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THE EFFECT OF MINI TRAMPOLINE EXERCISES ON WOMEN'S PHYSICAL FITNESS PARAMETERS

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ABSTRACT

The aim of this research is to investigate the effects of eight weeks of mini trampoline exercises applied to women on physical fitness parameters. The study included 23 female volunteers (experimental group=12; control group=11) with an average age of 20.5±1.38 years, who were enrolled in the Faculty of Sports Sciences at Dumlupınar University during 2022-2023 academic year. In the study, during the eight-week period, height and body weight, vertical jump, 20-meter sprint, 25-meter V Cut direction change, 1-minute sit-up, and core endurance values were measured at the beginning and end of the process. The training period was two months (8 weeks), with three days per week and one hour per day. After the three-week anatomical adaptation process, mini trampoline exercises were implemented within the eight-week period, increasing the speed of movements and the number of repetitions according to the participants' levels of progress. The data were evaluated using the SPSS (23.0) software package, and the necessary assumptions were checked before conducting the Mixed Measures ANOVA analysis, with a significance level set at $p<0.05$. As a result, when the differences between the groups before and after the training program were compared, significant improvements were observed in vertical jump (cm, mm), anaerobic power (watt), "20-meter" sprint (seconds, split seconds), "25-meter" V Cut direction change (seconds, split seconds), 1-minute sit-ups (minutes, repetitions), and core endurance (seconds) values in the experimental group, while a significant improvement in core endurance (seconds) values was found in favour of the control group. Regarding the group x measurement interaction, significant improvements in core endurance were observed in both groups. Considering the measurements of vertical jump (cm, mm), "20-meter" sprint (seconds, split seconds), and "25-meter" V Cut direction change (seconds, split seconds), there was a significant interaction in favor of the experimental group. After the eight-week mini trampoline exercise application in women, noticeable improvements were observed in some biomotor characteristics. In conclusion, based on the findings of our study, it has been determined that the eight-week mini trampoline exercises positively contributed to physical fitness.

Keywords: Physical fitness, women, mini trampoline.

INTRODUCTION

In the process of redefining conventional physical fitness paradigms, there has been a concerted effort to imbue the terminology with a comprehensive outlook and the expression of the terms more clearly and focusing on the beneficial aspects of fitness are emphasized. In this endeavor, a language has been employed that encapsulates a broader perspective, considering the functional aspects of fitness. Nevertheless, it is noteworthy that these refined definitions have yet to explicitly address the actual health outcomes directly associated with engaging in physical activity. Thus, an opportunity arises to bridge the gap between the theoretical framework of functionalized wellness and its tangible impact on individual health and overall health. The existing body of knowledge in exercise science and society's perception of physical fitness indicates that the definition of physical fitness should focus on its health-related aspects. Physical fitness comprises of several components such as cardiorespiratory fitness, muscular endurance, muscular strength, flexibility, coordination, and speed. Most studies examining the differences in physical fitness based on body fat have focused only on one aspect of fitness, namely cardiorespiratory fitness, in obese children and adolescents (Deforche et al., 2023). Physical activity and physical fitness are closely related because the content of physical fitness is influenced by an increase in physical activity. The effectiveness of physical activity based on environmental factors contributes more to an individual's fitness than genetic factors (Bouchard et al., 2012). Physical fitness has become a characteristic that can be measured by many different tests with validity in all areas. These include skill-related physical fitness tests, health-related protective physical fitness tests against diseases, and tests that measure individuals' fitness in social entertaining activities (Zorba, 2000). In the quest for diversity in daily physical activity, specific new trends have emerged. Mini trampoline activities have started to gain attention. The spreading speed of the Mini trampoline, also known as "Rebound" among the public, was slower than the spreading speed of the full-size trampoline. Towards the end of the 20th century, the mini trampoline began to be noticed when Albert E. Carter and his family traveled to countries that organized trampoline shows in 1977. Besides the popularity of his shows, Carter was dubbed the "Father of Rebound Exercise" in 1979 when his book titled "The Miracles of Rebound Exercise" was published. This work was turned into a study by NASA in 1978, describing the benefits of mini trampolines and other trampolines. With these studies, the popularity of mini trampolines increased significantly. By the 1980s, mini trampolines became an accessory for exercise for fitness instructors and participants. Starting from 2000, its international popularity peaked, and trampoline competitions were introduced as an Olympic event (Esposito & Esposito, 2009). Mini trampoline exercises involve a multi-component approach, affecting various physical factors such as strength, body stability, muscle coordination, joint range of motion, and spatial integration (Aragão et al., 2011). The flexible surface of the trampoline equipment has a stimulating effect on the neuromuscular system. It contributes to increased oxygen utilization capacity and vertical jump distance while reducing body weight and body fat percentage. It enhances overall physical fitness and athletic performance (Talanian et al., 2007; Edvardsen et al., 2011).

The numerous benefits of mini trampoline exercises, frequently used according to their purposes, have been proven through various studies. Its flexible springs allow for vigorous bouncing, increasing sensory system arousal levels, while also creating a rebound effect on the muscles to reduce tension. During plyometric training, high-impact forces can elevate a person's body weight up to three times during landing (Dufek & Bates, 1991). However, performing these synchronized movements repeatedly can lead to muscle soreness, overloading, and ultimately cause injuries to the skeletal muscles and joints (Hewett et al., 1996; Makaruk et al., 2014; Stemm & Jacobson, 2007). The elastic surface of the mini trampoline has shown tendencies to improve jumping biomechanics and even prevent impact trauma during landings (Dufek & Bates, 1991). Additionally, it has the potential to reduce mechanical load on the muscle system and enhance the effectiveness of the muscle-tendon complex (Arabatzi et al., 2018).

