J Health Rep Technol. 2023 October; 9(4):e141916. https://doi.org/10.5812/jhrt-141916.

Published online 2023 November 16. **Research Article**

Evaluating the Impact of Total Resistance Exercise (TRX) System on Female Students and Their Static Balance

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Received 2023 October 09; **Revised** 2023 October 29; **Accepted** 2023 November 04.

Abstract

Background: Physical inactivity during adolescence can result in an unfavorable consequence of imbalance. Total resistance exercise (TRX) muscle resistance exercise increases static balance and prevents muscle injuries in female students by strengthening body muscles.

Objectives: This study aimed to evaluate the impact of total body muscular resistance training on the static balance of female student cohorts.

Methods: This experimental study was conducted on 50 female students aged 12 - 15 who resided in Gorgan, Iran. The data collection tool was the stork's static balance test. The intervention group received ten training sessions (45 - 60 minutes) over ten weeks, but the control group received the routine school exercises. The collected data were subjected to statistical analysis using SPSS-21 software, wherein descriptive and inferential statistics, including paired *t*-test, independent *t*-test, and ANCOVA, were employed at a significance level of 0.05.

Results: ANCOVA analysis, after eliminating the pre-test influence, indicated that the intervention group significantly improved the static balance of both the right (Eta = 0.57, $P < 0.01$) and left leg (Eta = 0.46, $P < 0.01$), after total body muscle resistance exercise (TRX) intervention.

Conclusions: Based on the results, engagement in muscular can augment muscle strength and preserve the body's equilibrium. Therefore, managers and health professionals should use this inexpensive, applicable, and safe exercise method to increase physical fitness and prevent musculoskeletal injuries among students.

Keywords: Total Resistance Exercises, Static Balance, Students, Body Muscles, Girl

1. Background

The level of inactivity among adolescents has increased in the past few decades due to the industrialization of societies, lifestyle changes, the rapid growth of communication technologies, the attractiveness and increase of television programs, and the excessive use of computer games (1-3). Today, there is a lack of physical activity in children and adolescents (4). A majority of adolescents between the ages of 11 and 17 years, approximately 80%, are insufficiently active physically, as per the report published by the World Health Organization (WHO) (5). Most related research has suggested that the physical activity levels among adolescents fall below the recommended benchmark set by WHO, which is about one hour of moderate-intensity physical activity per day (5). Engagement in physical activities during childhood is significant in fostering better health outcomes during adulthood (6).

Being physically inactive can reduce muscle strength, which is associated with various movement disorders and abnormalities of the skeletal muscles, particularly in adolescent females (7, 8). Adolescent females frequently experience several issues, including weakened trunk

muscles, diminished strength in the skeletal muscles, and a higher incidence of conditions such as lordosis and kyphosis (8, 9). Most spinal abnormalities result in decreased balance and compromised motor function, culminating in back pain during the adolescent and adult stages of life (10). Inactivity during adolescence can lead to imbalance as a well-known adverse effect (11). Therefore, balance is considered a necessary and safe activity in daily life (12). Balance is regarded as an essential activity for life (13). The balance in movement activities is classified into static and dynamic (14). Static balance is maintaining a stable body position while sitting or standing on a fixed platform (12). The ability of the body to maintain body movement is called dynamic balance (15). The performance of the central muscles in the body is significantly influenced by static balance (16). Enhancing and sustaining static balance can be crucial in students' walking abilities and balance preservation as they become mature adults (17, 18). Physical exercises in adolescence strengthen muscle strength and balance the body (19).

Muscle resistance exercise, specifically total resistance exercise (TRX), is a type of training method suitable for individuals of all ages (20, 21). Total resistance exercise is a floating exercise by a rope, which can be performed in a small and limited space. One of the distinguishing features of TRX is that it involves exercises that target the muscles and joints at every level of the body (22, 23).

