Journal of Sport Sciences and Physical Education, **Vol. 10, July (2), pp11-17, king Saud Univ., Riyadh (2026/1448H.)**

The Effect of the Mediterranean Diet on Muscle Strength and Body Composition (Fat Mass, Fat-Free Mass, Skeletal Muscle) Among Resistance-Training Women

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(Received 9/3/2024; Accepted for publication 20/5/2024)

Abstract
This research aims to identify the effect of the Mediterranean diet (MD) on muscle strength and body composition (fat mass, fat-free mass, skeletal muscle) among resistance-training women in Jeddah, Saudi Arabia. The research used the experimental approach for the pre- and post-measurement in keeping with the nature of the research which was conducted on a non-probability sample consisting of 20 resistance-training women in health clubs. Qualitative analysis, questionnaires, and tests were used as a tool for data collection. The results of the research have shown that the Mediterranean diet had a positive effect in increasing muscle strength in the lower part of the body; it also leads to greater weight loss and reduction in fat mass among resistance-training women, while there was no effect found on muscle strength in the upper part of the body, muscle mass, or fat-free mass. The researcher recommended conducting similar research for both sexes using different methods of measurement for muscular strength.

Keywords: Mediterranean diet - muscle strength - body composition (fat mass, fat-free mass) - resistance-training women.

تأثير النظام الغذائي المتوسطي على قوة العضلات وتكوين الجسم (كتلة الدهون، الكتلة الخالية من الدهون، العضلات الهيكلية) لدى النساء الممارسات لتدريبات المقاومة

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(قدم للنشر في 2024/3/9م؛ وقبل للنشر في 2024/5/20م)

الملخص

يهدف هذا البحث إلى التعرف على تأثير النظام الغذائي المتوسطي (MD) على قوة العضلات وتكوين الجسم (كتلة الدهون، الكتلة الخالية من الدهون، العضلات الهيكلية) لدى النساء الممارسات لتدريبات المقاومة في مدينة جدة، المملكة العربية السعودية. استخدم البحث المنهج التجريبي بتصميم القياس القبلي والبعدي بما يتناسب مع طبيعة الدراسة، والتي أُجريت على عينة غير احتمالية مكونة من 20 امرأة من الممارسات لتدريبات المقاومة في الأندية الصحية. وتم استخدام التحليل الكمي، والاستبيانات، والاختبارات كأدوات لجمع البيانات.

أظهرت نتائج البحث أن النظام الغذائي المتوسطي له تأثير إيجابي في زيادة قوة العضلات في الجزء السفلي من الجسم، كما ساهم في فقدان أكبر للوزن وتقليل كتلة الدهون لدى النساء الممارسات لتدريبات المقاومة، بينما لم يُظهر أي تأثير على قوة عضلات الجزء العلوي من الجسم أو كتلة العضلات أو الكتلة الخالية من الدهون.

وأوصت الباحثة بإجراء دراسات مماثلة على كلا الجنسين باستخدام أساليب قياس مختلفة لقوة العضلات.

الكلمات المفتاحية: النظام الغذائي المتوسطي ـ قوة العضلات ـ تكوين الجسم (كتلة الدهون، الكتلة الخالية من الدهون) ـ النساء الممارسات لتدريبات المقاومة.

Introduction

In the realm of athletic performance, the pivotal synergy between a well-balanced diet and strategic nutrition supplements stands as the cornerstone for optimizing physical strength and achieving peak competitive excellence and body composition (Kerksick et al., 2018). Athletic performance was determined by precise and accurate nutrient intake and the availability of good stored energy to strengthen thoracic contractions (Thomas, 2016). Furthermore, a balanced nutritional diet may support the functioning of the immune system of athletes, thereby alleviating the demands during emergency, recovery and repair of patients (Marcos et al., 2003). Much later, the Mediterranean diet (MD) was widely studied for its nutritional adequacy which discovered its importance to health (Martinez-Lacoba et al., 2018). This diet is characterized by eating traditional foods of the inhabitants of the Mediterranean region (Greece, France, Spain, and Italy) with a high consumption of whole grains and legumes, olive oil, fish, and red meat products. It has been accepted as one of the healthiest food electronics in the world (Serra-Majem et al., 2019).