The cardiorespiratory system, by providing support to the body against the increased gravitational demand on muscles, leads to an increase in heart and respiratory rate, causing the heart and respiratory system to work more (Smith & Cook, 2007). The increased respiration and heart rate result in improved lymphatic drainage and venous return (Tortora & R., 2003). To maintain balance, muscles continuously work, increasing the demand for oxygen, thus promoting the constant activity of the cardiorespiratory system, which in turn enhances fitness during physical activities and exercises (Sherwood, 2004; Jones & Baker, 1996). Mini trampoline activities can serve as a beneficial exercise source for individuals facing multiple and profound learning challenges. Exercises performed on an unstable surface enhance sensory interaction between joints and muscles, stimulating postural mechanisms and balance reactions (Carr & Shepherd, 1998).

When examining the studies in the literature, it can be observed that mini trampoline exercises are included in exercise prescriptions and are preferred as a supportive element by coaches in many sports disciplines. Additionally, mini trampoline is also preferred for physical activity purposes. Considering the potential contributions of mini trampoline activities to women's physical fitness and the benefits it can provide to practitioners, a research study has been planned. It is believed that observing the impact of activities performed with mini trampoline on skill-related physical fitness parameters will contribute positively to future studies.

METHOD

Study Group

The study included a total of 30 female participants, divided into experimental (n=15, aged 20.5±1.38 years) and control (n=15, aged 21.5±1.29 years) groups. Participants were selected from students enrolled in Dumlupınar University during 2022-2023 academic year, who met the criteria of engaging in regular exercise for at least four years and provided voluntary informed consent (and possessed a medical report from a specialist confirming their suitability for sports activities).

Data Collection

Prior to the tests, detailed information about the tests was provided to the participants, and they were given a trial run to familiarize themselves with the procedures. The test protocol included recording body weight, height, and age of the participants. Subsequently, values for vertical jump, "20-meter" sprint, 25-meter V Cut direction change, 1-minute sit-ups, and core endurance tests were recorded on the data form. During the tests, the principle of active rest between tests was adhered to, ensuring the reliability of the data obtained. Vertical jump, "20-meter" sprint, 25-meter V Cut direction change, 1-minute sit-ups, and core endurance test values were determined. At least 3 (three) measurements were taken in each test battery, and the best values were included in the statistical analysis. Each test was conducted before the start of the training period, following the anatomical adaptation phase, and at the end of the training period. Participants in the control group did not participate in any training program other than the anatomical adaptation exercises.

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Height and Body Weight Measurement

The height and body weight of the voluntary participants in the study were measured using the Pulsemed BYH01 (Height Weight Fat Analysis Scale; with a precision of 1 mm and 0.01 kg). For height measurement, the participants stood upright on the scale with the sliding caliper fixed to touch the top of their head, and the height value was recorded. Additionally, the participants' body weight was measured while standing on the scale with their weight evenly distributed on both feet. Height was recorded in centimeters and millimeters, and body weight was recorded in kilograms on the data form. The participants were asked to wear appropriate clothing to ensure that the measurements were not affected (Tamer, Measurement and Evaluation of Physical-Physiological Performance in Sports, 2000).

Vertical Jump Test and Anaerobic Power Measurement

For the vertical jump test, the Fitjump brand vertical jump meter was placed on the ground, and the photoelectric switch sensor located at the front of the device was positioned approximately 30 cm away from the participants' feet, aligning with the midpoint of their feet in the sagittal plane. Before the jump, participants were instructed to keep their hands in contact with their waist with palms facing downwards and feet shoulder-width apart, with knees in a tense position. Upon the command of the expert, participants performed a vertical jump by bending their knees. During the jump, the hands were required to stay in contact with the body, and after the vertical jump, both feet were expected to land on the ground simultaneously. The results of jump height, anaerobic power, and flight time were displayed on the monitor of the Fitjump device.

The test was performed 3 times. A 5-minute rest interval was allowed between each trial, and the results were recorded on the data form in seconds and split seconds (Yıldız & Fidan, 2018). The determination of anaerobic power was assessed in kg-m/s units by the interface of the Fitjump brand vertical jump meter, using the Lewis formula (Erkmen et al., 2005).

Twenty (20) Meter Sprint Test

For the speed test, photocells (fitspeed, Sporsis) were positioned at the starting line and at a distance of 20 m from the starting line to mark the finish line. Participants performed the sprint test from a high starting position, 0.3 m behind the starting line, and ran through the space between the two photocells at the finish line. The test was conducted using a stopwatch system with a precision of ±0.01 seconds. The test was performed 3 times. A 5-minute rest interval was allowed between each trial, and the results were recorded on the data form in seconds and split-seconds (Yıldız & Fidan, 2018; Loturco et al., 2016).

25. meter V Cut Direction Change Test

The 25-meter V Cut direction change test was conducted in an area where Fitspeed brand (Sporsis Ltd.) photocell timing system was placed at the starting and finishing lines (Yıldız & Fidan, 2018). The test involved eight funnels, each with a 45° angle, placed at 5-meter intervals between the starting and finishing lines, creating four contact areas with a gap of 0.7 meters between each funnel. Participants were required to complete the 25-meter course by stepping on the designated areas between the funnels and changing direction accordingly. During the test, participants initiated the test from 50 cm behind the starting line using a high exit technique, and under the supervision of a test expert, they performed the test by changing direction and making contact with the designated areas with their feet. The test was performed 3 times. A 5-minute rest interval was allowed between each trial, and the results were recorded on the data form in seconds and split-seconds (Gonzalo-Skok et al., 2015).

