O MUNDO DA SAÚDE

DOI: 10.15343/0104-7809.202448e16002024I

Assessment of body composition in adolescents with obesity undergoing avocado oil supplementation

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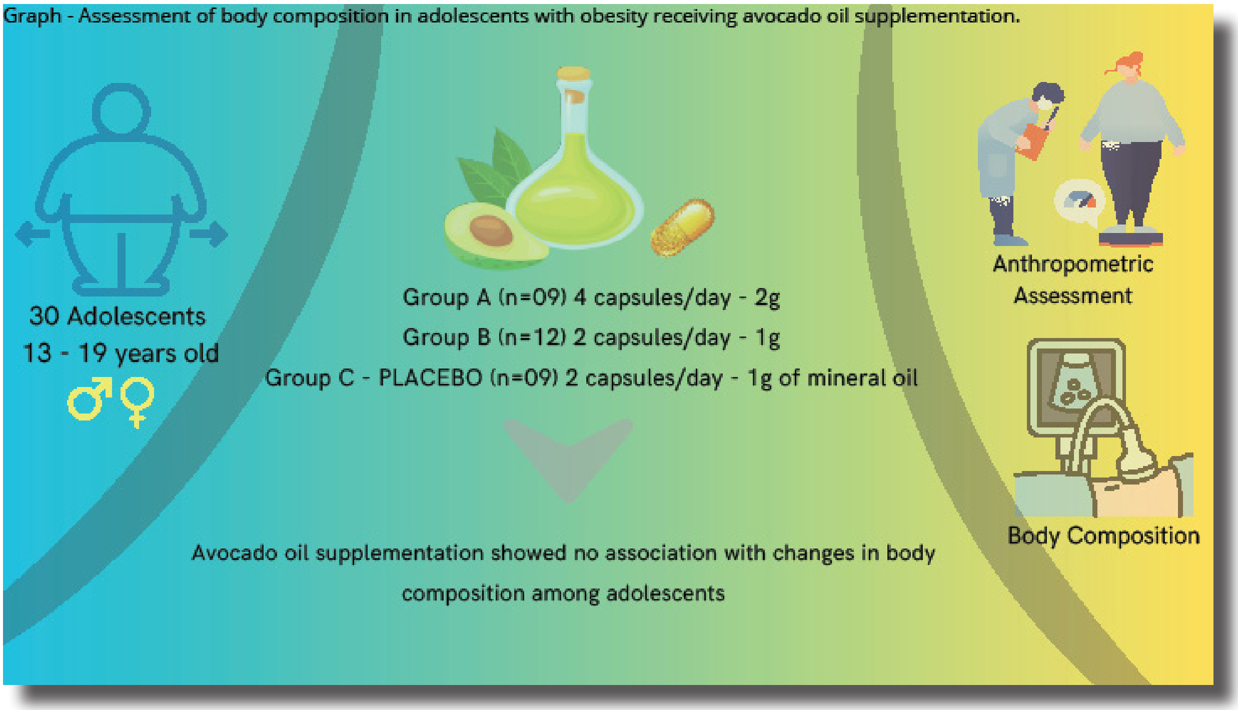
Graphical Abstract

Graph - Assessment of body composition in adolescents with obesity receiving avocado oil supplementation.



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Abstract

The prevalence of obesity is considered a global epidemic, with severe repercussions for public health. Therefore, the objective is to present preliminary data on the application of avocado oil as a supplement for the treatment of obesity. A randomized, double-blind, placebo-controlled clinical trial was conducted at a school clinic in the municipality of São Paulo. Thirty post-pubertal adolescents aged between 12 and 19 years were selected. They were divided into: group A (n=09), supplemented with 4 capsules/day containing 500 mg of avocado oil = 2 g of avocado oil; group B (n=12), supplemented with 2 capsules/day containing 500 mg of avocado oil = 1 g of avocado oil; and group C (n=09), supplemented with 2 capsules/day containing 500 mg of mineral oil – placebo group = 1 g of mineral oil. Anthropometric measurements such as body mass, height, body mass index (BMI), waist circumference (WC), neck circumference (NC), blood pressure, body composition by bioimpedance (Biodynamics), and ultrasound (Body Metrix) were evaluated. A significant increase in body mass was observed in the group supplemented with 1g, as well as a reduction in resistance, extracellular mass (kg), BMR, intracellular water (L), total water (L), FFM lean mass, and FFM total weight. The placebo group showed a reduction in resistance, an increase in body cell mass, lean mass, BMR, intracellular water (L), FFM lean mass, and FFM total weight. It was concluded that, despite the ingestion of a bioactive compound aiding in obesity control, qualitative changes related to eating habits remain crucial for achieving significant results in body composition.

