



# Effects of a 12-Week Body-Pump Training and Chamomile Consumption on the Lipid Profiles in Obese Adolescent Boys

Farzad Zehsaz <sup>1,\*</sup>, Negin Farhangi <sup>2</sup>

<sup>1</sup>Associate Professor, Department of Sport Physiology, Tabriz Branch, Islamic Azad University, Tabriz, Iran.

<sup>2</sup>Lecture in Sport Physiology, Department of Sport Physiology, Tabriz Branch, Islamic Azad University, Tabriz, Iran.

\*Corresponding Author: Farzad Zehsaz, Associate Professor, Department of Sport Physiology, Tabriz Branch, Islamic Azad University, Tabriz, Iran. Email: fzehsaz@iaut.ac.ir

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## Abstract

**Introduction:** The alarming rise in adolescent obesity worldwide, coupled with the significant occurrence of dyslipidemia, metabolic disorders, and cardiovascular diseases among overweight and obese children, underscores the urgency of this research.

**Objective:** This study aimed to examine the impact of a 12-week regimen of Body-pump training combined with chamomile intake on the lipid profiles of obese adolescent males.

**Methods:** This research was designed as a semi-experimental applied study involving 36 obese boys aged 14-16 years, who were randomly assigned to body-pump training+chamomile, body-pump training alone and control groups. Measurements of anthropometric indices, lipid profile indices and static strength were taken at pre-test and post-test. The intervention included 12 weeks and participants consumed 150 cc of chamomile twice daily. Data analysis was performed using ANCOVA.

**Results:** A significant difference was observed between the experimental and the control groups regarding body weight, BMI, triglyceride levels, total cholesterol, low-density lipoprotein, high-density lipoprotein, and the static strength ( $P<0.05$ ). Furthermore, a significant reduction in body weight, BMI, triglycerides, total cholesterol, and low-density lipoprotein was noted in the body-pump exercise+chamomile group when compared to the body-pump exercise group ( $P<0.05$ ). Conversely, no significant increase was detected in high-density lipoprotein or the static strength of upper and lower limbs across the groups ( $P<0.05$ ).

**Conclusion:** The implementation of Body-pump training, alongside the intake of chamomile, resulted in enhancements to lipid profiles and body composition metrics, while also contributing to an increase in muscle strength among adolescents following the Body-pump training regimen.

**Keywords:** Body-Pump Exercise, Chamomile, Lipid Profile, Obesity, Adolescents

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## 1. Introduction

Adolescence represents a unique phase of life characterized by significant physical development, alterations in body composition, and advancements in sexual and mental maturity. During this critical time, adherence to treatment for chronic illnesses tends to be notably low, often resulting in unsatisfactory treatment outcomes (1). This trend is particularly evident in obesity, which is the most prevalent chronic condition among teenagers. In recent decades, the significant increase in overweight and obesity rates among children and adolescents has become a pressing public health concern, now regarded as an epidemic. The global incidence of obesity in individuals aged 5 to 19 years surged from 0.7% in 1975 to 5.6% in 2016 for girls, and from 0.9% in 1975 to 7.8% in 2016 for boys (2). Projections suggest that by 2025, the number of overweight and obese children and adolescents worldwide could surpass 400 million (3). The persistently high obesity rates in developed countries, along with rising trends in developing nations, present significant social, clinical, and economic challenges, with implications for both

immediate and long-term health outcomes. The growing prevalence of overweight and obesity among adolescents is linked to an increased risk of metabolic disorders, including dyslipidemia, impaired glucose metabolism, insulin resistance, and cardiovascular diseases, which may contribute to premature mortality in adulthood (4).

Childhood obesity is largely linked to insufficient physical activity and unhealthy eating habits. Research indicates that participation in physical activity serves as a crucial intervention for preventing obesity and improving both metabolic and cardiovascular health among overweight adolescents (5). The World Health Organization recommends that children and adolescents engage in an average of 60 minutes of moderate to vigorous physical activity each day to achieve optimal health benefits. Nevertheless, more than 80% of adolescents do not meet this recommended activity level and often refrain from participating in sports (6). In response, researchers have designed a variety of training programs, including aerobic and resistance training, to facilitate weight loss. Additionally, there has been a notable



surge in interest in developing innovative exercise regimens, which may include activities such as CrossFit, aerobic workouts, and air pump exercises (7,8).

In recent years, the body pump training program has garnered significant attention as a prominent training method. Introduced by Miller in 1991, this approach encompasses both individual and group training formats, incorporating various techniques such as body balance, body attack, body combat, body step, and body jam (9). The core principle of body pump training revolves around performing high repetitions with low to moderate loads or intensities. Typically, a single training session can involve up to 800 movements targeting all major muscle groups. Research findings suggest that following a 12-week duration, overweight and obese women exhibited an elevation in their resting metabolic rate (10). Furthermore, studies have demonstrated that participation in the body pump training program positively influences muscle strength, enhances fat-free mass, and contributes to a reduction in body fat (11,12). It has also been suggested that body pump exercises could serve as an innovative and enjoyable method for improving body composition (9). However, some studies have failed to show favorable outcomes regarding body composition improvements (13,14). These differences can be linked to variations in the length of studies and the characteristics of the participants involved. As body pump training is a relatively recent addition to fitness regimens, there exists a significant gap in thorough research concerning the physiological adaptations linked to this training style. It is crucial for researchers in sports science to delve deeper into the potential adaptations that may arise from this training method, particularly since it seems to be beneficial in improving body composition, reducing atherogenic markers, and increasing muscle strength, primarily due to its emphasis on high training volume (9-11, 14).

In recent years, there has been a significant rise in the societal trend favoring the use of sports supplements, particularly herbal varieties, aimed at enhancing the effectiveness of sports activities. Herbal supplements are recognized for their availability, safety, affordability, and minimal side effects. Previous research has indicated that the intake of certain herbal supplements, such as ginger, saffron, green tea, caffeine, cumin, and turmeric, is advisable for promoting fat oxidation and improving atherogenic markers (15). Chamomile has also been identified as a beneficial nutritional option for lowering blood glucose levels, enhancing lipid profiles, and improving antioxidant capacity (16). Scientifically known as *Matricaria chamomilla*, chamomile is a medicinal plant that thrives in diverse regions globally. This plant is abundant in flavonoids and phenolic compounds, which serve as potent antioxidants that neutralize free radicals. Additionally, these compounds exhibit significant inhibitory effects on lipoxygenase, an enzyme involved in free radical production. Chamomile further prevents lipid peroxidation during the initial stages of fatty acid oxidation, which is associated with the formation of malondialdehyde and the release of lactate dehydrogenase and aspartate aminotransferase enzymes (17). Research indicates that an eight-week regimen of combined intermittent aerobic and resistance training, supplemented with chamomile, enhances body composition; however, it

does not appear to influence fasting blood sugar levels, insulin, or the insulin resistance index (18). Additionally, laboratory studies have demonstrated that the intake of 200 mg of chamomile extract, in conjunction with 12 weeks of aerobic exercise, leads to improvements in lipid profile metrics (19). Additionally, other studies indicate that participation in physical activities combined with the intake of chamomile extract contributes to a decrease in fasting glucose levels and improves serum concentrations of triglycerides, total cholesterol, and low-density lipoprotein (16, 17, 20). Consequently, it appears that the synergistic effects of chamomile consumption and physical exercise may be beneficial in enhancing body composition and mitigating pathogenic risk factors.