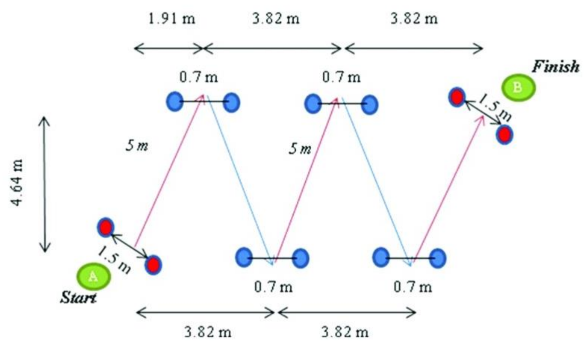

Figure 1. 25-meter V Cut Direction Change Test (Gonzalo-Skok et al., 2015)

1. minute Sit-Up Test

1-Minute Sit-Up Test: Participants start by lying supine on a mat with their feet shoulder-width apart and knees at a 90° angle. An assistant provides resistance to prevent the participant's feet from lifting off the mat. They are instructed to cross their arms over their chest. Upon the command "start" by the expert, participants actively flex their bodies to approximately 45° and then return to the starting position. The movement is performed for one minute. The number of correctly performed repetitions is recorded and entered into the data form (Mirzaei et al., 2013; Ashok, 2008).

Core Endurance Test

To evaluate core extensor endurance, participants were positioned prone on an examination table with their pelvis aligned at the upper edge of the table, ensuring that the upper edges of the iliac wings were in contact with the table. The pelvis, knees, and ankles were secured to the table with three straps, and the arms were bent at the elbows. Participants were instructed to isometrically hold their upper body in a horizontal position parallel to the ground upon the expert's command "start." The stopwatch was used to record the time in seconds and milliseconds until the desired movement form was compromised. The obtained result was recorded in the data form (Barati et al., 2013).

Heart Rate Measurement and Determination of Exercise Intensity

Participants' resting heart rate and heart rate values during mini trampoline exercises were determined using a Polar watch (Polar RC3 GPS Heart Rate Monitor, Finland). The heart rate monitor consists of a wristwatch with a transmitter feature and a chest strap with a radio frequency system. Instantaneous heart rate values from the chest strap were transmitted to the watch at 5-second intervals and recorded. To ensure data security and prevent data mixing, each Polar watch had its own unique code. The data was transferred to the computer software program (Polar ProTrainer 5 Professional Training Software for Windows) via a USB-connected infrared receiver. Participants' heart rate values before, during, and after the mini trampoline exercise were recorded in the individual data form (Tekin, 2020).

The determination of exercise intensity was calculated using the formula "Target heart rate = exercise intensity x (maximum heart rate - resting heart rate) + resting heart rate" (Nakanishi et al., 2015). The Karvonen formula was used to apply 60% of heart rate reserve (HRR) for moderate-intensity exercise and 80% of heart rate reserve (HRR) for high-intensity exercise (Çakaloğlu & Bayar, 2018).

Statistical Analysis

The statistical analysis of the data was conducted using the SPSS (23.0) software for Windows. A mixed-design ANOVA test was applied for the statistical calculations in the study. Prior to performing the statistical analyses, the assumptions of ANOVA were evaluated, including normal distribution, homogeneity of variance, and independence of observations. To check the assumption of normal distribution, skewness and kurtosis values were examined, and it was ensured that the obtained values fell between -1.5 and +1.5 (Tabachnick & Fidell, 2013). The second assumption, homogeneity of variance, was tested using Levene's test. For homogeneity of variance, it was necessary for the results to be non-significant ($p > .05$) (Tabachnick & Fidell, 2013). The final assumption, independence of observations, was verified, and it was determined that the researchers met the requirement for independent observations. For evaluating the effect size of the findings, Cohen's d formulation was preferred (Cohen, 1992). According to this formulation, $d = 0.20$ indicates a small effect size, $d = 0.50$ represents a medium effect size, and $d = 0.80$ indicates a large effect size. The significance level was considered as $p < 0.05$.

Training Protocol

After a three-week anatomical adaptation training program, participants were subjected to an eight-week training period for mini trampoline exercises. The training period was scheduled for two months (8 weeks), with three training sessions per week and each session lasting 1 hour. Before each training session, a 10–15-minute general warm-up followed by a 10-minute specific warm-up was performed to prepare the participants. After the training session, a 10-minute cool-down drill was conducted. During the training sessions, participants performed movement patterns with their own body weight on the mini trampoline under the guidance of the instructor. The speed and number of repetitions of the exercises were increased according to the participants' level of progress over the eight-week period.

Anatomical Adaptation Phase

Before the anatomical adaptation phase, participants were introduced to the perceived difficulty level using the OMNI-RES scale by a sports science specialist. The OMNI-RES scale is scored from 0 to 10, ranging from very light to very hard. The OMNI-RES scale was presented to participants for each exercise pattern, and they were asked to describe their perceived difficulty level (PDL) based on the scale. In general, in the 4-week anatomical phase, the participants were warned to increase the perceived difficulty level of the anatomical adjustment phase in weekly unit trainings one step higher than the previous week.

