Exercise Physiology and Performance Volume2 Issue1 (2024): 21-31

 DOI: 10.30486/EPP.2024.1107343

Original Article

The Impact of Combined Exercise and Kefir Yogurt Consumption on Some Metabolic Syndrome Indicators in Overweight Adolescent Girls

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Submission date: 17-04-2024   Acceptance date: 20-05–2024   Print Date: 10-06–2024

Abstract

Background: The present study aimed to investigate the effects of combined exercise and kefir yogurt consumption on certain indicators of metabolic syndrome in overweight adolescent girls.

Methods: The statistical population consisted of40 overweight non-athlete female students 20 to 30 years. Participants were randomly assigned to four groups: combined exercise group, kefir yogurt consumption group, combined exercise and kefir yogurt group, and a control group. Subjects engaged in combined exercise sessions three times a week for eight weeks. Additionally, participants in the kefir yogurt groups consumed 750 milliliters of Pegah kefir yogurt three times a day for eight weeks.

Result: The results revealed a significant difference between the combined exercise + kefir group and the other groups, indicating superior performance in the combined exercise + kefir group compared to the others.

Conclusion: Probably, exercise training along with kefir yogurt consumption have better effects on the improvement of Metabolic Syndrome Indicators in Overweight Adolescent Girls.

Keywords: Exercise training, kefir, Metabolic Syndrome, Girls.

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Introduction

Metabolic Syndrome is recognized as a set of risk factors, including obesity, insulin resistance, serum lipid disorders, and elevated blood pressure, contributing to non-communicable diseases such as cardiovascular diseases and type 2 diabetes(1) .Abdominal obesity, dyslipidemia, reduced high-density lipoprotein (HDL) cholesterol, increased serum triglycerides, high blood pressure, insulin resistance, impaired glucose tolerance, and type 2 diabetes are among the risk factors for metabolic syndrome(2, 3).

Metabolic syndrome is a collection of metabolic disorders, the simultaneous occurrence of which in an individual poses a greater risk than the individual likelihood of each one separately. Studies have indicated that there is a synergy in the occurrence of metabolic factors in different individuals, and the presence of this set of detrimental factors is more harmful than each one individually(4, 5).It has been reported that obesity has a direct relationship with metabolic syndrome, and the risk of developing metabolic syndrome increases with increasing obesity (6).Metabolic syndrome or insulin resistance syndrome refers to a cluster of disorders, including abdominal obesity, high blood pressure, elevated triglycerides, low HDL, and insulin resistance, putting individuals at risk for cardiovascular diseases and type 1 diabetes(7) . This syndrome was first described in 1988, stating that having three or more of the above criteria indicates susceptibility to metabolic syndrome (8).The exact pathogenesis of this condition is not precisely defined; however, various factors such as urbanization, sedentary lifestyle, genetics, race, aging, and unhealthy diets are likely contributors to the development of these disorders. It appears that reduced physical activity and increased calorie intake are among the most important factors in the initiation and exacerbation of obesity and metabolic syndrome. Metabolic syndrome in adolescents and young adults is on the rise, showing an increasing trend compared to the past, and it is one of the disorders closely associated with obesity, with the likelihood of its occurrence increasing with weight gain (9)