In light of the challenges and issues related to current treatment and management strategies for obesity, there is a pressing need to explore new approaches for its control. To address this necessity, the beneficial impact of medicinal plants in conjunction with physical exercise can be leveraged. Historically, medicinal plants and herbal supplements have been utilized as therapeutic options, and their popularity is on the rise due to the reduced side effects associated with synthetic medications. This research seeks to investigate the impact of a 12-week regimen of air pump training, in conjunction with chamomile consumption, on the lipid profile parameters of obese male adolescents.

## 2. Methods

### 2.1. Design and Participants

The present study utilized a semi-experimental and applied research design, implementing a pre-test-post-test framework over a span of 12 weeks. The focus was on overweight male adolescents aged 14 to 16 years, who represented the statistical population of interest. A total of 36 participants were recruited based on voluntary involvement and availability, following specific inclusion criteria established through GPower software (effect size 0.5, alpha error 0.05, statistical power 0.8). The inclusion criteria were as follows: 1. Evidence of general health as evaluated by the Goldberg General Health Questionnaire, 2. Age between 14 and 16 years, 3. Body mass index (BMI) ranging from 30 to 34.9 kg/m<sup>2</sup>, 4. No participation in sports activities in the six months prior, as indicated by the GPAQ physical activity questionnaire, and 5. No intake of sports supplements in the preceding six months. The exclusion criteria included: 1. Absence from more than two training sessions weekly, 2. Participation in other sports activities, 3. Experiencing a musculoskeletal injury during the training period, 4. Not consuming chamomile supplements, and 5. Inability to complete both the pre-test and post-test evaluations. Participants were randomly divided into three groups, each comprising 12 individuals: 1) the body pump combined with chamomile sweat group, 2) the body pump training group, and 3) the control group.

### 2.2. Procedure

The process of implementing the research involved several key steps following the final selection of participants. Comprehensive information regarding the research implementation and the results obtained

was communicated to both the participants and their families. Initially, each participant reviewed and signed an informed consent form, while written consent was also secured from each family member. In the initial session, anthropometric data, including height and weight, were documented in the morning. Following a 72-hour rest period, during which participants refrained from engaging in any sports activities, blood samples were obtained by a trained professional in a medical diagnostic laboratory, in accordance with the established timeline. The static muscle strength of both the upper and lower limbs was assessed using hand and foot dynamometers. Following these assessments, participants were invited to the gym to become acquainted with the training program. The researcher provided detailed instructions for the exercise implementation in a separate meeting, after which the exercise program was conducted by an expert skilled in the air pump exercise regimen. This air pump exercise program was executed over a span of 12 weeks, with sessions held three times per week, allowing for 48 hours of rest following the final session. Blood sampling, along with the measurement of anthropometric indicators and static strength of the upper and lower limbs, was repeated thereafter.

### 2.3. Measurements

#### 2.3.1. Anthropometric Measurements

Height and weight were conducted utilizing the Seka brand height and weight device, model 220, manufactured in Germany. This device possesses a sensitivity of 0.01 meters and 100 grams. Each participant's height was measured in accordance with the Frankfurt method, recorded in centimeters, while body weight was obtained and documented in kilograms.

#### 2.3.2. Biological Indices

In this investigation, various lipid profile indices were assessed, including triglycerides, total cholesterol, low-density lipoprotein (LDL), and high-density lipoprotein (HDL). Participants were directed to avoid all forms of physical activity during the overnight fasting period and for a duration of 72 hours leading up to the morning blood sampling. A trained specialist collected 10 cc of blood from the brachial vein, which was subsequently transferred into tubes containing EDTA. The serum was then separated from the blood using a HETICH centrifuge, manufactured in Germany, operating at 3000 rpm, and was frozen at -80 degrees Celsius for future biochemical analysis. For the measurement of lipid profile indices, Pars Azmoun kits produced in Iran were utilized, employing the enzymatic-calorimetric method for triglycerides and total cholesterol, and the photometric-enzymatic method for LDL and HDL.

#### 2.3.3. Static Strength of the Upper and Lower Limbs

To assess the isometric strength of both the upper and lower limbs, a Takei hand dynamometer and a YAGAMI foot dynamometer, both manufactured in Japan, were employed. For the evaluation of lower body strength, participants were instructed to flex their knees to an angle ranging from 130 to 140 degrees while maintaining an upright posture of the upper body.

Also, the category was adjusted based on height. Then the subject was asked to straighten the knees without putting pressure on the back muscles and using the lower body muscles and exerting maximum force. Following the adjustment of the indicator hand, the peak force was documented. In order to assess the strength of the trunk muscles, each participant was positioned on the apparatus such that their knees remained fully extended, with the handle situated in front of the thigh. Each participant took the handle and pulled the force upwards without deviating the body and only using the back muscles, it is necessary to remember that the head and trunk were in a vertical position during the test. A hand dynamometer was employed to assess the muscular strength of the upper body, specifically focusing on the upper limbs of both the right and left hands. Participants were instructed to adopt a standing posture, ensuring that their hands remained positioned alongside their bodies. Then, by holding a hand-held dynamometer once in the right hand and once in the left hand, the person could only bend his arm from his elbow joint to a 90-degree angle. The performer's wrist and forearm should be in a semi-rotated (inward rotation) position. After applying the maximum force, the recorded number was recorded on the device. All the tests were repeated twice and the average scores were recorded (19).

### 2.4. Body Pump Training Protocol

The body pump training regimen was implemented over a duration of 12 weeks, during which participants attended three sessions weekly. Each session had a duration ranging from 45 to 60 minutes. The program included 9 to 12 exercises utilizing free weights, specifically 1 kg, 2.5 kg, and 5 kg plates, along with steps, totaling approximately 800 repetitions per session. For each muscle group, the repetition count ranged from 50 to 100. The exercise regimen was structured to include two sets during the first four weeks, three sets from weeks five to eight, and four sets in the final four weeks. Each exercise segment lasted 4 to 6 minutes, with a one-minute interval for weight adjustments and rest between segments. Additionally, brief breaks of 5 to 10 seconds were incorporated between each exercise section. The training commenced with a comprehensive warm-up targeting the entire body, beginning with larger muscle groups such as the legs, chest, and back, followed by smaller muscle groups like the arms and shoulders, as detailed in Table 1. Each session concluded with a cool-down phase that included stretching exercises. Participants were encouraged to push themselves to the point of exhaustion. It is important to mention that the intensity of the heart rate during the training was monitored using a smartwatch (9).