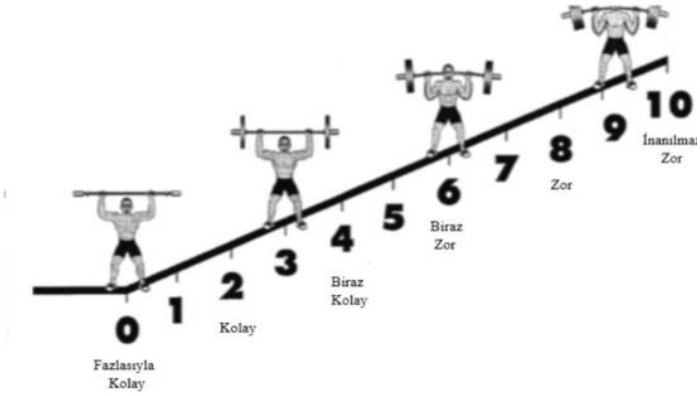

Figure 2. OMNI-RES Perceived Exertion Scale (Robertson et al., 2003).

In the first and second weeks, functional exercise patterns were performed with participants' own body weight in a 10-station circular training format. The exercises were conducted in a station format, with each station performed for a specific duration against time. The following exercises were included in the stations: forward lunge, push-ups, air squat, reverse crunch, jump rope, crunch, rope wave, and TRX exercises with body weight (e.g., balance lunge, modified chest press, knee tuck, hamstring curl, etc.) performed on a 30 cm-high box jump. Each station was performed for 30 seconds, followed by a 15-second rest between stations. After completing all 10 stations, participants had an active rest period of 2-3 minutes. This whole 10-station circuit was completed for 5 sets in one training session (Lee et al., 2021; Boyle, 2019). Starting from the third and fourth weeks, the duration for each exercise pattern in the 10-station circular training format was changed to 40 seconds, with a 20-second rest between stations. Like the previous protocol, participants completed 5 sets of the 10-station circuit, followed by a 2–3-minute active rest. (Kaikkonen et al., 2000; Boyle, 2019). During the anatomical adaptation phase, participants were instructed to perform the exercise patterns correctly within the given time frame at each station. After the anatomical adaptation phase, mini trampoline exercises were introduced, progressing from simpler to more complex patterns. During the main phase of the training session, the mini trampoline exercise patterns were designed to be included in the drills. The weekly program included functional training sessions on Mondays, Wednesdays, and Fridays.

During the 5th and 6th weeks, 10 mini trampoline exercises were selected, and each exercise was performed for 30 seconds at moderate intensity followed by 30 seconds at high intensity, back-to-back. After 60 seconds, participants moved on to the next exercise, completing 10 exercise patterns to form one set. This process was repeated for 3 sets, with 2-3 minutes of rest between sets. In the 7th and 8th weeks, the difficulty level was increased compared to the 5th and 6th weeks. Participants performed 10 mini trampoline exercises, with each exercise being performed for 45 seconds at moderate intensity followed by 30 seconds at high intensity, back-to-back. After 75 seconds, they moved on to the next exercise, completing 10 exercise patterns to form one set. This process was repeated for 3 sets, with 2-3 minutes of rest between sets. In the 9th and 10th weeks, the same 10 mini trampoline exercises from the 7th week were performed, with each exercise being performed for 45 seconds at moderate intensity followed by 45 seconds at high intensity, back-to-back. After 90 seconds, they moved on to the next exercise, completing 10 exercise patterns to form two sets. This process was repeated with 3-4 minutes of rest between sets. Finally, during the 11th and 12th weeks, the 10 mini trampoline exercises were performed, with each exercise being performed for 60 seconds at moderate intensity followed by 30 seconds at high intensity, back-to-back. After 90 seconds, participants moved on to the next exercise, completing 10 exercise patterns to form two sets. This process was repeated with 3-5 minutes of rest between sets.

Movement Patterns Implemented on Mini Trampoline

The mini trampoline is a platform designed to facilitate safe and effective exercises. It is elevated 30 cm from the ground and has sides measuring 60 cm each, with a distance of 125 cm between its corners. The platform consists of a robust hexagonal frame capable of supporting up to 200 kg, and it is connected to a flexible resistance mat through adjustable bands at 42 points along each hexagon's edge (the distance between corners of the mat being 100 cm) (Trendyol, 2023).

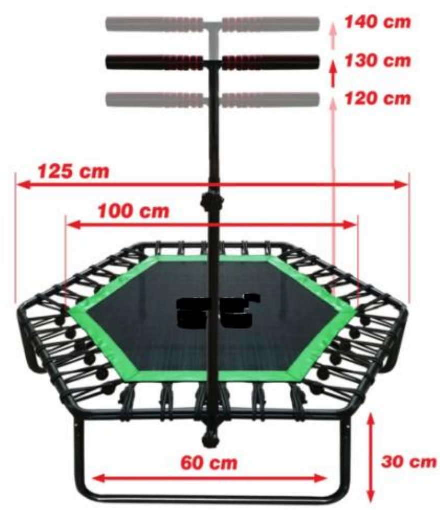

Figure 3. Mini Trampoline

Running Form; Running Man

Participants were instructed to maintain an upright posture with their head and torso aligned. They were asked to perform the running form with bilateral arm and leg movements, and slightly flexed thighs to a higher position (Byrdie, 2023).

Figure 4. Running Form; Running Man

Legs and arms opening and closing laterally; Jumping Jack

The "Jumping Jack" movement consists of two jumping phases. During the first jumping phase, participants perform abduction of both arms and legs in the frontal plane, while in the second jumping phase, they return to the starting position by performing adduction of arms and legs (Costa et al., 2011).