Treatment of metabolic syndrome in early ages is of particular importance, as this disorder tends to persist and intensify into adulthood when manifested in early stages. Various studies have emphasized the significance of lifestyle modification as a crucial factor in predicting and managing the consequences of this condition alongside pharmacological treatment, requiring substantial attention(10) .Physical activity has a substantial impact on overall body health and is considered an effective method in reducing metabolic syndrome and obesity(11). Previous studies have demonstrated the broad influence of physical activity on individuals with metabolic syndrome, indicating that low muscular fitness increases the risk of metabolic syndrome, establishing an inverse relationship between them. Abdominal obesity, associated with metabolic syndrome, leads to metabolic complications such as high blood pressure, type 1 diabetes, insulin resistance, and dyslipidemia. Moderate to intense physical activity reduces abdominal fat and overall body fat, potentially decreasing the risk of metabolic syndrome by reducing abdominal obesity Furthermore, obesity in early ages impairs endothelial function, contributing to increased blood pressure (12). Physical activity results in a reduction in both systolic and diastolic blood pressure, likely attributed to improved insulin sensitivity or increased nitric oxide endothelial activity. Studies have reported that exercise reduces triglyceride levels and high glycemic blood levels while improving HDL levels (13) Overall, exercise is considered a factor in controlling and improving metabolic syndrome and its associated complications. Despite the positive effects of physical activity on metabolic syndrome, the use of dietary supplements to expedite the control of metabolic syndrome indicators or prevent damages resulting from increased metabolic indices is also crucial. In this regard(14), probiotics, through enhancing gut microbiota, present beneficial effects on the host. Kefir, a type of probiotic dairy product, is prepared through fermenting milk with kefir grains. White kefir grains, resembling cauliflower, contain a mixture of bacteria, including lactobacilli and lactococci, as well as yeasts, and are rich in B-group vitamins, calcium, amino acids, and folic acid. Due to its low fat and lactose content, kefir finds application in many specific dietary regimens(15, 16). On the other hand, researchers have also focused on the impact of this beverage on individuals' performance and body composition. In a study aimed at investigating the effect of kefir on physical fitness and body composition as a measure for reducing cardiovascular risks, Kelly et al. (2015) conducted research. They found that 15 weeks of endurance exercise along with consumption of kefir, significantly reduces C-reactive protein levels. Given the theoretical foundations of using probiotics in the diet on physiological attributes, and the conflicting findings on its effect, and the observations of some researchers suggesting improvements in cardiovascular and respiratory performance and maximal oxygen consumption with probiotic supplements, the present study aims to elucidate the impact of combined exercise and kefir consumption on some indicators of metabolic syndrome in overweight girls.

Material and methods

This is an applied semi-experimental study. The participants in this research were female students from the Islamic Azad University, East Tehran Branch, who were overweight. The inclusion criteria for participation were personal consent to participate in the research, absence of cardiovascular problems, hormonal and blood disorders, non-smoking and non-alcohol consumption, and no other disorders that could bias the research results. Sample selection was conducted from among volunteers meeting the conditions.

The statistical population included non-athlete overweight female students aged 20 to 30 at the Islamic Azad University, East Tehran Branch, in the second semester of the academic year 2023. Among them, 40 individuals were selected as the research sample using the G*Power calculation. Initially, necessary information about the research and its stages was provided to the participants and information about the level of physical activity and the participants' health was obtained through a questionnaire. Subsequently, a consent form for participation in the study was presented to the participants. The participants were randomly assigned to four groups: Combined exercise group (10 participants), Kefir consumption group (10 participants), Combined exercise and kefir group (10 participants), and Control group (10 participants).

Firstly, sufficient information about the research was gathered using a library research method, and then data on the intervention were collected using a field method. Anthropometric measurements (height, weight, waist circumference, body fat percentage) were taken before the start of the research.

Height Measurement: Height was measured using a stadiometer (with a detection power of 1 millimeter), namely the seca stadiometer manufactured in Germany. The individuals were placed in the designated location without shoes, and the stadiometer was positioned on their head to determine their height.

Weight Measurement: Weight was measured using a BUERER digital scale manufactured in Germany. This measurement was taken in the morning and before the consumption of any food.

Body Mass Index (BMI): The body mass index is a simple index representing the ratio of weight to height, irrespective of gender, and has a strong correlation with body fat. BMI is calculated based on dividing weight in kilograms by the square of height in meters (kg/m2).

The narrowest part of the waist, just above the navel, was measured using a tape measure.

The body fat percentage was measured using the 720 Body Composition Analyzer.

Blood pressure was assessed using the Omron digital blood pressure monitor from Japan.

Measurement of Protein and Triglyceride Levels:

To measure the levels of low-density and high-density proteins and triglycerides, the participants used kits from the Parsian Company made in Iran. Blood samples were collected 24 hours before the study and 48 hours after its completion. Fasting blood samples were taken at 8 AM in the laboratory and by laboratory specialists, and 5 cc of blood was collected from each participant.