Keywords: Obesity. Adolescents. Supplementation. Avocado Oil. Body Composition.

INTRODUCTION

Obesity can be characterized as a complex disease with a multifactorial etiology, including genetic components, inadequate dietary habits, environmental, and behavioral factors, which substantially increase the risk of developing comorbidities such as cardiovascular diseases, various types of cancer, and diabetes[1].

In recent decades, the global increase in overweight and obesity has become an epidemic with serious public health implications[2]. In 2020, the WHO warned of the alarming growth of these issues, projecting that by 2025, 2.3 billion people will be overweight, with 700 million suffering from obesity[3]. In Brazil, in 2019, 19.4% of adolescents aged 15 to 17 were overweight, totaling around 1.8 million people, with a higher prevalence among girls (22.9%) than boys (16.0%). Obesity rates were also higher among girls (8.0%) compared to boys (5.4%)[4].

Excess weight during adolescence can have significant consequences in adulthood, such as an increased risk of metabolic syndrome — a set of metabolic and hormonal alterations that includes glucose intolerance (or diabetes), high blood pressure, dyslipidemia, and abdominal obesity, all factors related to insulin resistance[5]. During this stage of life, adolescents gain greater independence and autonomy, directly influencing their dietary choices and involvement in social activities, which can either exacerbate or mitigate these future risks[6].

Although there have been some improvements in diet quality among children and adolescents, data from NHANES 2003–2018 show that many continue to consume low-quality foods, such as late-night snacks and sugary beverages[7]. In response to these challenges and the growing obesity rates, the WHO set a target for 2025 to reduce premature mortality from chronic diseases by 25%, highlighting the importance of effective strategies to monitor excess body fat and promote healthy eating habits[2].

In this context, foods like avocado, with its rich profile of bioactive substances, offer a healthy and promising alternative for treating obesity and its comorbidities. Its oil, extracted from the ripe fruit pulp, is a gourmet product with health benefits, containing oleic acid, palmitic acid, and linoleic acid, as well as α-tocopherol and fat-soluble vitamins A and D[8].

α-Tocopherol has been considered the

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most efficient antioxidant for reducing the formation of free radicals[9]. Animal studies indicate that the type of dietary oil can influence body composition and adiposity[10]. In healthy adults with normal weight or overweight, it was observed that those who consumed a high-fat breakfast (43% of energy from MUFA, such as virgin olive oil) exhibited higher rates of postprandial fat oxidation compared to those who consumed an isocaloric meal with saturated fat. Additionally, the thermic effect was significantly higher in individuals with an elevated waist circumference (≥99 cm), suggesting that MUFA-rich meals promote greater postprandial fat oxidation[11].

The long-term impact of these differences in substrate oxidation rates and thermogenesis (body mass and composition) still needs to be clarified[12]. Studies have investigated the effects of monounsaturated fats (MUFA) on weight loss, serum lipid concentrations, and other cardiovascular risk factors in overweight individuals during 8 weeks of weight loss. The results showed that reducing energy intake had the same effect on weight loss, regardless of whether MUFAs were replaced with carbohydrates, without altering the concentrations of saturated fatty acids (SFAs) and polyunsaturated fats[10].

Considering the scarcity of exploratory studies on the effect of avocado oil supplementation on body composition in adolescents, it becomes relevant to evaluate the effect of supplementation on the body composition of obese adolescents.