**Table 1.** Six-Week Air Pump Exercise Program.

Exercise Program	Type of Movement	Sets Done every Two Weeks			Total Repetition
		First to Fourth Week	Fifth to Eighth Week	9th to 12th Week	
<b>Movement of Leg Muscles</b>	Scott	4 Sets of 24 Repetitions	3 Sets of 32 Repetitions	2 Sets of 47 Repetitions	95
<b>Movement of the Chest Muscles</b>	Chest Press	4 Sets of 20 Repetitions	3 Sets of 27 Repetitions	2 Sets of 40 Repetitions	80
<b>Movement of Back Muscles</b>	Underarm Rowing, Deadlift, Weight Lifting Double Movement, Power Shoulder Press	4 Sets of 19 Repetitions	3 Sets of 25 Repetitions	2 Sets of 37 Repetitions	75
<b>Triceps muscle Movement</b>	Back of the Arm from Behind with Barbell in a Seated Position, Back of the Arm with a Barbell, Money Raiser, Back of the Arm with a Dumbbell	4 Sets of 20 Repetitions	3 Sets of 26 Repetitions	2 Sets of 39 Repetitions	78
<b>68Biceps Muscle Movement</b>	Barbell Forearm	4 Sets of 17 Repetitions	3 Sets of 23 Repetitions	2 Sets of 34 Repetitions	68
<b>Movement of Leg Muscles</b>	Squat, Lunge and Jumping Squat	4 Sets of 18 Repetitions	3 Sets of 24 Repetitions	2 Sets of 36 Repetitions	772
<b>Movement of the Shoulder Muscles</b>	Swedish Swimming on Hands, Lateral Press, Underarm with Barbell and Shoulder Press	4 Sets of 19 Repetitions	3 Sets of 25 Repetitions	2 Sets of 38 Repetitions	76
<b>Abdominal Movement</b>	Lying and Sitting, Platelets in Vertical and Sideways Positions	4 Sets of 13 Repetitions	3 Sets of 17 Repetitions	2 Sets of 25 Repetitions	51+ 30 seconds

This method is fundamentally based on volume training. The existing research protocol originates from the work of Rustaden and his associates in 2017, who implemented various exercises with a high number of repetitions. In their study, each exercise was executed across multiple sets. Initially, participants performed repetitions of the squat, chest press, and other exercises until reaching fatigue, followed by a 10-second rest period. Additionally, participants were permitted to take brief pauses during the repetitions (see Table 1).

**2.5. Supplement Consumption**

In this research, participants ingested chamomile extract at a daily dosage of 150 cc, divided into two administrations: one in the morning at 10 am and another in the evening at 10 pm. The extraction of chamomile sweat was conducted using sweating machines, wherein five kilograms of chamomile were

combined with 35 liters of water, resulting in the collection of 24 liters of chamomile sweat (20).

**2.6. Nutritional Status**

The nutritional status of the participants was assessed by instructing each individual to maintain their usual diet throughout the training period. To reduce variability in daily dietary intake, participants were required to document their food consumption over a three-day period, which occurred both during the pre-test phase and at the conclusion of the 12th week of training. The assessment encompassed overall energy consumption along with the respective contributions of carbohydrates, fats, and proteins (see Table 2) (21). The results demonstrated that there were no statistically significant differences in daily energy intake, carbohydrates, proteins, and fats among the groups, with p-values recorded at 0.135, 0.890, 0.784, and 0.889, respectively.

**Table 2.** Energy Consumption and Macronutrients.

Variables	Group	Control Group	
		Before Training	After Training
<b>Energy (kcal per day)</b>	Body Pump Exercise + Chamomile Sweat	2454.50 ± 90.13	2446.90 ± 94.14
	Body Pump Exercise	2490.51 ± 85.58	2508.89 ± 61.13
	Control	2380.31 ± 52.20	2458.64 ± 93.06
<b>Carbohydrates (grams per day)</b>	Body Pump Exercise + Chamomile Sweat	344.92 ± 16.83	344.54 ± 19.65
	Body Pump Exercise	341.17 ± 14.46	347.26 ± 25.25
	Control	3425.77 ± 5.91	348.50 ± 19.29
<b>Protein (grams per day)</b>	Body Pump Exercise + Chamomile Sweat	114.63 ± 13.33	112.01 ± 17.27
	Body Pump Exercise	112.59 ± 10.18	110.76 ± 4.46
	Control	113.63 ± 9.19	114.15 ± 10.61
<b>Fat (g/day)</b>	Body Pump Exercise + Chamomile Sweat	95.20 ± 7.36	97.17 ± 12.72
	Body Pump Exercise	93.64 ± 6.12	97.47 ± 7.74
	Control	99.53 ± 9.32	95.10 ± 6.19

**2.7. Data Analysis**

The approach utilized for the analysis of data measurement involved the application of the ANOVA statistical test. To begin, the normality of the data distribution was assessed using the Shapiro-Wilk test, in accordance with the necessary assumptions for evaluating intergroup differences. Furthermore,

Bonferroni's post hoc test was performed to examine the differences between groups. The data were summarized using mean values and standard deviations. A significance level of P<0.05 was set, and all statistical analyses were carried out using SPSS version 26 software.

### 3. Results

#### 3.1. Demographic Data

The descriptive statistics concerning demographic indicators reveal that participants across the three groups were aged between 14 and 16 years. The mean weight and standard deviation for the air pump combined with baboon sweat exercise group was recorded at  $84.81 \pm 5.93$  kg, while the air exercise group exhibited a mean of  $83.41 \pm 25.6$  kg, and the control group had a mean of  $87.61 \pm 6.79$  kg. In terms of height, the respective means were  $162.89 \pm 6.70$  cm for the air pump + baboon sweat group,  $162.25 \pm 73.73$  cm for the air exercise group, and  $164.25 \pm 7.04$  cm for the control group. BMI values were  $31.98 \pm 1.69$  kg/m<sup>2</sup>,  $31.70 \pm 1.57$  kg/m<sup>2</sup>, and  $32.46 \pm 1.31$  kg/m<sup>2</sup> for the three groups, respectively. It is important to highlight that the normal distribution was maintained in both pre-test and post-test assessments, and no significant differences were found in body weight ( $F=1.36$ ,  $P=0.269$ ), height ( $F=0.243$ ,  $P=0.786$ ), or BMI ( $F=756$ ,  $P=0.478$ ) during the pre-test phase.