Kefir Consumption:

Participants in the group consumed 750 ml of Pegah Kefir yogurt three times a day for 8 weeks (17).

Exercise training protocol

In the current research, the participants engaged in combined exercises three times a week over an 8-week period. In alignment with the objectives of the current research, the exercise sequence began with resistance exercises, followed by aerobic exercises. Accordingly, the exercise routine commenced after warming up and performing stretching exercises. The resistance training consisted of two sets, each comprising 10 to 12 repetitions of weighted exercises, including chest presses, lateral pulls, leg press, and leg curls/extensions, at an intensity of 50-60% of their one-repetition maximum (RM1), with a maximum of one repetition. Each exercise lasted 40-60 seconds without rest, followed by 2 minutes of active rest between sets. Flexibility exercises were incorporated into the rest intervals (18). The exercise sessions were held at 10 AM. To ensure the proper execution of movements and control the intensity of exercises, the trainer-maintained supervision over the participants throughout the training period. In adherence to the principle of progressive overload, an RM1 test was conducted for the participants at the end of every two weeks. The intensity of the subsequent two-week program for each participant was determined based on the results, ranging from 60% to 50% of their one-repetition maximum (RMI). Following the completion of resistance training and a 10-minute rest interval, the aerobic exercise program was implemented, including brisk walking, jogging, and running for 10 minutes at an intensity of 55% to 60% of the heart rate reserve (19). It is noteworthy that heart rate intensity was monitored using a Polar heart rate monitor attached to the participants' chests. In the initial stages of the exercises, an additional minute was added each week to adhere to the progressive overload principle, ensuring that the duration of the exercises was maintained at 17 minutes in the final weeks Between the second and third weeks, fourth and fifth weeks, and sixth and seventh weeks, calculations were made to adhere to the principle of overload (RM1). At the beginning of the exercises, in order to adhere to the principle of overload, one minute was added to the exercise time each week. Descriptive statistical indices such as mean, standard deviation, frequency, frequency percentage, and chart plotting were utilized to describe the demographic characteristics of the subjects and research variables. After collecting the data, the normal distribution of the data was examined using the Shapiro-Wilk test, and the homogeneity of variances was assessed through the Levene test. two-way ANCOVA and the Tukey post hoc test were employed for statistical analysis. All statistical analyses were conducted at a significance level of $p \leq 0.05$.

Table1. Exercise training protocol

Resistance Increase	Weeks 1 and 2	Weeks 3 and 4	Weeks 5 and 6	Weeks 7 and 8
Sets	2 sets (10 to 12 repetitions	2 sets (10 to 12 repetitions	2 sets (10 to 12 repetitions	2 sets (10 to 12 repetitions
Rest between each set	60 seconds	60 seconds	60 seconds	60 seconds
Rest between each exercise	2 minutes	2 minutes	2 minutes	2 minutes
Time	10 to 11 minutes	12 to 13 minutes	14 to 15 minutes	16 to 17 minutes
Distance	700-1400 meter	1400-1800 meter	1800-2000 meter	2000-2400 meter
Intensity	55 to 60 percent of heart rate reserve	55 to 60 percent of heart rate reserve	55 to 60 percent of heart rate reserve	55 to 60 percent of heart rate reserve

Table 2. Mean and standard deviation of the participants' demographic and anthropometric characteristics

Group		Age (years)	Height (cm)	Weight (kg)	BMI (kg/m^2)
Control	Pre-test	26.50±2.42	1.58±0.76	70.37±6.36	28.5±1.46
	Post-test			69.23±7.39	28.1±1.31
Kefir Group	Pre-test	26.75±4.84	1.61±1.23	73.55±6.26	28.4±1.54
	Post-test			74.49±4.24	28.7±1.32
Exercise	Pre-test	27.62±3.62	1.63±1.54	72.65±6.74	27.3±1.40
	Post-test			69.35±5.79	26.01±0.41
Exercise + Kefir Group	Pre-test	28.09±3.07	1.62±0.93	71.32±6.37	27.2±1.05
	Post-test			68.06±5.42	25.9±2.38