MATERIALS AND METHODS

A pilot randomized, double-blind, placebo-controlled clinical trial was conducted at the Center for Health Promotion and Rehabilitation and Social Integration (PROMOVE) of São Camilo University Center, after the approval of the coordinator of the mentioned school clinic through a co-participation letter. Conducted in accordance with the principles of the Declaration of Helsinki, it was previously approved by the Research Ethics Committee (COEP), in accordance with the approved opinion nº 6.077.464 from the Specialized Educational Assistance Center (CAEE) nº 61242122.3.0000.0062. The research participants (adolescents), as well as their guardians, read and signed the Informed Consent Form (ICF), and in the case of minors, their parents and/or guardians signed the Consent and Assent Form (CAF).

Patients aged 12 to 19 in the post-pubertal stage (according to Tanner criteria)[13] were selected through the adolescent medicine department of the clinic, as well as external volunteer patients recruited via social media and educational institutions. The inclusion of research participants was carried out through an in-person screening consultation with data collection to confirm the criteria via anthropometric evaluation: weight, height, body mass index (BMI) calculation, waist circumference (WC), and blood pressure. Additionally, a brief anamnesis was conducted to collect personal data. Recent laboratory tests were analyzed for classification of metabolic syndrome criteria. Patients were excluded based on the following criteria: diagnosis of familial hypercholesterolemia, chronic diseases, endocrine or inflammatory bowel diseases, chronic and abusive consumption of alcohol and drugs, use of medications that could interfere with body composition, use of supplements or medications for weight reduction, moderate or intense physical activity (more than 3 times per week), allergy to any component of the formula, and current or recent participation in another interventional study protocol. A total of 30 adolescents with obesity and metabolic syndrome-related conditions were selected and divided into three groups: Group A (n=09), supplemented with 4 capsules/day containing 500 mg of avocado oil = 2 g of

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avocado oil; Group B (n=12), supplemented with 2 capsules/day containing 500 mg of avocado oil = 1 g of avocado oil; and Group C (n=09), supplemented with 2 capsules/day containing 500 mg of mineral oil – placebo group = 1 g of mineral oil.

In the consultation prior to supplementation and at the end of the 12-week intervention, fasting patients were evaluated for anthropometric measurements: body weight, height, waist circumference, and neck circumference.

For weight measurement (in kg), a Micheletti brand digital scale, model MIC3-LED, with a capacity of up to five digits, was used on a smooth and flat surface. The individual was barefoot, wearing light clothing, and with empty pockets, standing in the center of the platform in an upright position with weight evenly distributed on both feet, looking straight ahead. Height was measured using a Sanny ES2030 wall-mounted stadiometer, with the individual barefoot, standing upright in the center of the equipment, arms extended along the body, head raised, looking at a fixed point at eye level, and keeping the heels, calves, buttocks, scapulas, and back of the head in contact with the stadiometer. The parameter used to assess the adolescents' anthropometric profile followed the recommendations of the World Health Organization (WHO) according to the Body Mass Index (BMI), classified in Z-scores according to sex and age. The following criteria were used: underweight (< Z-score -2); normal weight (≥ Z-score -2 and < Z-score +1); overweight (≥ Z-score +1 and < Z-score +2); and obesity (≥ Z-score +2)[14].

For circumference measurements, a Cescorf steel anthropometric tape measure (2 meters) was used for waist measurement. The individual stood upright, with a relaxed abdomen, arms extended along the body, legs parallel and slightly apart, and clothing slightly loosened from the body. After a small mark was made at the midpoint between the lower edge of the last rib and the hip bone, the tape was passed around the waist over the mark and measured after the patient's full inspiration and expiration, according to the WHO (2000) protocol. The Waist/Height Ratio was used to identify cardiovascular risk, with a cutoff point of ≥0.5[13]. For neck circumference, the same tape was used with the individual seated upright, face forward in the Frankfurt Plane, with the tape positioned horizontally above the laryngeal prominence (Adam's apple) and the reading taken laterally[14,15].

Blood pressure was measured using the oscillometric method with a digital Omron® device, model HEM-7221NT, using appropriately sized cuffs for the arm circumference. The average of three systolic and diastolic blood pressure readings was considered, taken after one minute of rest, with the participant seated and the dominant arm supported on a stand[14,16,2,13].

