercise program modified the perimetric measurements of central adiposity without changing fat mass. In addition, this strategy attenuated the changes in the lipid profile that occurred during the experiment.

Further studies that use different dietary interventions and physical exercises are suggested so as to verify the possible effects on body composition and lipid profile in different groups and age groups. The use of coconut oil supplementation with caution by physical exercise practitioners who wish to lose weight is also suggested, since dietary requirements should be evaluated by a nutritionist.

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