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Ocena czynników wpływających na skuteczność terapii integracji sensorycznej u dzieci w wieku przedszkolnym i wczesnoszkolnym

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Effect of radiofrequency on postmenopausal adipose tissue: A randomized control trial

Wpływ radiofrekwencji na tkankę tłuszczową u kobiet po menopauzie: Randomizowane badanie kontrolowane

Shreen R Aboelmagd[1,2(A,B,C,D,E,F)], Mahmoud A Elsayed[3(A,B,C,D,E,F)], Mai Helmy Hassan[4(A,B,C,D,E,F)], Afaf M. Botla[1(A,B,C,D,E,F)], Hazem S. El Ashmawi[5(A,B,C,D,E,F)], Reham E. Hamoda[1,6(A,B,C,D,E,F)]

[1]Department of Physical Therapy for Woman's Health, Faculty of Physical Therapy, Cairo University, Giza, Egypt
[2]Department of Physical Therapy for Obstetrics and Gynecology, Faculty of Physical Therapy, Sphinx University, Assuit, Egypt
[3]Department of Physical Therapy, El Kasr Al Ainy Hospital, Cairo, Egypt
[4]Department of Physical Therapy, National Heart Institute, Cairo, Egypt
[5]Department of Obstetrics and Gynecology, faculty of Medicine, Cairo University, Giza, Egypt
[6]Department of Physical Therapy for Obstetrics and Gynecology, Faculty of Physical Therapy, October 6 University, 6 of October City, Giza, Egypt

Abstract

Aim. To determine the effect of radiofrequency on anthropometric measurements and lipid profile in postmenopausal women.
Material and methods. Sixty postmenopausal women diagnosed as having abdominal adiposity and abnormal lipid profiles were incorporated into this study. Participants were assigned at random into two equal groups. Group A adhered to a Mediterranean diet and engaged in aerobic exercise for 12 weeks (n = 30), whereas group B followed a Mediterranean diet and participated in both aerobic exercise and radiofrequency treatments for the same 12-week period (n = 30). Both groups had their anthropometric measurements, encompassing weight, body mass index (BMI), and waist circumference, along with lipid profile components involving total cholesterol (TC), high-density lipoprotein (HDL), low-density lipoprotein (LDL), very-low-density lipoprotein (VLDL), and triglycerides (TG), assessed before and after the 12-week program duration.
Results. Significant improvements ($p < 0.05$) were noted in all outcome measures within both groups. Upon post-treatment comparison, both groups exhibited statistically significant reductions in all anthropometric measurements, LDL and TG ($p < 0.05$), while there was a statistically significant increase in HDL ($p < 0.05$) favoring group B. Nevertheless, there were no significant differences between groups for TC and VLDL ($p > 0.05$) after treatment.
Conclusion. Radiofrequency has positive effect on anthropometric measurements and lipid profile in postmenopausal women.

Keywords

menopause, adipose tissue, radiofrequency, anthropometric measurements, lipid profile

Streszczenie

Cel. Celem badania było określenie wpływu radiofrekwencji na pomiary antropometryczne oraz profil lipidowy u kobiet po menopauzie.
Materiał i metody. Do badania włączono sześćdziesiąt kobiet po menopauzie, u których zdiagnozowano otyłość brzuszną oraz nieprawidłowy profil lipidowy. Uczestniczki zostały losowo przydzielone do dwóch równych grup. Grupa A przestrzegała diety śródziemnomorskiej i uczestniczyła w aerobowych ćwiczeniach przez 12 tygodni (n = 30), natomiast grupa B również przestrzegała diety śródziemnomorskiej, ale dodatkowo uczestniczyła w aerobowych ćwiczeniach i poddawana była zabiegom radiofrekwencji przez ten sam okres 12 tygodni (n = 30). W obu grupach przeprowadzono pomiary antropometryczne, obejmujące wagę, wskaźnik masy ciała (BMI) i obwód talii, a także składniki profilu lipidowego, takie jak całkowity cholesterol (TC), lipoproteiny wysokiej gęstości (HDL), lipoproteiny niskiej gęstości (LDL), lipoproteiny bardzo niskiej gęstości (VLDL) i trójglicerydy (TG), przed i po 12-tygodniowym programie.
Wyniki. Znaczące poprawy ($p < 0{,}05$) zanotowano we wszystkich mierzonych parametrach w obu grupach. Po zakończeniu leczenia w obu grupach zaobserwowano statystycznie znaczące zmniejszenie wszystkich pomiarów antropometrycznych, LDL i TG ($p < 0{,}05$), przy jednoczesnym statystycznie znaczącym wzroście HDL ($p < 0{,}05$) na korzyść grupy B. Niemniej jednak, nie stwierdzono znaczących różnic między grupami w przypadku TC i VLDL ($p > 0{,}05$) po zakończeniu leczenia.
Wnioski. Radiofrekwencja ma pozytywny wpływ na pomiary antropometryczne oraz profil lipidowy u kobiet po menopauzie.