Table 3. Descriptive indicators of research variables in the pre-test and post-test stages

Research Groups	Statistics	Control Group		Kefir Group		Combined Exercise Group		Combined Exercise + Kefir Group		Sig
		Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	
Waist Circumference	Mean	110.80	110.90	112.10	104.90	111.50	100.10	111.50	84.20	0.001*
	Standard Deviation	1.814	1.912	1.524	1.449	1.716	2.685	1.434	3.736	
Blood Pressure (Diastole)	Mean	8.70	8.80	8.80	8.10	8.60	8.40	8.80	7.90	0.001*
	Standard Deviation	0.675	0.632	0.632	0.738	0.699	0.516	0.632	0.568	
Blood Pressure (Systole)	Mean	12.60	12.80	13	12.60	12.80	12.10	13.20	12.10	0.001*
	Standard Deviation	0.966	0.919	1.054	1.075	1.033	0.994	1.033	0.876	
Low-density Lipoprotein	Mean	106.40	106.80	107	105	110.10	105.40	109.50	100.10	0.001*
	Standard Deviation	3.806	3.676	3.33	2.944	3.604	3.273	2.369	2.234	
High-density Protein	Mean	51.40	51.60	51.40	55.60	49.60	52.20	52.70	56.70	0.001*
	Standard Deviation	3.97	4.377	3.23	3.062	5.542	4.517	4.832	3.234	
Triglyceride	Mean	124	124	127.10	124.70	130.90	125.70	130.20	123	0.001*
	Standard Deviation	6.377	6.377	9.826	9.141	11.609	9.569	10.737	12.55	

* Significant

Results

The mean and standard deviation of the participants' demographic and anthropometric characteristics are presented in Table 2. The results showed a significant differences in Waist Circumference, Blood Pressure (Diastole and Systole), Low-density Lipoprotein ,High-density Lipoprotein and Triglyceride (Table 3, $p<0.05$).

Discussion

Based on the obtained results, combined exercise has a significant effect on the waist circumference of overweight girls (15-17). Previous research indicates that combined moderate-intensity exercise, even in the absence of dietary restrictions, can have significant effects on improving metabolic syndrome indicators (18). The neurological-muscular adaptations of these exercises include increased recruitment of motor units, frequency, and synchrony of motor units, ultimately leading to increased strength, efficiency, and muscular coordination and higher energy consumption (19). It delays the improvement in performance resulting from neural adaptations to fatigue and enables individuals to execute higher levels of performance, leading to an increase in energy expenditure (14).

Considering that the current research protocol was based on aerobic and resistance exercises, it is expected that fatty acids would be utilized as the primary fuel by muscles during the mentioned activity, leading to a reduction in body fat. According to studies, aerobic exercises increase the capacity for fat uptake and oxidation in muscles, resulting in an increase in the exercise-trained muscle. By increasing the activity of lipoprotein lipase enzyme, the capacity of beta-oxidation of fats in the muscle increases, and its significant effect is the increased share of fats and consequently a proportional decrease in the share of glucose in energy production during aerobic exercises.

These researchers demonstrated that the combination of kefir supplementation and aerobic exercise had no significant effect on waist circumference. The difference in participants, exercise intensity, and the use of a combined exercise in the present study may account for the disparity in reported results. Moreover, the results of the current study showed a significant difference in systolic and diastolic blood pressure between the combined and combined + kefir groups and the control group, with the greatest difference observed in the combined + kefir and kefir and combined + groups. Therefore, the combination + kefir group outperformed other groups. In the effectiveness of combined exercises on blood pressure, the obtained results are

Metabolic syndrome leads to the expansion of hypertension related to cardiovascular and renal diseases and has an impact on each of the metabolic syndrome indicators. The occurrence of hypertension in overweight and obese individuals is often the result of increased peripheral vascular resistance and stiffness. It seems that regular physical activity, as a non-pharmacological factor, may have the potential to improve blood pressure. Regular physical activity can bring about desirable changes in high blood pressure. There are various mechanisms through which aerobic exercise lowers blood pressure. Aerobic exercise increases blood flow, stress (stimulates nitric oxide production) in the endothelium, and, if the endothelium is healthy, leads to vasodilation, ultimately reducing blood pressure. Additionally, exercise may contribute to the restoration of endothelial function and effective reduction of blood pressure through the regulation of other risk factors such as lowering cholesterol, reducing blood sugar, and reducing hyperinsulinemia, which play an active role in hypertension.