#### 3.2. Body Composition

The evaluation of body composition was performed utilizing ANOVA to assess the differences in body weight and BMI, as illustrated in Table 3. The results from the subsequent assessment reveal a significant distinction among the groups: the air pump combined with chamomile veins exercise group, the air pump exercise group, and the control group. Additionally, a significant difference was observed between the air pump training group and the control group regarding both weight and BMI, as outlined in Table 4.

#### 3.3. Lipid Profile

The results obtained from the statistical covariance analysis revealed a significant variation in the changes of triglycerides, total cholesterol, low-density lipoprotein, and high-density lipoprotein across the different research groups ( $p=0.001$ ) (see Table 3). Furthermore, the outcomes from the post-test are detailed in Table 4. These results illustrate a marked difference in the levels of triglycerides, total cholesterol, and low-density lipoprotein among the group receiving air pump training combined with chamomile, the group undergoing air pump training alone, and the control group. Additionally, a significant difference was noted between the air pump training group and the control group regarding triglycerides, total cholesterol, high-density lipoprotein, and low-density lipoprotein. However, no significant difference was found in high-density lipoprotein levels when comparing the air pump training group combined with chamomile to the air pump training group alone.

#### 3.4. The Static Strength of the Upper and Lower Limbs

The ANOVA analysis was conducted to evaluate the variations in static strength of both the upper and lower limbs (refer to Table 3). The findings indicate a significant difference in static muscle strength between the groups for both the right and left upper limbs, as well as the lower limbs. Subsequently, the results from the follow-up test revealed a notable difference between the air pump training group combined with chamomile veins and the control group. However, no significant differences were found in the static muscle strength of the upper and lower limbs when comparing the air pump plus chamomile sweat training group with the air pump training group (see Table 4).

**Table 3.** Results of Analysis of Covariance Related to Changes in Body Composition and Lipid Profiles among Groups.

Variables	Group	Pre-test	Post-test	Adjusted Mean	Intra-Group	Inter-Group
Body Weight (kg)	Body Pump Exercise + Chamomile Sweat	$84.81 \pm 5.93$	$74.52 \pm 5.82$	74.86	0.001*	$F=26.85$ $P=0.001^*$
	Body Pump Exercise	$83.41 \pm 6.25$	$77.96 \pm 66.43$	79.35	0.502	
	Control	$87.61 \pm 6.79$	$86.00 \pm 5.49$	84.29	0.014*	
Body Mass Index (kilograms per square meter)	Body Pump Exercise + Chamomile Sweat	$31.98 \pm 1.69$	$28.19 \pm 2.99$	28.27	0.001*	$F=22.89$ $P=0.001^*$
	Body Pump Exercise	$31.70 \pm 1.57$	$29.62 \pm 1.67$	26.99	0.403	
	Control	$32.46 \pm 1.31$	$31.89 \pm 1.37$	31.46	0.015*	
Triglycerides (mg/dL)	Body Pump Exercise + Chamomile Sweat	$173.51 \pm 21.85$	$149.08 \pm 20.55$	154.83	0.001*	$F=80.88$ $P=0.001^*$
	Body Pump Exercise	$179.00 \pm 26.60$	$160.25 \pm 24.59$	161.01	0.172	
	Control	$187.00 \pm 40.38$	$189.50 \pm 37.33$	182.98	0.001*	
Total Cholesterol (mg/dL)	Body Pump Exercise + Chamomile Sweat	$172.5 \pm 24.46$	$148.33 \pm 26.94$	147.48	0.001*	$F=62.72$ $P=0.001^*$
	Body Pump Exercise	$173.75 \pm 25.15$	$156.67 \pm 21.51$	154.38	0.267	
	Control	$167.33 \pm 26.91$	$169.33 \pm 23.65$	172.46	0.001*	
Low-Density Lipoprotein (mg/dL)	Body Pump Exercise + Chamomile Sweat	$136.50 \pm 11.33$	$117.50 \pm 12.06$	11.19	0.001*	$F=63.38$ $P=0.001^*$
	Body Pump Exercise	$132.17 \pm 15.98$	$120.42 \pm 14.14$	121.97	0.197	
	Control	$133.08 \pm 13.45$	$134.00 \pm 12.54$	134.75	0.001*	
High Density Lipoprotein (mg/dL)	Body Pump Exercise + Chamomile Sweat	$40.75 \pm 3.36$	$50.00 \pm 4.57$	50.11	0.001*	$F=77.16$ $P=0.001^*$
	Body Pump Exercise	$39.42 \pm 5.31$	$48.92 \pm 5.97$	50.39	0.293	
	Control	$42.42 \pm 4.75$	$41.92 \pm 4.75$	40.32	0.001*	
The Standing Strength of the Left Upper Limb (kg)	Body Pump Exercise + Chamomile Sweat	$21.41 \pm 3.52$	$25.75 \pm 3.49$	25.17	0.001*	$F=29.05$ $P=0.001^*$
	Body Pump Exercise	$20.20 \pm 3.09$	$20.66 \pm 4.79$	25.14	0.774	
	Control	$20.55 \pm 5.61$	$24.16 \pm 4.79$	24.16	0.001*	
Standing Strength of the Right Upper Limb (kg)	Body Pump Exercise + Chamomile Sweat	$21.86 \pm 3.10$	$24.70 \pm 2.95$	23.77	0.001*	$F=8.82$ $P=0.001^*$
	Body Pump Exercise	$20.93 \pm 4.99$	$23.95 \pm 4.83$	23.85	0.100	
	Control	$19.65 \pm 5.70$	$22.22 \pm 4.98$	22.22	0.001*	
Lower Limb Static Strength (kg)	Body Pump Exercise + Chamomile Sweat	$39.48 \pm 9.82$	$46.41 \pm 9.03$	48.15	0.001*	$F=17.83$ $P=0.001^*$
	Body Pump Exercise	$45.15 \pm 10.28$	$52.08 \pm 9.54$	49.03	0.326	
	Control	$40.00 \pm 13.27$	$44.41 \pm 11.04$	44.41	0.001*	