Body composition analysis was conducted using bioelectrical impedance, following a prior preparation protocol, with the Biodynamics 310® device, which uses a low-intensity, imperceptible electric current (20 KHz and 100 KHz) that passes through the body, measuring the resistance offered by various tissues, with the individual lying on a stretcher and four electrodes placed on the feet and hands. Additionally, body composition was assessed through ultrasound, scanning strategic points on the body to obtain real images of fat and muscle tissues using the Body Metrix®. This analysis allowed the identification of: fat mass percentage and kg; lean mass percentage and kg; basal metabolic rate; comorbidity risk classification; and qualitative aspects of adipose and muscle tissue[17].

STATISTICAL ANALYSIS

To verify data normality, the Kolmogorov--Smirnov test was used, and the Levene test was applied to check for homogeneity of variance. The data were presented as mean ± standard deviation. For comparisons between baseline measurements and at the end of the intervention and avocado oil supplementation, the paired Student's t-test was used. For the analysis between groups A (supplemented with 4 capsules/day containing 500 mg of avocado oil = 2 g of avocado oil), B (supplemented with 2 capsules/day containing 500 mg of avocado oil = 1 g of avocado oil), and C (supplemented with 2 capsules/day containing 500 mg of mineral oil – placebo group = 1 g of mineral oil), one-way ANOVA with Fisher's post hoc test was applied. All data were analyzed using STATISTICA software version 6.0 for Windows, and the significance level was set at $p \leq 0.05$.

RESULTS

Thirty-four patients were selected to participate in the research and began supplementation with the capsules. However, four of these patients did not complete the protocol, as they did not undergo the necessary tests after the consultations, making it impossible to compare the results before and after capsule ingestion. Thus, the adherence rate to avocado oil supplementation was 88.2%. All patients were initially classified, during the consultation, as being at risk of developing cardiovascular diseases, and this classification remained unchanged after the research protocol was completed.

Groups A (2g), B (1g), and C (placebo) showed weight gain, which was statistically significant in group B. An increase in body mass index and abdominal adiposity was also observed, but without statistical significance (Table 1).

Table 1 - Descriptive analysis of anthropometric measurements and blood pressure levels in adolescents with obesity undergoing avocado oil supplementation. São Paulo, 2023.

Variables	Group A (2g)						Group B (1g)						Group C (placebo)					
	Pre			Post			Pre			Post			Pre			Post		
Weight (kg)	101.6	±	24.9	102.7	±	25.5	95.3	±	19.9	97.1	±	21.0*	90.4	±	15.4	91.8	±	15.3
Height (m)	1.6	±	0.1	1.6	±	0.1	1.6	±	0.1	1.6	±	0.1	1.6	±	0.1	1.7	±	0.1
BMI (kg/m²)	37.6	±	8.4	37.8	±	8.8	36.7	±	6.9	37.2	±	7.1	32.8	±	4.0	33.4	±	3.8
Waist Circumference (cm)	96.4	±	12.2	96.5	±	14.0	96.1	±	7.9	96.6	±	9.0	92.1	±	6.7	93.4	±	7.2
Neck Circumference (cm)	3.9	±	3.2	38.4	±	2.5	36.8	±	2.8	36.6	±	2.7	36.8	±	2.4	37.3	±	2.7
BMI/Age	1.6	±	0.5	1.7	±	0.5	1.4	±	0.5	1.6	±	0.7	1.4	±	0.5	1.3	±	0.5
Height/Age	1.0	±	0.0	1.0	±	0.0	1.0	±	0.0	1.0	±	0.0	1.0	±	0.0	1.0	±	0.0
Systolic BP (mmHg)	105.8	±	11.2	112.0	±	11.0	110.6	±	14.4	110.7	±	8.9	108.9	±	13.7	107.8	±	15.9
Diastolic BP (mmHg)	65.2	±	17.8	67.8	±	18.1	63.7	±	15.8	66.8	±	7.0	60.8	±	16.1	72.0	±	25.2

*Difference between pre- and post-supplementation, $p<0.05$.

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Table 2 - Comparison of Bioimpedance Data Pre and Post Avocado Oil Supplementation in Groups A (2g), Group B (1g), and Group C (Placebo). São Paulo, 2023.