The other results of the current study showed that combined exercise and kefir consumption significantly affect the levels of low-density lipoprotein (LDL), high-density lipoprotein (HDL), and triglycerides in overweight girls, with the combined + kefir group outperforming other groups. Regarding the lipid profile and its relationship with physical activity, it can be stated that the effectiveness of various physical activities on the lipid profile is influenced by its initial levels (13).

Adiponectin is a peptide with the ability to improve metabolic factors. However, its level is reduced in individuals with metabolic syndrome. On one hand, physical activity leads to the depletion of ATP reserves but, on the other hand, it results in an increase in AMP levels. The increase in AMP levels leads to increased AMPK activity. Adenosine Monophosphate-Activated Protein Kinase (AMPK), when activated, can stimulate the oxidation of fatty acids in the liver, inhibit cholesterol synthesis, stimulate lipoprotein and triglyceride synthesis, and promote fatty acid oxidation in skeletal muscles, aiding in the prevention of GLUT-4 translocation in sarcolemma. During periods of inactivity, the activity of lipoprotein lipase (LPL) decreases, and HDL is reduced by 20 percent. Increased muscular LPL activity after short-term physical activity has been widely reported to reduce dyslipidemia and atherosclerosis. Insulin resistance and fat cells reduce the effects of insulin and increase hydrolysis in triglyceride reserves (17). The increase in triglycerides leads to increased LDL oxidation, contributing to atherosclerosis. Although the occurrence of such mechanisms has been frequently reported after long-term exercises (19), the current research results demonstrate that combined exercises can comprehensively improve metabolic syndrome indicators. Furthermore, the consumption of kefir yogurt can facilitate and enhance the effectiveness of these exercises, reaching the desired and expected levels. Considering the positive and significant effects of combined exercise and kefir yogurt consumption on waist circumference, blood pressure, low-density lipoprotein (LDL), high-density lipoprotein (HDL), and triglyceride levels in overweight girls, it is recommended that overweight girls participate in exercise programs and utilize the combined exercise protocol from this study, along with kefir yogurt consumption in the specified amounts. This could provide them with the benefits of both methods for improving metabolic syndrome symptoms.

Conclusion

The results revealed a significant difference between the combined exercise + kefir group and the other groups, indicating superior performance in the combined exercise + kefir group compared to the others. Probably, exercise training along with kefir yogurt consumption have better effects on the improvement of Metabolic Syndrome Indicators in Overweight Adolescent Girls.

Acknowledgements

The present research is based on the findings of a Master's thesis published at the Islamic Azad University, East Tehran Branch. This study was supported by East Tehran Branch, Islamic Azad University, Tehran, Iran.

Funding

None

Conflict of interests

There is no conflict of interest on the part of the authors.

Ethical approval

This study protocol conformed by the ethical committee of Islamic Azad University East Tehran branch (Ethical code IR.IAU.ET.REC.1402.010).

Informed consent

All authors consent to this manuscript submission.

Author contributions

Conceptualization: N.V, M.H, A.E,; Methodology: N.V, M.H, A.E,; Software: N.V, M.H, A.E,; Validation: N.V, M.H, A.E,; Formal analysis: N.V, M.H, A.E,; Investigation: N.V, M.H, A.E,; Resources: N.V, M.H, A.E,; Data curation: N.V, M.H, A.E,; Writing - original draft: N.V, M.H, A.E,; Writing - review & editing: N.V, M.H, A.E,; Visualization: N.V, M.H, A.E,; M.GH; Supervision: N.V, M.H, A.E,; Project administration: N.V, M.H, A.E,; Funding acquisition: N.V, M.H, A.E

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