\* A significance Level of Less than 0.05 is Considered

**Table 4.** The Results of Post Hoc Analysis Related to Research Variables among Groups.

Variables	Group		P-Value
Body Weight (Kg)	Body Pump Exercise + Chamomile Sweat	Body Pump Exercise	0.021*
	Body Pump Exercise	Control	0.012*
	Control	Body Pump Exercise + Chamomile Sweat	0.001*
Body Mass Index (Kilograms Per Square Meter)	Body Pump Exercise + Chamomile Sweat	Body Pump Exercise	0.016*
	Body Pump Exercise	Control	0.049*
	Control	Body Pump Exercise + Chamomile Sweat	0.001*
Triglycerides (Mg/Dl)	Body Pump Exercise + Chamomile Sweat	Body Pump Exercise	0.034*
	Body Pump Exercise	Control	0.001*
	Control	Body Pump Exercise + Chamomile Sweat	0.001*
Total Cholesterol (Mg/Dl)	Body Pump Exercise + Chamomile Sweat	Body Pump Exercise	0.015*
	Body Pump Exercise	Control	0.001*
	Control	Body Pump Exercise + Chamomile Sweat	0.001*
Low-Density Lipoprotein (Mg/Dl)	Body Pump Exercise + Chamomile Sweat	Body Pump Exercise	0.002*
	Body Pump Exercise	Control	0.001*
	Control	Body Pump Exercise + Chamomile Sweat	0.001*
High Density Lipoprotein (Mg/Dl)	Body Pump Exercise + Chamomile Sweat	Body Pump Exercise	1.00
	Body Pump Exercise	Control	0.001*
	Control	Body Pump Exercise + Chamomile Sweat	0.001*
The Standing Strength Of The Left Upper Limb (Kg)	Body Pump Exercise + Chamomile Sweat	Body Pump Exercise	1.00
	Body Pump Exercise	Control	0.009*
	Control	Body Pump Exercise + Chamomile Sweat	0.010*
Standing Strength Of The Right Upper Limb (Kg)	Body Pump Exercise + Chamomile Sweat	Body Pump Exercise	1.00
	Body Pump Exercise	Control	0.006*
	Control	Body Pump Exercise + Chamomile Sweat	0.008*
Lower Limb Static Strength (Kg)	Body Pump Exercise + Chamomile Sweat	Body Pump Exercise	1.00
	Body Pump Exercise	Control	0.041*
	Control	Body Pump Exercise + Chamomile Sweat	0.038*

#### 4. Discussion

This Research Sought To Examine The Impact Of A 12-Week Program Involving Air Pump Training Alongside The Consumption Of Chamomile Tea On Lipid Profiles, Body Composition, And Functional Strength In Obese Boys Aged 14 To 16 Years. The Findings Revealed A Significant Improvement In Lipid Profile Indicators, Such As Triglycerides, Total Cholesterol, High-Density Lipoprotein, And Low-Density Lipoprotein, In Both The Group Receiving Air Pump Training With Chamomile Tea And The group undergoing air pump training alone, in comparison to the control group. Moreover, the air pump training combined with chamomile tea showed enhancements in these lipid parameters, except for high-density lipoprotein, when contrasted with the air pump training group. Additionally, both the air pump plus chamomile tea group and the air pump training group experienced significant reductions in body weight and BMI compared to the control group, with the former group demonstrating more pronounced improvements. Regarding static strength in the upper and lower limbs, both training approaches resulted in increased muscle strength among the obese participants relative to the control group; however, the differences between the two training groups were not statistically significant. Therefore, it is proposed that the integration of air pump training with chamomile tea consumption may provide more beneficial effects than air pump training alone in reducing pathogenic risk factors and improving body composition and muscle strength in adolescent boys.

Limited investigations have focused on the impact of air pump training on lipid profile alterations. This study assessed the effects of an eight-week progressive air pump training regimen on various atherogenic factors in obese women with dyslipidemia. The findings revealed that air pump training has a favorable effect on lipid profile metrics within this population. The researchers attributed these results to the training's influence on the secretion of catecholamine hormones, growth hormone, and cortisol, which enhances fatty acid oxidation, resulting

in decreased levels of blood triglycerides, total cholesterol, and low-density lipoprotein. Additionally, air pump exercises are thought to promote increased activity of the lipoprotein lipase enzyme and elevate anti-inflammatory cytokines, which may lead to higher levels of high-density lipoprotein and lower levels of low-density lipoprotein, while also aiding in the reverse transport of cholesterol. Engaging in body pump training at moderate intensities significantly enhances fatty acid oxidation during physical activity. The current study's results indicate that a 12-week air pump training program produces positive effects on lipid profile indices in obese boys. It is suggested that body pump training initiatives improve basal metabolism and caloric expenditure both during exercise and on non-exercise days, primarily by focusing on higher repetition movements and the involvement of multiple joint muscles. Furthermore, during exercise, there is a considerable likelihood that energy requirements are predominantly satisfied through aerobic metabolism and fatty acid oxidation.

Research indicates that during an air pump training session, individuals can burn as many as 350 kcal (11, 12). To support previous findings on the efficacy of exercise, various factors can be examined that contribute to the enhancement of lipid profile metrics. Historical studies reveal that a key determinant in lipid profile improvement, particularly in the reduction of blood triglycerides, is linked to increased mitochondrial biogenesis, enhanced lipolysis in adipose tissue, and elevated fatty acid oxidation as a result of physical activity. Specifically, exercise promotes the stimulation of PGC1 $\alpha$ , which is crucial for the upregulation of mitochondrial and oxidative enzymes (23). Enzymes that facilitate the fat oxidation process, such as citrate synthase and beta-hydroxyacyl-CoA dehydrogenase, are instrumental in augmenting fatty acid oxidation and basal metabolic rates (24). Furthermore, exercise positively influences the regulation of fatty acid transporters (FABPpm and FAT/CD36), suggesting that the modulation and adaptation of these transporters may significantly enhance overall fat oxidation within the body (25).

Resistance training, which involves the engagement of large and multi-joint muscle groups, requires a significant amount of energy during physical activity. It is thought that the expression of the lipoprotein lipase enzyme gene, along with the release of catecholamines, is vital for enhancing the activity of lipoprotein lipase. This process aids in the hydrolysis of triglycerides, leading to a decrease in blood triglyceride and low-density lipoprotein levels (26). On the other hand, cholesterol regulation is achieved through the reverse transport mechanism, which removes cholesterol from peripheral tissues and delivers it to the liver via high-density lipoprotein (HDL). This transfer is facilitated by the enzyme lecithin-cholesterol acyltransferase through a direct pathway, as well as by cholesterol ester carrier protein through an indirect pathway (27). Studies have shown that physical activity is associated with increased HDL levels, which can be attributed to heightened activity of lipoprotein lipase and lecithin cholesterol acyltransferase, along with a decrease in liver lipase activity (28).

The present investigation demonstrated significant anthropometric alterations resulting from the air pump intervention in contrast to the control group. These results are consistent with the observations made by Rustaden et al. (10). Additionally, Greco et al. (13) reported that following a 12-week air pump training program, enhancements in muscle strength and endurance were evident; however, the modifications in body composition were not markedly significant (13). The air pump training program is characterized as a group training approach that focuses on high training volume with lighter weights. In this regard, Rustaden et al. (9) examined the impact of air pump training on body composition alterations in overweight women. The training protocol for the air pump group involved performing 50 to 100 repetitions for each muscle group, alongside a resistance training program that included heavy intensity exercises of eight repetitions across three sets. The findings indicated an increase in energy expenditure during the workouts. Furthermore, it was noted that the air pump training method expends approximately 300 kcal more per session compared to traditional resistance training, making it a viable option for enhancing body composition, particularly in reducing fat mass (9). Additionally, Nicholson and colleagues (14) affirmed that prolonged periods of 26 weeks of low-load, high-repetition resistance training can lead to improvements in muscle strength, walking speed, and certain balance attributes among the elderly (14).