Variables	Group A (2g)						Group B (1g)						Group C (placebo)					
	Pre			Post			Pre			Post			Pre			Post		
Phase Angle (º)	6.4	±	1.0	6.5	±	1.1	6.7	±	1.0	6.7	±	1.0	6.8	±	1.0	6.8	±	0.6
Resistance (ohms)	513.3	±	77.1	494.6	±	69.3	526.0	±	68.6	509.4	±	72.4*	510.4	±	73.9	490.4	±	71.6*
Reactance (ohms)	57.4	±	9.2	56.7	±	11.3	61.1	±	9.1	59.1	±	8.7	60.5	±	7.7	57.8	±	5.9
Body Cell Mass (kg)	29.5	±	4.7	30.4	±	4.4	28.7	±	5.4	29.3	±	6.0	28.9	±	5.4	29.6	±	5.2*
Body Cell Mass (%)	29.7	±	4.2	30.3	±	4.0	30.6	±	4.0	30.5	±	3.9	39.9	±	23.4	32.3	±	2.3
Extracellular Mass (kg)	32.2	±	5.9	32.8	±	6.7	28.9	±	5.0	29.6	±	5.1*	29.7	±	5.5	30.5	±	5.3
Extracellular Mass (%)	32.1	±	3.2	32.3	±	3.0	30.6	±	2.1	30.9	±	2.2	32.9	±	3.0	33.4	±	2.7
Lean Mass (kg)	61.7	±	9.8	63.3	±	10.3	57.6	±	10.0	58.9	±	10.7*	58.6	±	10.4	60.2	±	10.2*
Lean Mass (%)	61.8	±	6.5	62.6	±	5.7	61.1	±	5.6	61.4	±	5.5	64.8	±	3.7	65.6	±	4.0
Fat Mass (kg)	39.9	±	16.3	39.5	±	15.9	37.6	±	12.3	38.1	±	12.9	31.8	±	6.5	31.7	±	7.0
Fat Mass (%)	37.6	±	5.7	37.4	±	5.7	38.9	±	5.6	38.6	±	5.5	35.2	±	3.7	34.4	±	4.0
ECM/BCM	1.1	±	0.1	1.1	±	0.2	1.0	±	0.1	9.7	±	30.0	1.0	±	0.1	1.0	±	0.1
BMI	37.6	±	8.3	37.8	±	8.7	36.6	±	6.8	42.5	±	19.5	33.1	±	3.7	33.5	±	3.8

to be continued...

DOI: 10.15343/0104-7809.202448e16002024I

...continuation table 2

Variables	Group A (2g)						Group B (1g)						Group C (placebo)					
	Pre			Post			Pre			Post			Pre			Post		
BMR (kcal)	1925.1	±	304.7	1973.7	±	319.6	1798.0	±	312.5	1837.5	±	332.6*	1826.8	±	324.8	1877.1	±	319.2*
Intracellular Water (L)	22.3	±	3.1	23.1	±	2.8	21.2	±	5.0	22.0	±	5.5*	22.7	±	4.5	23.5	±	4.6*
Intracellular Water (%)	54.0	±	3.8	54.3	±	4.3	53.2	±	4.4	49.3	±	9.5	55.5	±	3.9	55.2	±	2.8
Extracellular Water (L)	19.0	±	2.9	19.5	±	3.4	18.6	±	3.9	20.8	±	6.2	18.3	±	4.3	19.1	±	4.2
Extracellular Water (%)	46.0	±	3.8	45.7	±	4.3	46.8	±	4.4	47.1	±	4.4	44.5	±	3.9	44.8	±	2.8
Total Water (L)	41.3	±	5.1	42.7	±	5.0	39.8	±	7.8	41.5	±	8.4*	41.0	±	8.2	42.7	±	8.5*
Total Water (%)	100.0	±	0.0	100.0	±	0.0	100.0	±	0.0	100.0	±	0.0	100.0	±	0.0	100.0	±	0.0
FFM Lean Mass	67.3	±	3.5	67.9	±	2.9#	69.0	±	3.3	70.2	±	2.4*	69.9	±	2.6	70.6	±	2.9*
FFM Total Weight	41.8	±	6.2	42.6	±	5.2	42.2	±	5.2	43.1	±	4.6*	45.3	±	3.4	46.4	±	3.8*