Słowa kluczowe

menopauza, tkanka tłuszczowa, radiofrekwencja, pomiary antropometryczne, profil lipidowy

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Introduction

Menopause, referred to as the climacteric, signifies the phase in a woman's life when menstrual cycles permanently stop, signifying the termination of her childbearing capacity. The typical age range for menopause onset is generally between 47 and 54 years. In the medical field, menopause is commonly described as the absence of menstrual bleeding for a continuous period of one year [1].

Menopause causes changes in adipose tissue distribution, leading to central adiposity and an elevated susceptibility to metabolic conditions like insulin insensitivity, type II diabetes, and cardiovascular disorders. These changes are attributed to hormonal fluctuations, reduced muscle mass, and a slower metabolic rate [2, 3]. The abrupt decrease in estrogen after menopause causes decreased thermogenesis, potentially contributing to abdominal obesity, which is prevalent in about 67% of women after menopause [4]. Moreover, menopause is linked to alterations in the metabolic function of adipose tissue, affecting both subcutaneous adipose tissue (SAT) and visceral adipose tissue (VAT). In SAT, postmenopausal women displayed hypertrophy of adipocytes, heightened inflammation, occurrences of hypoxia, and increased fibrosis, leading to greater accumulation of visceral fat. In VAT, menopause is linked to hypertrophy of adipocytes, infiltration of immune cells, and development of fibrosis, resulting in reduced insulin sensitivity. These results underscore that menopause induces notable shifts in adipose tissue phenotype linked to metabolic dysfunction in both SAT and VAT [5].

The transition into menopause has an adverse impact on lipid profile, marked by high concentrations of total cholesterol (TC), low density lipoprotein (LDL), and triglycerides (TG), and sometimes reduced high density lipoprotein (HDL) [6, 7]. This unfavorable lipid profile significantly contributes to the onset and progression of cardiovascular disease, a major cause of illness and death among postmenopausal women [8-10].

Mediterranean diet, when combined with regular physical activity, proves to be an effective strategy for managing weight in obese individuals, particularly menopausal women facing weight gain. Adhering more closely to this diet during menopause is accompanied by a lower likelihood of becoming overweight or obese, along with enhanced cardiometabolic health and reduced menopausal symptoms [11].

Radiofrequency is a complementary strategy utilizing high-frequency electromagnetic energy to heat adipose tissue, thereby increasing local cellular metabolism and promoting lipolysis. This biochemical process leads to the release and breakdown of TG, generating glycerol and non-esterified fatty acids available for energy production. Consequently, adipocytes undergo hypotrophy, reducing their volume. To prevent restorage or ectopic accumulation, a combined approach of exercise with radiofrequency can enhance lipid removal efficiency, potentially leading to improved outcomes in lipid management [12-14].

Given that obesity and accumulation of visceral fat after menopause have been accompanied by various detrimental health consequences like dyslipidemia, metabolic syndrome, heightened cardiovascular disease risk, osteoporosis, malignancies, and increased mortality [15], there is a pressing need for efficacious interventions targeting central adiposity in postmenopausal women. To date, there has been a dearth of research exploring the impact of radiofrequency on adipose tissue in postmenopausal women. Hence, this novel approach may introduce a new avenue in physical therapy for treating this problem.

Materials and methods

Study design

A pre-test –post-test randomized control design. The study was conducted between February 2023 and September 2023. The study received ethical approval from the Institutional Review Board at the Faculty of Physical Therapy, Cairo University prior to starting [No: P.T.REC/012/004407]. It was registered at ClinicalTrials.gov [NCT05895435]. The study followed the principles outlined in the Declaration of Helsinki for conducting human research. Each participant provided informed consent after receiving a thorough explanation of the study's nature, objectives, and potential benefits. They were also informed that they could decline participation or withdraw at any point, with an assurance of the utmost confidentiality regarding their provided information.