Previous studies have demonstrated that physical exercise has a beneficial impact on body composition. A significant mechanism underlying these observations is the frequent movement and sustained muscle contractions that occur during exercise, which activate the AMPK, ERK1.2, and CamkII signaling pathways. This activation enhances the functionality of fatty acid transporters, notably the CD36 transporter. Moreover, exercise increases the activity of AMPK protein in muscle tissue, which can positively influence the expression of enzymes that play a role in fatty acid oxidation and the Krebs cycle. Both short-term and long-term training programs have been shown to positively affect the expression of genes such as PGC-1 alpha, PPAR gamma, and CPT-1 (30). From a hormonal perspective, engaging in moderate to low-intensity exercise can stimulate the release of

hormones that promote greater fatty acid oxidation. Ultimately, the adaptations that improve anthropometric measures are influenced by a variety of factors, including mechanical loading, hormonal responses, muscle contractions, the secretion of myokines, growth factors, cytoskeletal receptors, and other significant elements (31).

The implementation of high-volume exercises leads to enhanced metabolic stress and the secretion of anabolic hormones, including insulin-like growth factor 1; however, this particular study did not assess changes in muscle mass (32). The findings of the current study corroborate that air pump exercises can effectively contribute to reductions in body weight and BMI among obese boys. Engaging multi-joint muscles may facilitate an increase in basal metabolism on non-training days as well as throughout the day. In a related investigation, Grieco et al. (2011) examined the impact of a 12-week air pump training regimen on anthropometric changes, muscle strength, and aerobic fitness in women. This training program was conducted twice a week, yet no significant enhancements were observed in physical fitness, body mass, or body fat (13). The training duration was considered sufficient; however, the frequency of two sessions per week might not have been enough to promote changes in skeletal muscle and adipose tissue. In contrast, the current study implemented a regimen of three sessions per week, indicating that the structure and prescription of the exercise program are essential elements that affect the efficacy of exercise in facilitating adaptations in body composition.

This research employed Chamomile extract as a botanical supplement alongside physical exercise, demonstrating a combined effect on the improvement of anthropometric measurements and lipid profiles in obese male participants. Previous studies have highlighted the positive influence of chamomile tea on enhancing lipid profiles, with Rafrat et al. (17) endorsing its consumption for enhancing atherogenic and glycemic markers in patients with type 2 diabetes (17). A meta-analysis has also indicated that chamomile extract plays a significant role in reducing levels of triglycerides, cholesterol, and low-density lipoprotein (33). The effects of different chamomile extracts on blood glucose levels are thought to arise from the suppression of key enzymes that play a role in gluconeogenesis and glycogenolysis, alongside the enhancement of glucose utilization in peripheral tissues, especially within muscle and adipose tissues. Furthermore, chamomile extract may slow down the digestive process and lower the rates of carbohydrate absorption (34). The extract additionally improves insulin sensitivity by activating the peroxisome proliferator-activated receptor (PPAR) family, which plays a vital role in the regulation of glucose and lipid balance (35). Notably, the activation of PPAR $\gamma$  in adipocytes is recognized as an effective approach in antidiabetic treatment (36). Luteolin, found in chamomile extract, has been demonstrated to increase the expression of the adiponectin gene. This elevation subsequently facilitates peripheral glucose utilization through the activation of the AMPK enzyme and the expression of the PPAR $\gamma$  gene in both muscle and adipose tissues, thereby improving metabolic processes (37). Nevertheless, a comprehensive understanding of the precise mechanisms by which this plant influences metabolic pathways necessitates further molecular-level investigation.

The present study demonstrated an improvement in static muscle strength in both the upper and lower limbs of the participants. It was observed that muscle fatigue intensifies when a high volume of repetitions is executed alongside the engagement of movement units (9). This increase in activation is linked to a greater recruitment of motor units, particularly in type II fibers. It appears that the high repetition training regimen has positively influenced muscle strength development. Consequently, the findings from six weeks of air pump training, conducted three times a week, demonstrate effectiveness in enhancing muscle strength. A notable limitation of the current study is the absence of an analysis regarding the impact of chamomile consumption, as well as the failure to investigate its influence on alterations in lipid profiles. Furthermore, this study did not assess the pubertal status of adolescents - whether they were before, during, or after puberty - thereby neglecting to account for the effects of growth on changes in lipid profiles.

#### 4.1. Conclusion

Overall, the implementation of the air pump training program, along with the intake of chamomile sweat, resulted in enhancements to lipid profile indices. Additionally, alterations in body weight and BMI were noted, while the air pump exercises proved effective in increasing muscle strength. This innovative training approach, characterized by its diverse range of exercises, is recommended for adolescent boys facing obesity, as it may help prevent and ameliorate pathogenic risk factors (atherogenic indicators), as well as enhance functional strength and promote favorable anthropometric changes.

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#### Footnotes

**Authors' Contribution:** Study concept and design: Z. F; F. N. Acquisition of data: Z. F. Analysis and interpretation of data: F. N. Drafting of the manuscript: Z. F; F. N. Critical revision of the manuscript for important intellectual content: Z. F. Statistical analysis: Z. F. Administrative, technical, and material support: F. N. Study supervision: Z. F; F. N.

**Conflict of Interests:** The researchers confirm that there is no conflict of interests in this study with any participant.

**Data Availability:** The data that support the findings of this study are openly available upon request from the corresponding author.

**Ethical Approval:** Approval for this study was obtained from the university. The authors confirm that all steps and requirements of this study comply with ethical guidelines. Participants were informed about the characteristics of the study and gave written informed consent.