*Difference between pre- and post-supplementation, p<0.05
Caption:# C versus A p<0.05 (one-way ANOVA with Fisher's post hoc test)

After analyzing body composition through bioimpedance, it was observed that the placebo group showed a reduction in resistance, as well as increases in body cell mass, lean body mass, basal metabolic rate (BMR), intracellular water (in liters), FFM lean mass, and FFM total weight. The group supplemented with 1 gram of avocado oil showed similar results, with a reduction in resistance and increases in weight, extracellular mass (in kg), BMR, intracellular water (in liters), total water (in liters), FFM lean mass, and FFM total weight (Table 2).

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Table 3 - Evaluation of body composition through ultrasound before and after avocado oil supplementation was conducted in groups A (2g), B (1g), and C (placebo). São Paulo, 2023.

Variables	Group A (2g)						Group B (1g)						Group C (Placebo)					
	Pre			Post			Pre			Post			Pre			Post		
Weight (kg)	101.3	±	25.0	101.3	±	25.6	95.2	±	19.9	96.4	±	20.5	93.0	±	15.4	93.3	±	15.1
% Fat	44.6	±	10.4	44.7	±	10.5	43.3	±	11.4	42.2	±	12.5	36.7	±	3.1	40.8	±	9.0
Fat Mass (kg)	30.3	±	19.9	28.6	±	21.8	21.6	±	14.3	25.4	±	13.9	20.4	±	8.4	25.6	±	6.7
Lean Mass (kg)	20.0	±	17.0	14.8	±	2.4	14.4	±	3.5	14.6	±	3.6	25.0	±	18.3	24.8	±	20.2@
Water (kg)	39.8	±	5.9	39.9	±	6.4	39.0	±	9.5	40.0	±	9.5	43.3	±	6.9	40.3	±	8.4

Caption:@ C versus B p<0,05 (ANOVA one way).

According to the ultrasound data, the placebo group showed a statistically significant increase in lean mass (in kg) compared to group B (1g) after supplementation (Table 3).

DISCUSSION

In this randomized controlled clinical trial with adolescents aged 13 to 19 from the city of São Paulo, no significant changes in body composition were observed after avocado oil supplementation. Additionally, group B, which received 1 gram of avocado oil, showed similar changes to group C, which received capsules with neutral mineral oil (placebo). These results suggest that the observed changes may not be associated with the use of avocado oil. No associations were found between avocado oil intake and indicators of overall body adiposity, central adiposity, or body composition.

There is a limitation in the existing literature on the effects of avocado consumption in adolescents, with few studies specifically focused on this age group. Most research investigates avocado consumption in broader age groups. The study by Segovia-Siapco *et al.*[7] revealed that, although avocado consumption improved the diet quality of adolescents, there were no significant associations with anthropometric measures such as BMI, waist-to-height ratio, and body composition (mass, fat-free mass, and body fat percentage). This may be due to the lower average avocado intake among adolescents compared to adults and the lack of investigations specific to this age group.

The literature also suggests that avocado may aid in weight control for adults[18]. One

DOI: 10.15343/0104-7809.202448e16002024I

study indicated that including half an avocado per day in a weight-loss diet did not result in significant differences in weight loss compared to replacing mixed fats with 30g of fat, such as margarine and oil. Another study showed that consuming half an avocado at lunch significantly reduced hunger and the desire to eat in overweight adults[19]. Additionally, diets rich in monounsaturated fatty acids (MUFA), like those found in avocados, may protect against abdominal fat accumulation and complications associated with diabetes[20]. Studies also suggest that including avocado may improve satiety and gut microbiota composition, contributing to weight control[21].

A study with children and adolescents from Hispanic families, in which lower-income families received 3 avocados per week and higher-income families received 14 avocados per week for 6 months, in addition to biweekly nutritional education sessions, revealed that only the adolescents showed a significant reduction in the waist-to-hip ratio. However, the different levels of avocado availability did not result in significant changes in the anthropometric measures of the children and adolescents. The authors conclude that further research is needed to assess whether avocado consumption can promote metabolic health in this age group[22].

