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Original Research

The effect of Total-Body Resistance Exercise (TRX) on muscle endurance of female students

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Abstract:

Background:

Resistance exercise has an important role in increasing muscle strength and endurance. Increasing muscle endurance reduces fatigue and back pain, and also maintains body balance and musculoskeletal status. Therefore, this study was conducted to evaluate the effect of TRX resistance exercise on muscular endurance of female high school students.

Methods:

This experimental study was performed on 50 patients, who had been selected by simple random method and assigned to two groups of intervention and control. Intervention group received 8 sessions of TRX resistance exercise by two instructors as the researcher's assistants (2 sessions per week for 50-60 minutes per session). Control group received the school's routine training and exercise. The upper body endurance was measured by sit-up test and lower body endurance was measured by Scott test. The collected data were entered into SPSS-21 statistical software and analyzed by descriptive and inferential statistics.

Results:

Covariance test showed a significant difference in upper body muscle strength with elimination of pre-test effect ($P<0.01$, Eta=0.39). It also showed a significant difference in lower body muscle endurance with elimination of pre-test effect ($P<0.01$, Eta=0.67).

Discussion:

The results showed that TRX resistance exercise increased the muscular endurance of upper and lower torso in female students. Therefore, it is recommended to use this simple, low-cost, but effective training method in sport centers, homes and small spaces.

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Introduction

Adolescents' physical health is considered as the main framework of a young society (1). Exercise and physical activity in adolescence play an important role in health and prevention of chronic diseases such as diabetes, heart disease, obesity, overweight, liver disorders, etc (2, 3). Regular exercise programs increase the physical and mental performance of individuals (4). Unfortunately, according to studies, more than 80% of the world's adolescents are not physically active (5). Most studies show that the rate of physical activity in adolescents is lower than the average standard defined by World Health Organization, which is 60 minutes of medium intensity physical activity per day (6, 7). However, physical activity in adolescence improves health in adulthood (8, 9). Most physical activity has a positive, immediate and long-term effect on adolescents' health (10). But today, due to factors such as changes in lifestyle, children's entertainment with television, computer games and the Internet, we see a decrease in mobility and physical activity in adolescents (11). According to studies, today's adolescents have less physical activity than their peers in the last decade (12). This inactivity in adolescents has many negative consequences on their health (13). Muscle weakness and decreased muscle endurance is one of the complications of inactivity in adolescent girls (14, 15). This causes an increase in musculoskeletal disorders, back pain and fatigue (16, 17). Weakness in the mid body muscles causes loss of balance, reduced efficiency and increased injury (18). Studies show a close relationship between muscle endurance and physical activity (19). Meanwhile, exercise plays an important role in increasing muscle endurance (20). Therefore, physical exercises increase endurance, joint mobility and balance, and reduce stress, all of which contribute to increased quality of life (21, 22).

Total body resistance exercise (TRX) is one of the effective protocols for strengthening muscle strength (23). Studies have shown that 8 weeks of regular TRX training increases endurance, reduces weakness, and prevents muscle damage (24). TRX exercises are also performed with a special rope with two handles (8). This training method is designed to use body weight (25). Muscular activity in this training method is performed on the main and lateral muscles in all directions of movement (26, 27). In other words, TRX resistance exercise is an effective exercise method, which uses only a rope that allows exercise in a limited and small space, even in the absence of sport clubs or gyms (28). Therefore, resistance exercise is used as an effective method in creating maximum muscle strength along with muscle hypertrophy (29). The muscular resistance exercise rope is portable and can be connected in different places (26, 30), which makes this training method more cost-effective and practical that can be performed in different settings (31). Therefore, due to the convenience of this exercise method, researchers decided to conduct a study to investigate the effect of TRX resistance exercise on endurance of female students in Gorgan, Iran.

Method

This classic experimental study with two intervention and control groups was performed on 50 female high school students in Gorgan in 2021. The study environment included all female high schools in Gorgan. Inclusion criteria for this study were; being 13 to 15 years old, being female students, having no history of musculoskeletal abnormalities according to self-reported at the beginning of the study, and providing written informed consent from parents. Exclusion criteria were unwillingness to continue participating in sports sessions and

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being absent for more than two exercise sessions. The sample size of this study was calculated to be 50 people based on Okhli's study (2019), using G* Power sample size software with effect size of 0.72, test power of 80%, and confidence interval of 95% (32). Significant level of 0.05 was considered for all tests. The participants in this study were divided into two intervention (n = 25) and a control group (n = 25) by simple random allocation method. The multi-stage cluster method was used for sampling. First, the researcher prepared a list of female high schools in Gorgan. Then, by simple random sampling method, 3 schools were selected as the research environment. Then, after reviewing the health records and consulting with the school's sport coaches, the researcher prepared a list of students who were eligible to enter the study. It should be noted that before conducting this research, the research project was approved by the Faculty's Research Committee, while obtaining a bioethics code, registration right, and a clinical trial code. At first, the researcher presented an introductory letter to the school's officials and obtained their permission for sampling. The study objectives and method were explained to the educators, school's principals and students' parents. Written informed consent was obtained from parents and students. All participants were assured that their personal information will be kept confidential and they can withdraw from the study at any time. The study was performed blindly. The researcher had no information about the control or intervention groups as well as how to measure endurance strength before and after the intervention. Randomization was also performed by school's sport coaches. The intervention was performed in a sport club under the supervision of a special coach with a bachelor's and master's degree in physical education.