Participants

Sixty postmenopausal women diagnosed by their physicians as having abdominal adiposity and abnormal lipid profile. They were recruited at random from the physical therapy outpatient clinic, El Kasr Al Ainy, Egypt. Inclusion criteria necessitated the selection of ambulatory sedentary women who had experienced natural menopause at least one year prior to their participation in the study, and who had no history of surgical removal of the uterus and/or both ovaries [16]. The participants, aged between 47 and 60 years, had a body mass index (BMI) ranging from greater than 25 kg/m² to less than 35 kg/m², along with a waist circumference exceeding 88 cm. Additionally, they had TC $\geq$ 239 mg/dl, HDL $\leq$ 50 mg/dl, LDL $\geq$ 100 mg/dl, and TG $\geq$ 150 mg/dl. Exclusion criteria encompassed individuals with conditions such as cancer, renal failure, hepatic diseases, musculoskeletal diseases, tumours, as well as women with pacemakers, those undergoing hormonal replacement therapy, or taking any medications to manage to address weight issues or abnormal lipid profiles. Additionally, women with skin diseases that contraindicated the application of radiofrequency were excluded.

Randomization

The participants were assigned at random into two equally sized groups, designated as group A and group B, utilizing the coin toss method. Following randomization, there were no withdrawals or dropouts from the study, Figure (1).

Interventions

Group A followed a Mediterranean diet and participated in aerobic exercise for a duration of 12 weeks, while group B followed a Mediterranean diet and underwent both aerobic exercise and radiofrequency treatments over the same 12-week period.

Mediterranean diet

Every participant in both groups (A and B) adhered to a Mediterranean diet for a duration of 12 weeks. The dietary regimen advised an increased intake of fruits, vegetables, whole grains, and legumes, while replacing the intake of animal-origin saturated fats with plant-origin unsaturated fats. Moreover, participants were encouraged to incorporate bioactive compounds recognized for their antioxidant and anti-inflammatory benefits, such as polyphenols and omega-3 fatty acids [11].

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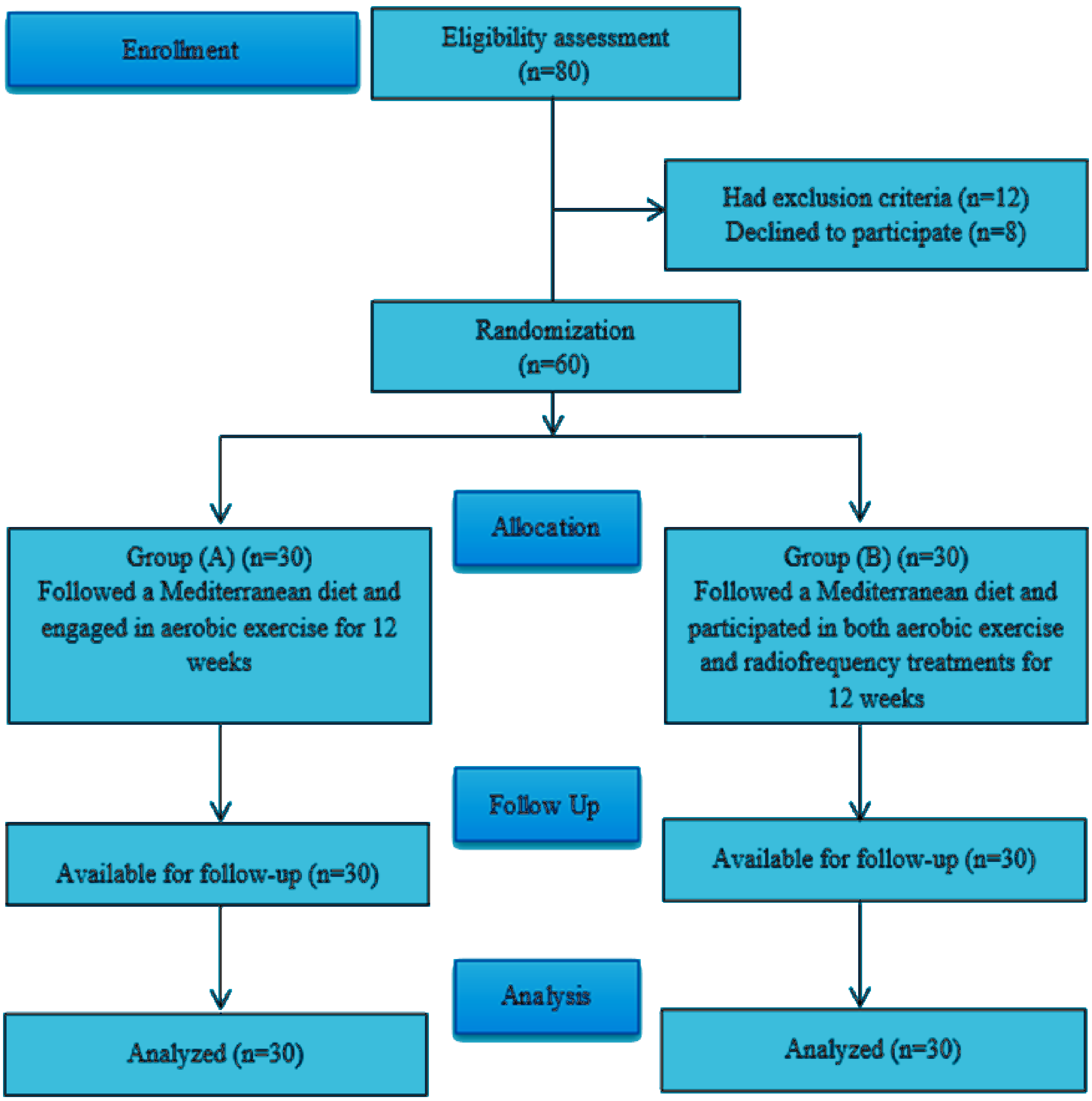