Recent studies have proven that following the Mediterranean diet affected cognition, while its health

benefits reduce heart diseases including high blood pressure, type 2 diabetes, certain types of cancer, and some chronic diseases which could significantly delay prevention. MD also relates to mortality and morbidity, and is associated with a longer, healthier life when adhered to (La Lastra et al., 2001; Sánchez-Hernández et al., 2020; Sofi et al., 2010). Stringent adherence to the Mediterranean diet has also been shown to be effective in improving the performance of shaping exercises in less than 4 days (Baker et al., 2019). While no studies have been conducted on this effect, the regime increases chest strength, as the strength of the chest muscles is one of the basic parts of the abdomen, which gains special importance because it is associated with sports performance in general. Chest strength gains great attention from coaches and athletes in various sports competitions and events because of its conducibility to athletic achievements (Polus, 2010). In athletics, various types of weightlifting and speed swimming (Abdel-Fattah, 1997) may improve levels of physical fitness for better performance in a range of special sports (Stone, 1993). This is also associated with muscle cramps, even if it begins to decrease (Edwards & Loprinzi, 2018). With these factors in mind, it is not surprising that recognized entities such as the American College of Sports Medicine (ACSM) in 2009 and the World Health Organization (WHO) in 2010 have recognized spasticity on a regular basis. Resistance training is the most widely used exercise for muscular strength, but to determine the effectiveness of a resistance training program, it is important to measure strength as accurately as possible. In laboratory settings, the use of advanced dynamometers and isokinetic dynamometers is the most advanced method for performing spastic strength. However, a drawback of this combination is that a precision equipment is needed and its reliance on only one joint (Perrin, 1993). In addition to the common use of the Single Repetition Maximum (1RM) strength test, the strength level is performed, thus defining 1RM as the full maximum strength that can be lifted at a time while improving the correct lifting technique (Kraemer et al., 2006). This featured a 1RM test which could not beat the other. The 1RM test is allowed to evaluate strength in multiple pressing competitions. As long as no procedures are necessary, it is cost-effective. 1RM testing is commonly performed by trained individuals during training sessions, which may limit the need for pre-test adjustment. In addition, we have successfully fulfilled the Dynamo Meter standards, where a safe 1RM has been tested across different populations, even among distressed and sick children. Although the test tends to spend more time assessing strength among a large number of participants, many people believe that it can test the “gold standard” of mechanical strength (Grgic et al., 2020).

Methods

1- Participants

The purpose of the experiment and contents and method of the test were presented to the participants through the announcement and for the participants who voluntarily participated, the researcher reminded them in advance that their identity would be confidential, the participants agreed and signed the participation agreement. Participants in this study were 20 female athletes who had previously practiced resistance training for more than a year from Jeddah, Saudia Arabia, with an average age of 35.3. The data of 20 persons was collected to be analyzed. They were healthy and fully understood the content and method of the exercise test and the subjects' knowledge in advance. It has been shown that the average weight is 63.6 kg, while the average height is 159.4 cm, Which makes the body mass in the normal area (Table 1). The average body mass shows lower scores of 21.3 kg for Fat mass, 23 kg for muscle mass, and 42.1kg higher scores for free-fat mass (Table 1).

Table 1. Characteristics of the research sample in Jeddah City

Variables	Measuring unit	Average	Standard deviation
Age	year	35.3	10.1933
height	cm	159.4	6.7699
weight	kg	63.615	14.5003
BMI	kg/m2	24.895	4.5013
Fat mass	kg	21.310	8.7519
Fat-free mass	kg	42.185	8.4396
Muscle mass	kg	23.010	5.0500

2- Measures and Methods

The measurement items and methods for the subjects’ Mediterranean diet (MD) on muscle strength and body composition (fat mass, fat-free mass, skeletal muscle) are as follows.