Scott test was used to assess and measure muscle endurance of lower body (20), with following steps: The students stand with their back against the wall. Hips and knees are bend to a 90 degree angle. They are then asked to lift one foot 5 cm off the ground and hold as long as possible. The timing starts when the leg is raised and stops when the leg is lowered.

Sit-up test was used to measure upper body endurance. This test is used to check the strength of abdominal muscles. In this study, participants wear minimum sportswear. Then they lay on the ground with the legs being bent. Hands are placed next to the ears. Someone is holding the legs tightly. Then, they perform the test for 1 minute (16). In this study, two people observed and recorded the number of sit-ups for confirmation.

In total, 8 sessions (2 sessions per week) of TRX endurance exercise were held in the intervention group for 50 to 60 minutes each (Table 1). At the end of this study, to eliminate any discrimination between the two study groups, several resistance training sessions were held in the club and at home for samples in the control group that were willing to participate in resistance exercise sessions.

The collected data were entered into SPSS-21 statistical software. The result of Shapiro test did not show normality between the variables of this study. Data were analyzed by descriptive (table, mean, standard deviation) and inferential statistics (Independent t-test, Wilcoxon, Mann-Whitney and Covariance tests) at a significant level of 0.05.

Results

Independent t-test showed no significant difference between the intervention and control groups in terms of age (p=0.49), weight (p=0.36), height (p =0.48) and BMI (P=0.89).

Wilcoxon test in the control group did not show a significant difference in upper body (P=0.16) and lower body muscles strength

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(P=0.17) before and after the intervention (Table 2).

Wilcoxon test in the intervention group showed a significant difference in upper body (P=0.01) and lower body muscles strength (P<0.01) before and after the TRX exercise (Table 2).

Mann-Whitney test did not show a significant difference between the intervention and control groups in terms of upper body (P=0.47) and lower body muscles strength (P=0.44) before the intervention (Table 2), but it showed a

Table 1: The TRX muscle resistance training sessions and exercises (33)

TRX Exercise	Explanation	Involved muscles
Chest press	Position the body back on the center of the device. Grasp the TRX handles and angle the body. Bend your elbows to align your body with the surface of your chest. Then return the body to the starting point by opening the elbows triceps	Large chest, deltoid, and triceps
Suspended lounge (both legs)	Insert one of the legs into both handles so that the foot locks in the handles. Take a step from the center of the device. Now, gently bend the knee that bears the weight of the body. Remember, the foot should be in front of the knee. Then return the knee to its original position.	Quadriceps, hamstring, serine
Rowing, both hands	Turn your body towards the device. Hold the handles so that they are close together. Positioned so that the whole body is in a straight line. Lift the body up to chest level and then return to the starting position.	Trapezius, large dorsal, and deltoid
Scott	Grab both handles with both hands while facing the device. The distance between the hands should be a normal. Bend your knees so that they are behind your feet until your thighs are parallel to the ground, using your arms only as a support to maintain balance. Then return to the starting position.	Quadriceps, hamstring, serine
YTW	Hold both handles while standing in front of the device. The hands should cover the entire range of motion in three movements while doing a circular motion. This is a three-step movement that the body must return to the starting position after completing each step. The body slowly angles. Hands are raised in a Y-shape to the top of head. Then hands are brought down side ways completely open to form a T-shape. Finally, arms are lowered and placed next to thighs to form a W shape.	Deltoid, trapezius, and rhomboid muscles
Romanian deadlift (both legs)	Insert one foot into both handles. Take one step away from the center of the device. Bend over while the lower back is straight and the involved leg is slightly bent to hip level. Now bend the upper torso towards the ground. Finally return to the original position.	Hamstring and serine
Triceps	Position your back towards the device center. Hold both handles with the hands above the head and fully extended. The body should be in the same direction and the elbows should be level with the shoulders. Bend your elbows to a 90-degree angle and then return to the first stretched position.	Triceps
Hamstring	Lie down with your back on the floor. Insert the heel of each foot into the handles so that the back of the foot is in contact with them. Then pull the heels in a bridge-like position towards the hips and hold in the same position. Do inward and outward motion alternately.	Hamstring
Plank (flat)	While using your elbows on the floor as a support, lie on your back and insert your feet into the handle so that top of your feet are inside the	*Rectus, transverse,*