Figure 1. Flow chart of the study

Aerobic exercise

Each participant in the both group (A and B) participated in an aerobic exercise program on a treadmill (Phantom AC6069m, China), tri-weekly sessions, for 12 weeks. Every training session comprised warming-up, active, and cooling down phases. The session began with five minutes for warming-up in the form of range of motion and stretching exercises. In the active phase, participants engaged in a thirty-minute treadmill walking, maintaining a moderate speed matched to 60–70% of their maximum heart rate (HRmax), which was determined using the following equation: HRmax = 220 − age [17]. Finally, the session ended with a five-minute cooling down on treadmill with low speed and without inclination.

Radiofrequency

Each participant in study group B received radiofrequency, for 40 minutes/session, twice weekly for 12 weeks. The position of the participant during the sessions was supine, ensuring she was comfortable with a cushion placed under her head and her knees flexed. Participants were advised to hydrate adequately before and after each session. The power of the device was 150 Watt and the heating temperature was adjusted according to the participant's tolerance. For the application, the gel was applied to the lower abdomen. The device was then activated, and the radiofrequency head was placed on the lower abdomen. The intensity was gradually increased until the participant felt a warming sensation. The

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head of the device was moved slowly in a circular motion across the entire abdominal area. At the end of the session, the device automatically turned off [18].

Outcome measures

Anthropometric measurements

Anthropometric assessments, encompassing weight, height, and waist circumference, were taken for all participants in both study groups prior to and following the completion of the treatment. By using a standard weight and height scale, weight and height were assessed for each participant while wearing lightweight clothing and no footwear. BMI was computed by dividing participants' weight in kilograms by the square of their height in meters. The waist circumference was determined with a tape measure, taken at the narrowest point between the lower ribcage edge and the iliac crest when finishing a standard breath out [19].

Lipid profile components

After a 12-hour fast, blood samples were collected from all participants in the two groups prior to and after the treatment regimen. These samples were then sent to the laboratory center for the measurement of total cholesterol (TC), high-density lipoprotein (HDL), low-density lipoprotein (LDL), very-low-density lipoprotein (VLDL), and triglycerides (TG) using a Spectrophotometer [20].

Sample size estimation and statistical analysis

To ascertain an optimal sample size, a power analysis was performed utilizing GPower 3.1 software. Parameters were derived from a comparable study conducted by Vale et al. [21], which examined the impact of aerobic and radiofrequency treatments on adipose tissue in healthy women. A power of 80%, significance level of 0.05, and effect size of 0.8 were inputted into GPower, determining a requisite total of 52 participants for this study. However, to account for a potential dropout rate of 15%, the final number of subjects was increased to 60. Data analysis was conducted using the Statistical Package for the Social Sciences software (SPSS Inc., Chicago, Illinois, USA) version 20 for Windows. Data were presented as mean ± SD. Data underwent screening for normality assumption, homogeneity of variance, and identification of any potential outliers. Both Shapiro-Wilk and Kolmogorov-Smirnov tests confirmed that all measured variables exhibited a normal distribution ($p > 0.05$). An unpaired t-test was employed to compare the characteristics of subjects between the two groups. Additionally, a MANOVA was conducted to assess both within-group and between-group effects for the measured variables. A significance level of $p \leq 0.05$ was established.