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#### ORCID iD

Farzad Zehsaz  <https://orcid.org/0000-0003-0224-3404>

#### References

- Nicolucci A, Maffei C. The adolescent with obesity: what perspectives for treatment? *Ital J Pediatr.* 2022;**48**(1):9. [PubMed ID: 35033162]. [PubMed Central ID: PMC8761267]. doi: 10.1186/s13052-022-01205-w.
- NCD Risk Factor Collaboration (NCD-RisC). Worldwide trends in body-mass index, underweight, overweight, and obesity from 1975 to 2016: a pooled analysis of 2416 population-based measurement studies in 128.9 million children, adolescents, and adults. *Lancet.* 2017;**390**(10113):2627-2642. [PubMed ID: 29029897]. [PubMed Central ID: PMC5735219]. doi: 10.1016/S0140-6736(17)32129-3.
- Asgari E, Askari M, Bellissimo N, Azadbakht L. Association between Ultraprocessed Food Intake and Overweight, Obesity, and Malnutrition among Children in Tehran, Iran. *Int J Clin Pract.* 2022;**2022**:8310260. [PubMed ID: 36081808]. [PubMed Central ID: PMC9433238]. doi: 10.1155/2022/8310260.
- Horesh A, Tsur AM, Bardugo A, Twig G. Adolescent and Childhood Obesity and Excess Morbidity and Mortality in Young Adulthood-a Systematic Review. *Curr Obes Rep.* 2021;**10**(3):301-310. [PubMed ID: 33950400]. doi: 10.1007/s13679-021-00439-9.
- Li D, Chen P. The Effects of Different Exercise Modalities in the Treatment of Cardiometabolic Risk Factors in Obese Adolescents with Sedentary Behavior-A Systematic Review and Meta-Analysis of Randomized Controlled Trials. *Children (Basel).* 2021;**8**(11):1062. [PubMed ID: 34828775]. [PubMed Central ID: PMC8623410]. doi: 10.3390/children8111062.
- Mora-Gonzalez J, Esteban-Cornejo I, Solis-Urra P, Rodriguez-Ayllon M, Cadenas-Sanchez C, Hillman CH, Kramer AF, Catena A, Ortega FB. The effects of an exercise intervention on neuroelectric activity and executive function in children with overweight/obesity: The ActiveBrains randomized controlled trial. *Scand J Med Sci Sports.* 2024;**34**(1):e14486. [PubMed ID: 37691352]. doi: 10.1111/sms.14486.
- Petridou A, Siopi A, Mougios V. Exercise in the management of obesity. *Metabolism.* 2019;**92**:163-169. [PubMed ID: 30385379]. doi: 10.1016/j.metabol.2018.10.009.
- Bülbul S. Exercise in the treatment of childhood obesity. *Turk Pediatri Ars.* 2020;**55**(1):2-10. [PubMed ID: 32231444]. [PubMed Central ID: PMC7096559]. doi: 10.14744/TurkPediatriArs.2019.60430.
- Rustaden AM, Haakstad LAH, Paulsen G, Bø K. Effects of BodyPump and resistance training with and without a personal trainer on muscle strength and body composition in overweight and obese women-A randomised controlled trial. *Obes Res Clin Pract.* 2017;**11**(6):728-739. [PubMed ID: 28392264]. doi: 10.1016/j.orcp.2017.03.003.
- Rustaden AM, Gjestvang C, Bø K, Hagen Haakstad LA, Paulsen G. BodyPump versus traditional heavy load resistance training on changes in resting metabolic rate in overweight untrained women. *J Sports Med Phys Fitness.* 2018;**58**(9):1304-1301. [PubMed ID: 28745475]. doi: 10.23736/S0022-4707.17.07613-7.
- Rustaden AM, Gjestvang C, Bø K, Haakstad LAH, Paulsen G. Similar Energy Expenditure During BodyPump and Heavy Load Resistance Exercise in Overweight Women. *Front Physiol.* 2020;**11**:570. [PubMed ID: 32587526]. [PubMed Central ID: PMC7298122]. doi: 10.3389/fphys.2020.00570.
- Harris N, Kilding A, Sethi S, Merien F, Gottschall J. A comparison of the acute physiological responses to BODYPUMP™ versus isocaloric and iso-time steady state cycling. *J Sci Med Sport.* 2018;**21**(10):1085-1089. [PubMed ID: 29525202]. doi: 10.1016/j.jsams.2018.02.010.
- Greco CC, Oliveira AS, Pereira MP, Figueira TR, Ruas VD, Gonçalves M, Denadai BS. Improvements in metabolic and neuromuscular fitness after 12-week bodypump® training. *J Strength Cond Res.* 2011;**25**(12):3422-31. [PubMed ID: 22080312]. doi: 10.1519/JSC.0b013e3182160053.
- Nicholson VP, McKean MR, Burkett BJ. Low-load high-repetition resistance training improves strength and gait speed in middle-aged and older adults. *J Sci Med Sport.* 2015;**18**(5):596-600. [PubMed ID: 25154701]. doi: 10.1016/j.jsams.2014.07.018.
- Yedjou CG, Grigsby J, Mbemi A, Nelson D, Mildort B, Latinwo L, Tchounwou PB. The Management of Diabetes Mellitus Using Medicinal Plants and Vitamins. *Int J Mol Sci.* 2023;**24**(10):9085. [PubMed ID: 37240430]. [PubMed Central ID: PMC10218826]. doi: 10.3390/ijms24109085.
- Lubkowska A, Bryczkowska I, Gutowska I, Rotter I, Marczuk N, Baranowska-Bosiacka I, Banfi G. The Effects of Swimming Training in Cold Water on Antioxidant Enzyme Activity and Lipid Peroxidation in Erythrocytes of Male and Female Aged Rats. *Int J*