- Mediterranean diet (MD): The Nutisurvey software 2007 program was used to design the nutritional program for the participants and calculate their caloric needs while reducing the daily calorie consumption by about 500 calories per day. Then, a program similar to the Mediterranean diet—rich in olive oil, fish, chicken, nuts, low in artificial sugars, commercial sweets, pastries, butter, margarine, red meat, vegetables, and fruits—was designed (refer to Appendix (2)). The food groups were distributed as follows: 15% protein (~0.8 g/kg/day), 50% medium/low glycemic index carbohydrates, 35% fat (≥10% monounsaturated fatty acids, <10% fatty acids), saturated fat, no trans-fat, and 1.1 g omega-3 for women, dietary fiber content ≥25 g.
- Body composition: This was calculated using physical measurements before applying the diet by means of the Bioelectrical Impedance Analysis (BIA) device, and after 4 weeks of applying the system post-measurements.
- Muscle strength: The 1RM test has been reliably used to evaluate maximal muscle strength (Grgic et al., 2020), and conducting tests before and after applying the Mediterranean diet by performing a one-repetition maximum of the chest push-up and a one-repetition maximum of the leg push-up.
- Training program: The training program for resistance exercises comprised 12 training sessions per month, 3 days per week. The duration of the session ranged from one hour to one hour and a half, and 5-6 different exercises were performed in one session, aiming to strengthen all basic muscle groups such as back muscles, chest muscles, shoulder muscles, arm muscles, leg muscles, and abdominal muscles. Weights were chosen so as to allow them to perform 8-12 repetitions and perform 3-4 sets for each exercise.

Table 2. Study sample vocabulary

Age		
	Repetition	**Ratio**
Less than 30	8	%40.0
From 30 to 40 years	6	%30.0
Older than 40 years	6	%30.0
Total	20	%100.0
Height		
Less than 155 cm	8	%40.0
From 156 to 160 cm	5	%25.0
From 161 to 165 cm	4	%20.0
Higher than 166 cm	3	%15.0
Total	20	%100.0

Table (2) shows the distribution of the study sample items according to age and Height, the largest percentage of women practicing resistance training were those whose ages were less than 30 and height less than 155 cm by 40%. While those whose ages are between 30 to 40 and over 40 by 30%. On the other hand, find that the height from 156 to 160 cm by 25%, while From 161 to 165 cm by 20%, and higher than 166 cm by 15% From this we conclude that the greater the length, the lower the percentage.

Data analysis

The data of this study were analyzed using the SPSS 28.0 statistical program. First, the t-test for two dependent samples to verify the hypothesis of measuring strength before and after applying the Mediterranean diet, In addition to descriptive statistics, it was used a frequency and relative frequencies analysis was conducted.

In addition, post-hoc was performed using Scheffe's to determine if there is homogeneity in contrast.

Results and Discussion

Results

There are statistically significant differences between the averages of 1RM muscle strength measurements for leg-pushing exercises and the averages of physical measurements (weight, body mass index, fat mass) for women practicing resistance training on the pre- and post-test, while no statistically significant differences were found between the averages of 1RM muscle strength measurements for chest-push exercises and the averages of body measurements (muscle mass, fat-free mass).

From Table 3 below, it is clear that there are no statistically significant differences between the average values of strength measurements for chest-push exercises for women practicing resistance training on the pre- and post-test, where the value of sig = 0.097, which is greater than the value of $\alpha = 0.05$. Therefore, we may accept the null hypothesis, meaning that there is no difference in the values of the averages of strength measurements for chest-push exercises for women practicing resistance training before applying the Mediterranean diet and after applying the Mediterranean diet, which indicates that applying the Mediterranean diet did not affect the strength measurements of chest-push exercises for women practicing resistance training. However, Table 3 below shows that there are statistically significant differences between the average values of strength measurements for leg-push exercises for women practicing resistance training on the pre- and post-test, where the value of sig = 0.000 which is less than the value of $\alpha = 0.05$. Therefore, we reject the null hypothesis, meaning that there is a difference in the average values of strength measurements. For leg-push exercises for women who practice resistance training before applying the Mediterranean diet and after applying the Mediterranean diet, the differences are in favour of the post-test.

Table 3. Measuring the significance of differences in the mean strength measurements of push-up exercises for women practicing resistance training on the pre- and post-test before and after applying the Mediterranean diet.