Results

Subjects' characteristics

At pre-treatment assessment, both groups exhibited similarity in age, height, and all measured outcomes ($p > 0.05$) (Tables 1-3).

Table 1. Subjects' characteristics of both groups

Item	Group A (n = 30)	Group B (n = 30)	t-value	p-value
	Mean ± standard deviation			
Age [year]	53.6 ± 3.9	51.7 ± 3.6	1.9	0.062
Height [cm]	163.2 ± 2.5	164 ± 2.7	−1.28	0.206

SD = standard deviation; p = probability

Anthropometric measurements

Within both groups, all anthropometric measurements displayed statistically significant decreases after treatment ($p < 0.05$). On comparing the two groups after treatment, group B showed significantly greater reductions in all anthropometric measurements compared to group A ($p < 0.05$) (Table 2).

Table 2. Anthropometric measurements for both groups

Anthropometric measurements	Group A (n = 30)	Group B (n = 30)	t-value	p-value
	Mean ± standard deviation			
Weight [kg]				
Pre-treatment	86.9 ± 3	88.7 ± 3.8	3.67	0.060
Post-treatment	83.9 ± 3.3	80.9 ± 3.4	11.5	0.001*
% of change	3.4%	8.9%		
P-value	0.001*	0.001*		

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Anthropometric measurements	Group A (n = 30)	Group B (n = 30)	t-value	p-value
	Mean ± standard deviation			
BMI [kg/m²]				
Pre-treatment	32.6 ± 0.9	32.9 ± 1.1	1.94	0.169
Post-treatment	31.3 ± 1.4	29.2 ± 1.2	34.7	0.001*
% of change	4%	11.2%		
P-value	0.001*	0.001*		
Waist circumference [cm]				
Pre-treatment	90.8 ± 2.7	92 ± 3	2.92	0.093
Post-treatment	87.3 ± 3.4	85.7 ± 3.6	14.3	0.001*
% of change	4%	7%		
P-value	0.001*	0.001*		

*BMI = Body mass index; SD = standard deviation; p = probability; * = significant with p < 0.05*

Lipid profile components
Within both groups, there were statistically significant decreases in TC, LDL, VLDL, and TG ($p < 0.05$), along with a statistically significant increase in HDL ($p < 0.05$). When comparing the two groups after treatment, significant reductions were observed in LDL and TG ($p < 0.05$), while there was a significant increase in HDL ($p < 0.05$) favoring group B. However, there were no significant differences between the groups for TC and VLDL ($p > 0.05$) after treatment.

Table 3. Lipid profile components for both groups

Lipid profile components	Group A (n = 30)	Group B (n = 30)	t-value	p-value
	Mean ± standard deviation			
TC [mg/dl]				
Pre-treatment	199.5 ± 8.4	200.3 ± 14.3	0.064	0.801
Post-treatment	197.4 ± 8.2	192.8 ± 13.5	2.60	0.112
% of change	1%	3.7%		
P-value	0.001*	0.001*		
HDL [mg/dl]				
Pre-treatment	35.4 ± 2.6	35.5 ± 2.2	0.033	0.857
Post-treatment	36.2 ± 2.9	37.9 ± 2.5	6.18	0.016*
% of change	2.2%	6.7%		
P-value	0.001*	0.001*		
LDL [mg/dl]				
Pre-treatment	161.3 ± 8.1	161.1 ± 10.6	0.006	0.939
Post-treatment	157.4 ± 7.9	150.5 ± 10.6	7.897	0.007*
% of change	2.4%	6.6%		
P-value	0.001*	0.001*		
VLDL [mg/dl]				
Pre-treatment	33.5 ± 2.2	33.7 ± 2.4	0.039	0.844
Post-treatment	32.3 ± 1.9	31.7 ± 2.2	1.50	0.225
% of change	3.5%	5.9%		
P-value	0.001*	0.001*		
TG [mg/dl]				
Pre-treatment	166.7 ± 9.8	165.8 ± 11.4	0.125	0.725
Post-treatment	163.7 ± 9.6	157.6 ± 11.8	4.759	0.033*
% of change	1.8%	5%		
P-value	0.001*	0.001*		

*TC = total cholesterol, HDL = high-density lipoprotein, LDL = low-density lipoprotein, VLDL = very-low-density lipoprotein, TG = triglycerides; mg/dl = milligram/deciliter; SD = standard deviation; p = probability; * = significant with p < 0.05.*

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Discussion

Postmenopausal women often experience weight gain, especially abdominal fat, due to declining estrogen levels, android fat distribution, aging, and reduced activity. This leads to health risks like dyslipidemia, metabolic syndrome, cardiovascular issues, osteoporosis, cancers, and higher mortality [15]. Thus, this study aimed to assess the radiofrequency effect on anthropometric measurements and lipid profile in postmenopausal women.