- Environ Res Public Health. 2019;**16**(4):647. [PubMed ID: 30813224]. [PubMed Central ID: PMC6406484]. doi: 10.3390/ijerph16040647.
17. Rafrat M, Zemestani M, Asghari-Jafarabadi M. Effectiveness of chamomile tea on glycemic control and serum lipid profile in patients with type 2 diabetes. *J Endocrinol Invest.* 2015;**38**(2):163-70. [PubMed ID: 25194428]. doi: 10.1007/s40618-014-0170-x.
  18. Lee JS, Kim CG, Seo TB, Kim HG, Yoon SJ. Effects of 8-week combined training on body composition, isokinetic strength, and cardiovascular disease risk factors in older women. *Aging Clin Exp Res.* 2015;**27**(2):179-86. [PubMed ID: 24997614]. doi: 10.1007/s40520-014-0257-4.
  19. Rafrat M, Zemestani M, Asghari-Jafarabadi M. Effectiveness of chamomile tea on glycemic control and serum lipid profile in patients with type 2 diabetes. *J Endocrinol Invest.* 2015;**38**(2):163-70. [PubMed ID: 25194428]. doi: 10.1007/s40618-014-0170-x.
  20. Tokmakidis SP, Kokkinidis EA, Smilios I, Douda H. The effects of ibuprofen on delayed muscle soreness and muscular performance after eccentric exercise. *J Strength Cond Res.* 2003;**17**(1):53-9. [PubMed ID: 12580656]. doi: 10.1519/1533-4287(2003)017<0053:teoiod>2.0.co;2.
  21. Sharp C. Kinanthropometry and Exercise Physiology Laboratory Manual. Tests, procedures and data. *Br J Sports Med.* 1996;**30**(2):186. [PubMed Central ID: PMC1332397].
  22. Sharghi M, Mansurkhani SM, Larky DA, Kooti W, Niksefat M, Firozbakht M, Behzadifar M, Azami M, Servatyari K, Jouybari L. An update and systematic review on the treatment of primary dysmenorrhea. *JBRA Assist Reprod.* 2019;**23**(1):51-57. [PubMed ID: 30521155]. [PubMed Central ID: PMC6364281]. doi: 10.5935/1518-0557.20180083.
  23. Bagheri R, Rashidlamir A, Motevalli MS, Elliott BT, Mehrabani J, Wong A. Effects of upper-body, lower-body, or combined resistance training on the ratio of follistatin and myostatin in middle-aged men. *Eur J Appl Physiol.* 2019;**119**(9):1921-1931. [PubMed ID: 31240397]. doi: 10.1007/s00421-019-04180-z.
  24. Juhas I, Skof B, Popović D, Matić M, Janković N. Effects of an eight-week exercise program on parameters of the lipid profile of female students. *J Med Biochem.* 2020;**39**(1):40-45. [PubMed ID: 32549776]. [PubMed Central ID: PMC7282232]. doi: 10.2478/jomb-2019-0006.
  25. Ouerghi N, Fradj MKB, Bezrati I, Khammassi M, Feki M, Kaabachi N, Bouassida A. Effects of high-intensity interval training on body composition, aerobic and anaerobic performance and plasma lipids in overweight/obese and normal-weight young men. *Biol Sport.* 2017;**34**(4):385-392. [PubMed ID: 29472742]. [PubMed Central ID: PMC5819474]. doi: 10.5114/biolsport.2017.69827.
  26. Durstine JL, Grandjean PW, Cox CA, Thompson PD. Lipids, lipoproteins, and exercise. *J Cardiopulm Rehabil.* 2002;**22**(6):385-98. [PubMed ID: 12464825]. doi: 10.1097/00008483-200211000-00002.
  27. Talanian JL, Galloway SD, Heigenhauser GJ, Bonen A, Spriet LL. Two weeks of high-intensity aerobic interval training increases the capacity for fat oxidation during exercise in women. *J Appl Physiol.* 1985. 2007;**102**(4):1439-47. [PubMed ID: 17170203]. doi: 10.1152/jappphysiol.01098.2006.
  28. Burns SF, Miyashita M, Stensel DJ. High-Intensity Interval Exercise and Postprandial Triacylglycerol. *Sports Med.* 2015;**45**(7):957-68. [PubMed ID: 25851583]. doi: 10.1007/s40279-015-0327-6.
  29. Marques LR, Diniz TA, Antunes BM, Rossi FE, Caperuto EC, Lira FS, Gonçalves DC. Reverse Cholesterol Transport: Molecular Mechanisms and the Non-medical Approach to Enhance HDL Cholesterol. *Front Physiol.* 2018;**9**:526. [PubMed ID: 29867567]. [PubMed Central ID: PMC5962737]. doi: 10.3389/fphys.2018.00526.
  30. Mann S, Beedie C, Jimenez A. Differential effects of aerobic exercise, resistance training and combined exercise modalities on cholesterol and the lipid profile: review, synthesis and recommendations. *Sports Med.* 2014;**44**(2):211-21. [PubMed ID: 24174305]. [PubMed Central ID: PMC3906547]. doi: 10.1007/s40279-013-0110-5.
  31. Zechner R, Zimmermann R, Eichmann TO, Kohlwein SD, Haemmerle G, Lass A, Madeo F. FAT SIGNALS—lipases and lipolysis in lipid metabolism and signaling. *Cell Metab.* 2012;**15**(3):279-91. [PubMed ID: 22405066]. [PubMed Central ID: PMC3314979]. doi: 10.1016/j.cmet.2011.12.018.
  32. Gaidhu MP, Fediuc S, Anthony NM, So M, Mirpourian M, Perry RL, Ceddia RB. Prolonged AICAR-induced AMP-kinase activation promotes energy dissipation in white adipocytes: novel mechanisms integrating HSL and ATGL. *J Lipid Res.* 2009;**50**(4):704-15. [PubMed ID: 19050316]. [PubMed Central ID: PMC2656664]. doi: 10.1194/jlr.M800480-JLR200.
  33. Schoenfeld BJ. The mechanisms of muscle hypertrophy and their application to resistance training. *J Strength Cond Res.* 2010;**24**(10):2857-72. [PubMed ID: 20847704]. doi: 10.1519/JSC.0b013e318e840f3.
  34. Schoenfeld BJ, Peterson MD, Ogborn D, Contreras B, Sonmez GT. Effects of Low- vs. High-Load Resistance Training on Muscle Strength and Hypertrophy in Well-Trained Men. *J Strength Cond Res.* 2015;**29**(10):2954-63. [PubMed ID: 25853914]. doi: 10.1519/JSC.0000000000000958.
  35. Khalid N, Abdelrahim DN, Hanach N, AlKurd R, Khan M, Mahrous L, Radwan H, Naja F, Madkour M, Obaideen K, Khraiweh H, Faris M. Effect of camel milk on lipid profile among patients with diabetes: a systematic review, meta-analysis, and meta-regression of randomized controlled trials. *BMC Complement Med Ther.* 2023;**23**(1):438. [PubMed ID: 38049802]. [PubMed Central ID: PMC10696884]. doi: 10.1186/s12906-023-04257-5.
  36. Kato A, Minoshima Y, Yamamoto J, Adachi I, Watson AA, Nash RJ. Protective effects of dietary chamomile tea on diabetic complications. *J Agric Food Chem.* 2008;**56**(17):8206-11. [PubMed ID: 18681440]. doi: 10.1021/jf8014365.
  37. Weidner C, Wowro SJ, Rousseau M, Freiwald A, Kodelja V, Abdel-Aziz H, Kelber O, Sauer S. Antidiabetic effects of chamomile flowers extract in obese mice through transcriptional stimulation of nutrient sensors of the peroxisome proliferator-activated receptor (PPAR) family. *PLoS One.* 2013;**8**(11):e80335. [PubMed ID: 24265809]. [PubMed Central ID: PMC3827197]. doi: 10.1371/journal.pone.0080335.
  38. Spiegelman BM. PPAR-gamma: adipogenic regulator and thiazolidinedione receptor. *Diabetes.* 1998;**47**(4):507-14. [PubMed ID: 9568680]. doi: 10.2337/diabetes.47.4.507.
  39. Ding L, Jin D, Chen X. Luteolin enhances insulin sensitivity via activation of PPAR $\gamma$  transcriptional activity in adipocytes. *J Nutr Biochem.* 2010;**21**(10):941-7. [PubMed ID: 19954946]. doi: 10.1016/j.jnutbio.2009.07.009.