Despite the protocol of the present study being accompanied by general dietary re-education guidelines, the 12-week intervention did not promote a significant reduction in body mass. The lack of effect observed in our research may be related to biological and individual factors. It is possible that the response to avocado oil varies among individuals due to genetic variations that affect lipid metabolism and the inflammatory response. Additionally, behavioral factors, such as adherence to dietary recommendations and physical activity, may influence the effectiveness of the supplementation. The complexity of obesity and the need for long-term multidisciplinary interventions for significant body mass reduction must also be considered[22,21].

The study had some limitations, such as the difficulty in reaching the initial sample of 45 patients due to eligibility criteria and commitment to undergoing exams and attending consultations. The analysis of dietary intake revealed challenges in promoting significant qualitative changes in eating habits, which may have influenced the effectiveness of the supplementation. Bioimpedance, the method used to assess body composition, may underestimate body fat in overweight or obese individuals, and the higher proportion of body water in adolescents[23] may complicate the interpretation of results, as confirmed by discrepancies between the comparative values in bioimpedance and ultrasound exams (intracellular and extracellular water % (L), and the amount (kg) of fat mass and lean mass).

Although the results did not show statistically significant changes in body composition, they should be interpreted with caution. Additional studies with larger cohorts, more focused on adolescents, are necessary to explore whether avocado oil supplementation truly impacts body composition and if this effect varies according to sex, age, or other participant characteristics. This research contributes to the understanding of the impact of avocado oil supplementation and highlights the importance of continuing to investigate dietary interventions in the management of obesity and metabolic health.

CONCLUSION

In conclusion, the present study demonstrated that avocado oil supplementation was not associated with changes in body composition in the adolescent population. These results require further investigation and replication in order to understand the impact of avocado oil on weight control, adiposity, and metabolic risk factors early in life. I declare that the final data will be published as a supplement to those presented here.

DOI: 10.15343/0104-7809.202448e16002024I

FUNDING: Empresa Flor do Abacate Comércio e Industria LTDA.

CRediT author statement

Conceptualization: Filizzola, APL; Freiberg, CK; Kobal, PS; Silva, SMCS; Castro, AGP; Masquio, DCL; Saied, YH; Cardoso Filho, JO; Ganen, AP. Methodology: Filizzola, APL Freiberg, CK; Kobal, PS; Silva, SMCS; Castro, AGP; Masquio, DCL; Saied, YH; Cardoso Filho, JO; Ganen, AP. Validation: Filizzola, APL; Freiberg, CK; Kobal, PS; Silva, SMCS; Castro, AGP; Masquio, DCL; Saied, YH; Cardoso Filho, JO; Ganen, AP. Statistical analysis: Ganen, AP. Formal analysis: Filizzola, APL; Freiberg, CK; Ganen, AP. Investigation: Filizzola APL; Freiberg, CK; Kobal, PS; Silva, SMCS; Castro, AGP; Masquio, DCL; Yasmin Hany Saied; Cardoso Filho, JO; Ganen, AP. Resources: Filizzola, APL; Freiberg, CK; Kobal, PS; Silva, SMCS; Castro, AGP; Masquio, DCL; Saied, YH; Cardoso Filho, JO; Ganen, AP. Writing-original draft preparation: Filizzola, APL; Freiberg, CK; Kobal, PS; Silva, SMCS; Castro, AGP; Masquio, DCL; Saied, YH; Cardoso Filho, JO; Ganen, AP. Writing-review and editing: Filizzola, APL; Clara Korukian Freiberg; Ganen, AP. Visualization: Filizzola, APL; Freiberg, CK; Kobal, PS; Silva, SMCS; Castro, AGP; Masquio, DCL; Saied, YH; Cardoso Filho, JO; Ganen, AP. Supervision: Kobal, PS; Ganen, AP; Freiberg, CK. Project administration: Kobal, PS; Freiberg, CK; Masquio, DCL.

All authors have read and agreed to the published version of the manuscript.

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DOI: 10.15343/0104-7809.202448e16002024I

Received: 12 march 2024.
Accepted: 23 september 2024.
Published: 25 october 2024.