	Variables	Average	Sample volume	Standard deviation	T-Value	Level of Meaning
Chest push exercises	Strength measurements for chest push-ups (Kg) (before Mediterranean diet)	40.400	20	10.5613	-1.748	0.097
	Strength measurements for chest push-ups (Kg) (after Mediterranean diet)	40.975	20	10.6752		
Leg push exercises	Strength measurements for Leg Press (before Mediterranean diet) (Kg)	98.700	20	40.0849	-2.741	0.013
	Strength measurements for Leg Press (after Mediterranean diet) (Kg)	103.675	20	39.8016		

However, in Table 4 below we find that there are statistically significant differences between the values of the average weight and mass of women practicing resistance training on the pre- and post-test, where the value of sig = 0.000 which is less than the value of $\alpha = 0.05$. Therefore, we reject the null hypothesis, meaning that there is a difference in the values of the average weight and the body mass of women practicing resistance training before applying the Mediterranean diet and after applying the Mediterranean diet, with the differences being in favour of the pre-test. For the average weight of the women practicing resistance training on the pre-test was 63.615 which was greater than the average weight of the women practicing resistance training on the post-test at 62.285, in addition to the fact that the average body mass of women practicing resistance training on the pre-test was 24.895 which was greater than the average body mass of women practicing resistance training on the post-test at 24.325. This indicates that applying the Mediterranean diet effected a decrease in the weight and body mass of the women practicing resistance training. The average body mass index of women before the application of the MD is greater than their average after its application.

Table 4. Measuring the significance of differences in the average weight and BMI of women practicing resistance training on the pre- and post-test before and after applying the Mediterranean diet.

	Variables	Average	Sample volume	Standard deviation	T-Value	Level of Meaning
We	Before applying the Mediterranean diet	63.615	20	14.5003	5.272	0.000

	After applying the Mediterranean diet	62.285	20	14.6592		
BMI	Before applying the Mediterranean diet	24.895	20	4.5013	5.433	0.000
	After applying the Mediterranean diet	24.325	20	4.5023		

As for the MD's effect on the loss or increase of fat mass among women who practice resistance training on the pre- and post-test, Table 5 below shows that the value of sig = 0.000 which is less than the value of α = 0.05, and therefore we reject the null hypothesis, meaning that there is a difference in the mean values of the fat mass of women practicing resistance training before applying the Mediterranean diet and after applying the Mediterranean diet, and the differences are in favour of the pre-test, as the average fat mass of women practicing resistance training on the pre-test was 21.310 which is greater than the average fat mass of women practicing resistance training on the post-test, which was 19.685. This indicates that the application of the Mediterranean diet effected a decrease in the fat mass of women practicing resistance training, as the average fat mass of women before application is greater than their average after application, while there are no statistically significant differences between the average values of fat-free mass for women practicing resistance training on the pre- and post-test, where the value of sig = 0.321 which is greater than the value of α = 0.05. Therefore, we accept the null hypothesis, meaning that there is no difference in the average values of the fat-free mass among women who practiced resistance training before applying the Mediterranean diet and after applying the Mediterranean diet. In other words, applying the Mediterranean diet did not affect the fat-free mass of women practicing resistance training.

Table 5. Measuring the significance of the mean differences in the body composition of women practicing resistance training on the pre- and post-test before and after applying the Mediterranean diet.

	Variables	Average	Sample volume	Standard deviation	T-Value	Level of Meaning
Fat mass	Before applying the Mediterranean diet	21.310	20	8.7519	5.730	0.000
	After applying the Mediterranean diet	19.685	20	8.4098		
Fat-free	Before applying the Mediterranean diet	42.185	20	8.4396	-1.019	0.321
	After applying the Mediterranean diet	42.475	20	8.5011		
Increase	Before applying the Mediterranean diet	23.010	20	5.0500	-1.568	0.133
	After applying the Mediterranean diet	23.225	20	5.2583		

As to the effect of the Mediterranean diet on increasing the muscle mass, it is clear from Table 5 that there are no statistically significant differences between the average values of muscle mass among women practicing resistance training on the pre- and post-test, where the value of sig = 0.133 which is greater than the value of α = 0.05. Therefore, we accept the null hypothesis, meaning that there is no difference in the average values of muscle mass among women practicing resistance training before applying the Mediterranean diet and after applying the Mediterranean diet, thereby indicating that applying the Mediterranean diet did not affect the muscle mass of women practicing resistance training.