Figure 5. Legs and Arms Opening and Closing Laterally; Jumping Jack

Jumping with inward and outward rotation of the lower extremities; Jumping Ab Twists: Participants start in an upright position with feet slightly together and arms at shoulder height with elbows bent and parallel to the ground. Upon vertical jumping on the trampoline, participants initiate the movement by rotating their feet and slightly bent knees towards the right side. Upon landing back on the trampoline surface, they immediately jump again and complete the movement by rotating towards the left side.

Figure 6. Jumping Ab Twists: Jumping with inward and outward rotation of the lower extremities.

Single Leg Hops

Participants were positioned with an upright posture, facing forward, and their body weight evenly distributed on both feet. Two hops were performed on each leg, while the other leg's knee was flexed, and the thigh region brought into flexion to demonstrate the movement pattern. During the execution of the exercise, the arms were positioned at approximately 90 degrees from the elbows to contribute to maintaining the posture of the body.

Figure 7. Single Leg Hops

Two-Legged Bouncing

Participants were positioned with their hands in contact with the mini trampoline's handles, and their feet were parallel and separated from each other by hip-width. The knees were slightly bent, and the arms were in a flexed position, with the body and abdominal region slightly relaxed at the sides. Participants then performed a rhythmic up-and-down bouncing movement. At each bounce, they contacted the trampoline mat.

Figure 8. Two-Legged Bouncing

Forward and Backward Scissors with Legs; Lunge

Participants were instructed to stand on the mini trampoline with slightly bent knees in a lunge position. They were asked to perform jumps while in this position. At the highest point of the jump, they executed a scissor-like movement with their legs, with one leg positioned forward and the other leg backward, contacting the mini trampoline's mat, and then they jumped again. This motion facilitated alternating the position of the legs, bringing the back leg forward and the front leg backward. Throughout the movement, the arms remained active and in a bilateral position.

Figure 9. Forward and Backward Scissors with Legs

Jump Squat

Participants were positioned on the mini trampoline with their feet parallel and hip-width apart, knees slightly bent, and arms in flexion, relaxed at the sides of the body and abdomen. They were instructed to perform rhythmic upward and downward squatting jumps. During each jump, they made contact with the mini trampoline mat.

Figure 10. Jump Squat

Jumping Leg Hyper Adduction

Participants kept their hands on the mini trampoline's handles with their feet parallel and hip-width apart, and knees slightly bent. They were instructed to perform rhythmic upward and downward jumps while crossing their legs in a hyper-adduction movement. Throughout the movement, their hands remained on the mini trampoline's handles. They made contact with the trampoline mat during each jump.

Figure 11. Jumping Leg Hyper Adduction

Torpedo Jump

Participants stood with their feet parallel and hip-width apart, knees tense, and arms touching the sides of their bodies. They were instructed to perform rhythmic upward and downward jumps while using plantar flexion of their feet. During each jump, they made contact with the trampoline mat.

Figure 12. Torpedo Jump

High Knees Running

Participants stood upright with their heads facing forward, distributing their body weight evenly on both feet. While keeping their body and core stable, they were instructed to lift their knees as high as possible and simulate running in place. To support the leg movement, participants were encouraged to swing their arms actively back and forth bilaterally.

Figure 13. High Knees Jumping

Tuck Jump

Participants kept their hands on the mini trampoline's handles while standing with their feet parallel and hip-width apart, and their knees slightly bent. They then performed a rhythmic up-and-down jumping movement, raising their knees towards their abdominal region. Throughout the movement, their hands remained on the mini trampoline's handles. At each jump, they made contact with the trampoline mat.

Figure 14. Tuck Jump

Jumping with Hyperabduction of Legs

Participants kept their hands on the mini trampoline's handles while standing with their feet parallel and hip-width apart, and their knees slightly bent. They then performed a rhythmic upward jumping movement, hyper-abducting their legs, with their elbows tense and body parallel to the ground. Throughout the movement, their hands remained on the mini trampoline's handles. At each jump, they made contact with the trampoline mat (Höchsmann et al., 2018).