Within both groups, there were significant improvements in both anthropometric measurements and lipid profile components. Upon comparing post-treatment results between the groups, significant reductions were observed in all anthropometric measurements, LDL, and TG levels, as well as a significant increase in HDL levels in favor of group B. Nevertheless, no significant differences were noted between the groups cincerning TC and VLDL after treatment.

The favorable effects of combining diet and exercise on anthropometric measurements and lipid profile in group A found support in the work of Trichopoulou et al. [11], who reported that the combination of a Mediterranean diet and physical activity has demonstrated encouraging outcomes for weight loss in obese persons, and has shown similar positive effects in obesity associated with menopause. Additionally, Poirier et al. [22] and Fontana et al. [23] demonstrated that combined diet and exercise led to a significant decrease in body weight and significant improvements in risk factors related to coronary heart disease, such as LDL cholesterol levels in the plasma, the ratio of HDL cholesterol, and levels of C-reactive protein. Regular exercise increases anti-inflammatory cytokines and decreases pro-inflammatory agents released by adipocytes by reducing visceral and total body fat [24].

The present study's findings demonstrate that incorporating radiofrequency alongside a Mediterranean diet and aerobic exercise had a greater impact on anthropometric measurements, HDL, LDL, and TG compared to a Mediterranean diet and aerobic exercise alone. These results were consistent with previous research studies. In a study by Kiedrowicz et al. [25], it was found that radiofrequency has the long-term cosmetic benefits, sustained for a minimum of six months. This long-term effect manifested in decreased body weight, lowered BMI, and reduced waist circumference. In addition, El Gendy et al. [26] revealed the efficacy of 10 sessions of tripollar radiofrequency in decreasing thickness of subcutaneous fat in the abdominal region and decreasing waist circumference in abdominal adiposity patients. Moreover, Van Der Lugt et al. [13] reported that 12 sessions of radiofrequency led to enhancements in skin appearance and cellulite reduction in the buttocks that were highly rated on satisfaction surveys by female patients aged 24-58 years. Furthermore, Abdel-Aal et al. [27] revealed the efficacy of adding radiofrequency to a weight reduction program, in the form of diet and cavitation, on reducing weight, BMI, waist circumference, and skinfold after the three-month intervention period in central obese subjects.

The positive effect of radiofrequency could be attributed to its high-frequency electromagnetic energy that effectively generates thermal energy within adipose tissue when applied cutaneously. The heat generated by radiofrequency devices transforms into thermal waves due to the impedance of tissues, leading to increased lipolysis and metabolism in adipocytes. This results in triglyceride breakdown and release of fatty acids that can be utilized for energy generation, causing fat cell shrinkage. Radiofrequency stimulation also promotes neocollagenesis and lifting effects in the skin [12, 28].

Strengths and limitations

The present research has several valuable strengths. It represents the first investigation in Egypt analyzing the effects of a 12-week program integrating radiofrequency, Mediterranean diet, and aerobic exercise on abdominal adiposity and lipid profile in postmenopausal women, this work holds importance. A key strength is the study's accurate measurement of circulating lipids to assess changes, providing crucial insights. Moreover, the authors carefully devised the research by predetermining the required participant sample size. This thoughtful methodology enhances the credibility and reliability of the study's results.

While exhibiting strengths, this study has some limitations. Participants were only followed for 12 weeks. Longer follow-up is needed to determine if the effects are sustained over time. One additional limitation is that the sample was restricted solely to postmenopausal women. The effects of radiofrequency treatment on anthropometric measures and lipid profiles may differ in other demographic groups or life stages. Expanding the inclusion criteria could improve the generalizability of these findings to a broader population.

Conclusion

A 12-week program of radiofrequency combined with Mediterranean diet and aerobic exercise resulted in greater improvements in anthropometric measurements, LDL, HDL, and triglycerides compared to Mediterranean diet and aerobic exercise alone in postmenopausal women with abdominal adiposity and abnormal lipid profiles.

Adres do korespondencji / Corresponding author

Hazem El Ashmawi

E-mail: hsashmawi@gmail.com

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Piśmiennictwo/ References

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