Discussion

The results related to the effect of the Mediterranean diet on muscle strength and body composition (fat mass, fat-free mass) among resistance trainees showed that there are statistically significant differences between the average weight values of women practicing resistance training before applying the Mediterranean diet and after applying the Mediterranean diet. The results also showed that the differences are in favour of the pre-test, which indicates that applying the Mediterranean diet affected the weight loss of women exercising resistance training.

Moreover, significant differences were also noted between the average values of the body mass index (BMI) for women who practiced resistance training before applying the Mediterranean diet and after applying the Mediterranean diet. Hence, this result indicates that applying the Mediterranean diet had the impact of reducing the body mass index among women who practiced resistance training.

Statistically significant differences were observed in the mean fat mass (FM) values of women engaging in resistance training before and after adopting the Mediterranean diet. The study outcomes demonstrated a preference for the pre-test scenario, indicating a notable reduction in the fat mass index among women practicing resistance training following the implementation of the Mediterranean diet. The researcher attributes this reduction to the effective impact of adhering to the Mediterranean diet, leading to a noteworthy decrease in both the body weight and fat mass.

This result was similar to that of a study by Dellis et al. (2020) regarding the decrease in body weight, body mass index, and body fat mass when applying the Mediterranean diet.

Conversely, there were no statistically significant differences in the mean values of fat-free mass (FFM) among women practicing resistance training before and after adhering to the Mediterranean diet. The absence of a noticeable change in the fat-free mass among women in the Jeddah Governorate suggests that the Mediterranean diet did not exert a discernible effect on the fat-free mass.

Similarly, no statistically significant differences were identified in the mean values of the skeletal muscle mass (SMM) for women engaging in resistance training before and after following the Mediterranean diet. The lack of a discernible change in muscle mass among women in the Jeddah Governorate implies that the application of the Mediterranean diet did not yield a noticeable effect on their muscle mass.

No statistically significant differences were observed in the average values of strength measurements for chest-push exercises (maximum weight lifting for one repetition max 1RM) among women engaged in resistance training before

and after adhering to the Mediterranean diet. The absence of a discernible change in strength measurements for chest-push exercises among women practicing resistance training in the Jeddah Governorate suggests that the application of the Mediterranean diet did not yield a noticeable effect on this particular aspect of strength.

Conversely, statistically significant differences were identified in the average values of strength measurements for leg-push exercises (maximum weight lifting for one repetition max 1RM) among women practicing resistance training before and after implementing the Mediterranean diet. The outcomes favoured the post-test scenario, indicating a notable increase in the strength of leg-push exercises among women engaged in resistance training. This underscores the considerable impact of the Mediterranean diet on enhancing muscular strength among individuals participating in resistance training in the Jeddah Governorate.

In conclusion, the study revealed that while the Mediterranean diet did not exhibit a significant impact on fat-free mass, muscle mass, or strength measurements for chest-push exercises among women practicing resistance training in the Jeddah Governorate, it demonstrated a noteworthy positive effect on the strength of leg-push exercises. What these findings would seem to emphasize is a nuanced effect of the Mediterranean diet on specific aspects of body composition and strength in the context of resistance training.

Conclusion

After presenting the research data and discussing its results in light of ascertaining the extent to which the Mediterranean diet affects muscular strength and body composition (fat mass, fat-free mass, muscle mass) among female resistance trainees in the Jeddah Governorate, it was concluded that adherence to the Mediterranean diet is restricted. Calories had a positive effect on reducing weight and fat mass since they increased muscle strength in the lower part of the body among those practicing resistance training, while no noticeable effect was found in the measurements of muscle strength in the upper body nor was there any increase in muscle mass and fat-free mass.

Acknowledgements

This work were supported in part by university of Jeddah

Conflicts of Interest

The authors declare no conflict of interest.

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