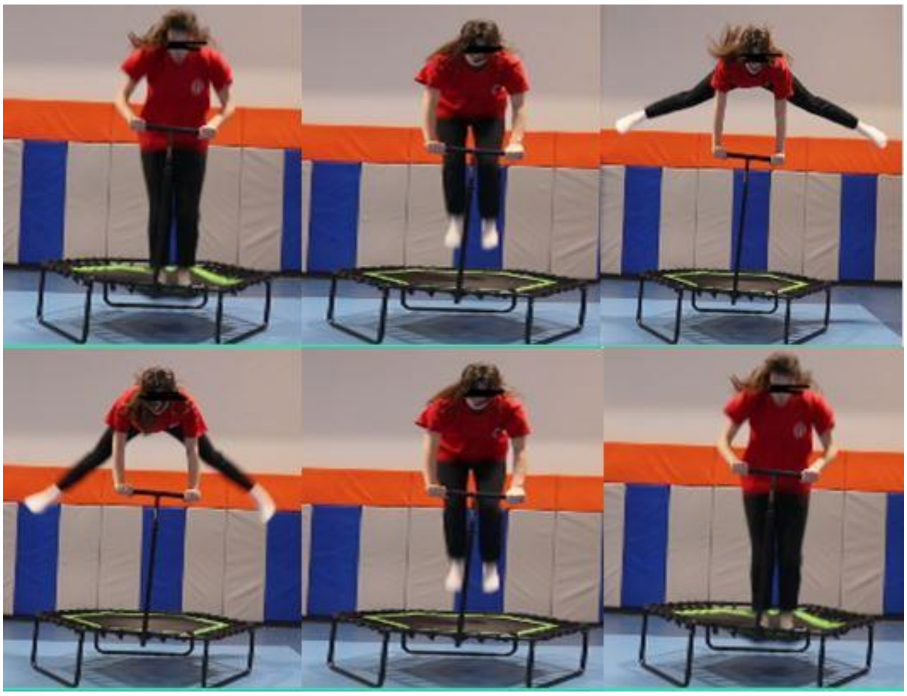

Figure 15. Jumping With Hyperabduction of Legs

Data Evaluation and Statistical Analysis

The data was organized using Microsoft Excel (2007) for Windows. Statistical analysis was conducted using the SPSS (17.0) program for Windows. In this study, a mixed-design ANOVA test was employed due to the experimental nature of the research, and within-group and between-group calculations were preferred (Tabachnick et al., 2007). Prior to statistical procedures, assumptions of ANOVA were assessed, including normal distribution, homogeneity of variances, and independence of observations. For the normal distribution assumption, skewness and kurtosis values were examined, and it was expected that the values fall within the range of -1.5 to +1.5 (Tabachnick & Fidell, 2013). The obtained data exhibited normal distribution as the normality values were within the expected range. The homogeneity assumption was verified using Levene's test to ensure that the variances across groups were not significantly different ($p > 0.05$) (Tabachnick & Fidell, 2013). The findings indicated that the distribution was homogeneous. The third assumption, independence of observations, was met as researchers ensured the independence of the data points. To calculate the effect size of the obtained findings, Cohen's d formulation was preferred (Cohen, 1992). Effect sizes were interpreted as $d = 0.20$ for a small effect, $d = 0.50$ for a medium effect, and $d = 0.80$ for a large effect. The significance level was set at $p < 0.05$ for determining statistical significance.

FINDINGS

Table 1. Comparison of pre-test and post-test BMI values (kg/cm) by groups (*p<0.05)

Variables	Group	N	Average	Std. H.	F	*p*	η²
BMI Pre test	ExperimentalGroup	12	20,55	2,243	1,335	0,261	0,06
	Control Group	11	21,491	3,18			
BMI Post test	ExperimentalGroup	12	20,567	2,422			
	Control Group	11	21,366	3,155			

When the data obtained from the control and experimental groups were examined before and after the applied training method (Table 3.5), it was observed that the change in the average body mass index (BMI) of the two groups was not statistically significant ($F_{1,21} = 1.335$, $p = 0.261$). The effect size is of moderate magnitude ($\eta^2 = 0.060$).

Table 2. Comparison of Vertical Jump Values Before and After the Training for Each Group (cm) (*p<0.05)

Variables	Group	N	Average	Std. H.	F	*p*	η²
Vertical Jump Pre test	ExperimentalGroup	12	29,954	2,439	0,999	0,329	0,045
	Control Group	11	26,56	2,861			
Vertical Jump Post test	ExperimentalGroup	12	31,896	3,316			
	Control Group	11	27,536	4,079			

When the data obtained from the pre- and post-training measurements for both the control and experimental groups were analyzed (Table 3.8), it was observed that the average vertical jump values did not show a statistically significant change between the two groups ($F_{1;21}= 0.999$; $p=0.329$). The effect size was found to be low ($\eta^2=0.045$). Upon further examination of the results from the simple effect test (Table 3.9), based on the interaction between group and measurement, it was observed that although there was no significant difference in the changes between the two groups at the end of the training period, the change in the control group was statistically insignificant ($p=0.177$), whereas the change in the experimental group was found to be significant ($p=0.008$).

Table 3. Comparison of pre-test and post-test anaerobic power values by groups (watt) (*p<0.05).

Variables	Group	N	Average	Std. H.	F	*p*	η²
Vertical Jump Pre-test	ExperimentalGroup	12	637,689	56,945	1,644	0,214	0,073
	Control Group	11	641,166	78,603			
Vertical Jump Post-test	ExperimentalGroup	12	660,308	54,957			
	Control Group	11	649,035	84,509			

According to Table 3.11, when the data obtained from the pre-test and post-test anaerobic power values of the control and experimental groups were examined, the changes in the mean anaerobic power values were not statistically significant ($F_{1;21}= 1.644$; $p=0.214$). The effect size is of moderate level ($\eta^2=0.073$). Upon further examination of the results of the simple effect test in Table 3.12, based on the group x measurement interaction table results, it was observed that there was no significant difference in the changes that occurred in both groups at the end of the training process. However, while the change between the pre-test and post-test in the control group was statistically insignificant (p=0.354), the change in the experimental group was found to be statistically significant (p=0.008).

Table 4. Comparison of Pre-test and Post-test "20 Meter" Speed Values by Groups (m/s) (*p<0.05)

Variables	Group	N	Average	Std. H.	F	*p*	η^2
Speed Pre-test	ExperimentalGroup	12	4,066	0,322	3,802	0,065	0,153
	Control Group	11	4,348	0,337			
Speed Post-test	ExperimentalGroup	12	3,643	0,337			
	Control Group	11	4,133	0,315			

According to Table 3.14, when the data obtained from the pre-test and post-test of the control and experimental groups were examined, it was observed that the average "20-meter" speed values did not show statistically significant changes (F 1;21= 3.802; p=0.065). The effect size is high (η^2=0.153). When the results of the simple effect test were examined, according to Table 3.15, there was no significant difference between the changes observed in both groups at the end of the training process. However, while the change between the pre-test and post-test of the control group was found to be statistically significant (p=0.011), the change in the experimental group was also found to be statistically significant (p<0.05).