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	handle. Now stay in this situation as much as possible.	*and side muscles*
Side Hold Isometric with rope	Stand sideways to the center of the device. Hold both handles at the level of the chest. Angle your body. Now move the body up and down by moving the cuffs up and down.	Side and transverse muscles

Table 2: Comparison of muscle strength in the two groups before and after the intervention

Group / Time		Intervention	Control	P-value
Upper body muscles	Before intervention	38.93 ± 4.81	37.97 ± 4.51	P = 0.47
	After intervention	42.49 ± 4.19	36.08 v 4.04	P < 0.01
	P_Value	P = 0.01	P = 0.16	
Lower body muscles	Before intervention	32.76 ± 4.87	31.8 ± 3.84	P = 0.44
	After intervention	43 ± 3.67	33.36 ± 2.17	P < 0.01
	P_Value	P < 0.01	P = 0.17	

significant difference between the intervention and control groups in terms of upper body (P=0.01) and lower body muscles strength (P<0.01) after the intervention (Table 2).

Covariance test showed a significant difference in the upper body muscular strength with elimination of pretest effect (P<0.01, Eta=0.39), so that 39% of strength changes in upper body muscles could be explained by TRX resistance exercise.

Covariance test also showed a significant difference in the lower body muscular strength with elimination of pretest effect (P<0.01, Eta=0.67), so that 67% of strength changes in lower body muscles could be explained by TRX resistance exercise.

Discussion

The results of this study showed that TRX resistance exercise increased endurance in upper and lower body muscles of female students. These results are consistent with other studies.

Kiani (2021) stated that 8 weeks of TRX resistance exercise increases endurance and strengthen the muscles of mid body (24). Ilbeigi (2014) showed that 6 weeks of TRX training increases muscle endurance and reduces fatigue and low back pain (16). Abbaszadeh (2018) revealed that regular exercise increases muscle endurance and mental health, and also reduces muscle injuries (34).

Lai (2021) in a study showed that TRX exercise increases muscle strength, physical fitness, and lower body strength (35). Seo (2021) argued that endurance training prevents the destruction of body mass and increases muscle strength and function (36).

Ansari (2020) in a study showed that 6 weeks of TRX training can increase the strength and endurance of upper and lower body muscles (26).

Mahmudieh (2017) revealed that endurance exercises such as griping robber band, increase grip strength and endurance (37). Nakhzari (2018) stated that exercises that increase endurance improve aerobic activity, reduce fatigue and enhance daily performance (38). Dehghani (2021) showed that 8 weeks of continuous endurance training increased muscle strength in the participants (23).

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Hovanloo (2021) revealed that resistance exercise (TRX), by increasing muscle coordination, increases the coordination of neuromuscular systems and also enhances endurance and joint stability (39). Emami (2020) in a study showed that TRX training techniques increase muscle strength and prevent fatigue in motor activities (40).

Mohammadi (2021) argued that resistance training increases muscle flexibility and endurance (41). Barbalho (2021) also showed that resistance exercise increases muscle endurance by creating muscle tension (42).

According to the results of these studies, it can be said that increasing endurance leads to muscle strength, followed by strengthening of pelvic floor and diaphragm muscles, and consequently balances the muscle function (43). This is while reducing endurance leads to decreased stability and body balance (44). Muscular strength and endurance stabilize the spine and improve motor function (45). Thus, since resistance exercise increases the muscle endurance of upper and lower torso, this simple but effective exercise method can be used to strengthen students' muscles. One of the limitations of this study was the lack of necessary facilities and physical space in schools for the implementation of intervention. In order to minimize the limitations in this study, the intervention instead of schools, was implemented in the gyms.

Conclusion

The results of this study showed that 8 weeks of resistance training increased the endurance of upper and lower body muscles in female students. Therefore, it can be said that doing resistance exercises strengthens muscle endurance. According to similar studies, increasing muscle endurance in girls helps to maintain balance, prevent musculoskeletal abnormalities, increase health, improve quality of life, and reduce fatigue and back pain. Therefore, since TRX resistance exercise is a simple and practical method that can be performed even in small spaces or at home, we recommend this exercise method to be used in schools by educators and school health officials to encourage students stay healthy and proactive.

Acknowledgement

This study was approved by Aliabad Kotoul Islamic Azad University with the ethics code: IR.IAU.CHALUS.REC.1400.057, and clinical trial registration code: IRCTID: IRCT20211212053363N1, which were obtained from the bioethics committee of the Islamic Azad University of Aliabad Kotoul, Golestan province. The researchers consider it necessary to thank and appreciate the efforts of schools' sport coaches and all students who helped us in conducting this study.

Conflicts of Interest

No conflict of interest was observed in this study.

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