Table 5. Comparison of "25 Meter V Cut" Direction Change Values for Pre-Test and Post-Test by Groups (s, ss) (*p<0.05)

Variables	Group	N	Average	Std. H.	F	*p*	η^2
Agility Pre-test	ExperimentalGroup	12	8,583	0,324	2,276	0,146	0,098
	Control Group	11	8,709	0,269			
Agility Post-test	ExperimentalGroup	12	8,018	0,433			
	Control Group	11	8,379	0,357			

According to Table 3.17, when the data obtained from the pre-test and post-test of the control and experimental groups were examined, it was observed that the changes in the average agility values of the two groups were not statistically significant (F 1;21= 2.276; p=0.146). The effect size is moderate (η^2=0.098). Upon analyzing the results of the simple effect test as shown in Table 3.18, it can be observed that there is no significant difference between the changes that occurred in both groups at the end of the training process. However, while the change between the pre-test and post-test of the control group was found to be statistically significant (p=0.008), the change in the experimental group was found to be statistically significant (p<0.05).

Table 6. Comparison of Pre-Test and Post-Test 1-Minute Sit-Up Values by Groups (sec/repetition) (*p<0.05)

Variables	Group	N	Average	Std. H.	F	*p*	η^2
Sit up Pre-test	ExperimentalGroup	12	36,67	7,797	2,005	0,171	0,087
	Control Group	11	37,36	8,25			
Sit up Post-test	ExperimentalGroup	12	40,5	7,052			
	Control Group	11	38,09	9,093			

According to Table 3.26, when the data obtained from the pre-test and post-test of the control and experimental groups were examined, it was observed that the mean values of 1-minute sit-up performance did not show a statistically significant change ($F_{1;21}= 2.005$; $p=0.171$). The effect size was found to be moderate ($\eta^2=0.087$). When the results of the simple effect test were examined based on Table 3.27, it was observed that there was no significant difference in the changes that occurred in both groups at the end of the training process. The change in the control group between pre-test and post-test was not statistically significant ($p=0.651$), while the change in the experimental group was found to be statistically significant ($p=0.020$).

Table 7. Comparison of Pre-test and Post-test Trunk Endurance Values by Groups (s) (*p<0.05)

Variables	Group	N	Average	Std. H.	F	*p*	η^2
Trunk Endurance Pre-test	ExperimentalGroup	12	215,330	43,781	7,103	0,014	0,253
	Control Group	11	207,550	36,55			
Trunk Endurance Post-test	ExperimentalGroup	12	255,750	51,325			
	Control Group	11	224,730	39,005			

According to Table 3.32, when the data obtained from the pre-test and post-test of the control and experimental groups were examined, a statistically significant change in the average trunk endurance values of both groups was observed ($F_{1;21}= 7.103$; $p=0.014$). The effect size is high ($\eta^2=0.253$). Further analysis using the simple effect test according to Table 3.33 revealed that there was a statistically significant difference between the pre-test and post-test values in the control group ($p=0.013$), as well as in the experimental group ($p<0.05$).

CONCLUSION and DISCUSSION

When examining the comparison of pre-test and post-test results of the control and experimental groups for the eight-week mini trampoline exercises in women, it was observed that there was no statistically significant change in the average body mass index (BMI) values of both groups. The effect size is moderate. When examining the results of the simple effect test, it was found that there was no statistically significant change in BMI values in the control group. Similarly, in the experimental group, although a change was observed, it was not statistically significant as in the control group. When reviewing the relevant literature, it is stated that in the study conducted by Aalizadeh et al., a statistically significant difference was found in body fat percentages between the experimental and control groups (Aalizadeh et al., 2016). On the other hand, in the study by Filho et al., which used mini trampolines, there was no statistically significant difference in body mass index measurements between the experimental and control groups (Malysz et al., 2019). According to the study conducted by Alonso et al. on mini trampoline exercises in young women, comparing the pre- and post-intervention body mass index values of the experimental and control groups, no significant difference was detected (Alonso et al., 2005). Other studies examined in the relevant literature suggest that high-intensity exercises are more effective in reducing body fat compared to low-intensity exercises (Coker et al., 2009; Irving et al., 2008). Our findings are in parallel with the results obtained from the relevant literature.

When comparing the pre- and post-test results of the experimental and control groups for the average vertical jump values after the eight-week mini trampoline exercises in women, no statistically significant difference was observed. The effect size was found to be low. Upon examining the simple effect results, there was no significant difference between the changes observed in both groups at the end of the training period. However, the change in the control group between the pre-test and post-test was not statistically significant, whereas the change in the experimental group was found to be statistically significant. Upon reviewing the relevant literature, it is stated that the 8-week mini-trampoline training conducted by Şahin et al. showed positive effects on vertical jump performance when comparing pre- and post-test results (Şahin et al., 2016). Similarly, Karakollukçu et al. reported improvement in vertical jump performance after 12 weeks of trampoline training in their study (Karakollukçu et al., 2015). On the other hand, Yamakata et al. conducted a study using mini trampoline and found no statistically significant difference in vertical jump pre-test and post-test values (Yamakata et al., 2022). According to the study conducted by Atiković et al., a 15-week mini-trampoline training aimed at improving vertical jump performance resulted in a statistically significant difference when comparing pre-test and post-test values (Atiković et al., 2018). Similarly, the study conducted by Ross & Hudson in 1997, which aimed to improve vertical jump through mini trampoline usage, reported a statistically significant difference when comparing pre-test and post-test values (Ross & Hudson, 1997).

The comparison of pre-test and post-test results of the experimental and control groups in the eight-week mini trampoline exercises for women revealed that there was no statistically significant difference in the mean anaerobic power values between the two groups. The effect size was found to be moderate. According to the simple effect results, when the changes in both groups were compared at the end of the training period, no significant difference was observed. However, while the change in the control group between the pre-test and post-test was statistically insignificant, the change in the experimental group was found to be statistically significant. When reviewing the relevant literature, it was reported that the 12-week trampoline training conducted by Karakollukçu et al. did not result in any changes in anaerobic power performance (Karakollukçu et al., 2015). In a study conducted by Witthaut, when comparing anaerobic power performances, no significant difference was found, but there was a significant improvement in the experimental group (Witthaut, 1969). Similarly, in a study by Delaney et al., when pre- and post-intervention values were compared, no significant difference was found, but the researchers emphasized the risk of injury (Delaney et al., 2009).

When examining the comparison of pre-test and post-test results of the eight-week mini trampoline exercises in both the experimental and control groups of women, the changes in average speed values were not statistically significant. The effect size was found to be high. According to the Simple effect results, although there was no significant difference when comparing the changes in both groups after the training process, there was a statistically significant difference in the change between the pre-test and post-test values in both the control and experimental groups. In the relevant literature, in a study conducted by Ronnestad et al., no significant difference was found in speed values between pre- and post-intervention assessments (Ronnestad et al., 2008). In a study by Haslofça et al., changes in height, body weight, and body fat percentage in certain age groups were reported to negatively affect the speed parameter (Haslofça et al., 2017). On the other hand, Karakollukçu et al. reported improvement in speed values in the group that underwent 12 weeks of trampoline training (Karakollukçu et al., 2015).

When examining the comparison of pre-test and post-test results of the eight-week mini trampoline exercises in both the experimental and control groups of women, the changes in average 25-meter V Cut agility values were not statistically significant. The effect size was found to be moderate. According to the Simple effect results, although there was no significant difference when comparing the changes in both groups after the training process, there was a statistically significant difference in the change between the pre-test and post-test values in both the control and experimental groups. In the relevant literature, Lourenço et al. reported a statistically significant difference in motor skill values between pre- and post-intervention assessments in a trampoline-based study, with the difference favoring the experimental group (Lourenço et al., 2015). Similarly, Çakto found a significant difference in agility values between pre- and post-intervention assessments in a study examining motor skills of participants (Çakto, 2019). Hahn, Shin & Lee highlighted a statistically significant difference in agility values between pre- and post-intervention assessments in a study investigating the effects of modified trampoline training (Hahn et al., 2015).

When examining the comparison of pre-test and post-test results of the eight-week mini trampoline exercises in both the experimental and control groups of women, the changes in average 1-minute burpee values were not statistically significant. The effect size was found to be moderate. According to the Simple effect results, although there was no significant difference when comparing the changes in both groups after the training process, there was a statistically significant difference in the change between the pre-test and post-test values in the experimental group, while no significant difference was found in the control group. In the relevant literature, Güler et al. reported a statistically significant difference in burpee values in favor of the experimental group when comparing pre- and post-intervention assessments (Güler et al., 2019). Similarly, Nalbant found a statistically significant difference in burpee values between pre- and post-intervention assessments in male and female participants (Nalbant, 2018).

When examining the comparison of pre-test and post-test results of the eight-week mini trampoline exercises in both the experimental and control groups of women, it was found that the changes in average body endurance values were statistically significant. The effect size was found to be high. According to the Simple effect results, there was a statistically significant difference in the change between the pre-test and post-test values in both the control and experimental groups. In the relevant literature, Güler et al. reported a statistically significant difference in endurance values in favor of the experimental group when comparing pre- and post-intervention assessments (Güler et al., 2019). Similarly, Brante et al. found a significant difference in body endurance values in favor of the experimental group when comparing pre-test and post-test values (Brante et al., 1984). Hellberg et al. also reported a significant difference in endurance values in favor of the experimental group when comparing pre-test and post-test values (Hellberg et al., 2017).

As a result of our study, significant differences in favor of the experimental group were identified compared to the control group. In terms of vertical jump (cm, mm), anaerobic power (watt), "20-meter" speed (s, ss), "25-meter" V Cut change of direction (s, ss), 1-minute sit-up (minute, count), and core endurance (s) values, the experimental group showed significant improvements, while the control group demonstrated significant improvements in core endurance (s). In terms of the group x measurement interaction, both groups exhibited significant improvements in core endurance. Considering the measurements of vertical jump (cm, mm), "20-meter" speed (s, ss), and "25-meter" V Cut change of direction (s, ss) in relation to the groups, a significant interaction in favor of the experimental group was observed. The eight-week mini trampoline exercise application in women resulted in noticeable improvements in some biomotor features.

In conclusion, based on the findings of our study, the eight-week mini trampoline exercises have positively contributed to physical fitness.

SUGGESTIONS

- Increasing the applicability of mini trampoline exercises in different age groups
- Presenting mini trampoline exercises as an alternative exercise option to coaches
- Adding it as a supportive exercise method in plyometric training
- Considering its potential benefits for athletes during post-injury rehabilitation
- Believed to contribute to the dynamic adaptation of balance ability neurologically

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