Total resistance exercise is known to effectively enhance the vertebral column's stability, restore the joints' deep sensation, strengthen the lumbar region's muscles, and promote balance throughout the body (24, 25). Muscle resistance exercises strengthen leg tendons and maintain body balance (26). Strength training significantly affects the establishment of balance by strengthening ligaments and joint stability and stimulating proprioception (27-30), increasing muscle strength, reducing the possibility of osteoporosis, and improving balance in adolescence, adulthood, and old age (31). Therefore, the TRX exercise can be a simple, low-risk, and applicable training technique (20).

2. Objectives

Based on previous studies and the practicality of this particular exercise method, this study aimed to evaluate the impact of TRX on the static balance of female students.

3. Methods

An experimental study, adhering to classic methodology, was performed in 2022 in Gorgan, Golestan province, Iran, on 50 female students between 12 and 15 years old. This research was conducted in female secondary schools in Gorgan. The inclusion criteria were limited to female students between 12 and 15 years old with no congenital musculoskeletal or physical conditions, as determined via their health records and self-reported data. The exclusion criteria included a lack of consent by parents or students to participate and missing more than two exercise sessions during the training period. The research environment was women's sports clubs and secondary schools of Gorgan. The sample size was determined as much as 50 individuals, according to Okhli et al. (8), using the G*Power software. An effect size of 0.72, test power of 80%, and confidence interval of 95% were applied in the calculations. A significance level of 0.05 was utilized for all testing purposes.

Initially, the researcher compiled a roster of secondary schools catering to female students aged 12 - 15 in Gorgan. Subsequently, a simple randomization technique was employed, and two schools were chosen as the setting for the study. In addition, the researcher identified a group of students deemed eligible for study participation. Then, a convenience sampling method was utilized to select 50 students who fulfilled the inclusion criteria. Then, these 50 students were randomly divided into two intervention and control groups (25 people for each group).

Students and their parents were thoroughly informed about the study's objectives and methodology, and the researcher secured their informed consent while guaranteeing the data safety, anonymity, and confidentiality. The researcher further told all participants in the survey that they had the option to withdraw from the study at any given time. The control group underwent the school's customary exercise program, which the school's sports coach oversaw. Meanwhile, the intervention group completed ten resistance exercise sessions, each lasting 45 to 60 minutes, over ten weeks (two sessions per week). The exercises were conducted with the guidance of a sports coach, and their design was informed by relevant scientific literature and specialized books on sports science. The exercises from previous sessions were incorporated and revisited during each session (Table 1).

The static balance of participants was evaluated using the Stork Test, which involves the subject standing barefoot on a flat surface with their hands on their hips. The individual then positions their non-supporting leg close to the knee of their supporting leg while maintaining this fixed stance. The duration for which the subject can sustain this posture is regarded as the score for the Stork Test. Any error made during the test results in the timer

Table 1. Total Resistance Exercise, Exercises as the Correct Way to Perform Each Movement, and the Muscles Involved

TRX Exercise	Description	Involved Muscles
Chest press	Take hold of the TRX handles and position the body accordingly. Proceed to bend the elbows, ensuring they remain parallel to the chest, before returning the body to its initial position by extending the triceps while opening the elbows.	Triceps brachii, deltoid, and large chest
Suspended lounge (both legs)	Place one leg into both handles, securing the foot in place. Step away from the center of the device before softly bending the knee to support the body's weight. The foot should be positioned in front of the knee. Finally, return the knee to its initial position.	Quadriceps, hamstring, serine
Rowing, both hands	Rotate the body towards the device and grasp the handles, positioning them near one another. Ensure that the entire body is aligned in a straight line. Proceed to elevate the body until it reaches chest level before returning it to its initial position.	Trapezius, large dorsal, and deltoid
Scott	Hold both handles of the device while standing in front of it. Proceed to bend the knees, ensuring they are situated behind the feet until the thighs parallel the ground. The arms should only be used to maintain balance. Finally, return the body to its initial position.	Quadriceps, hamstring, serine
YTW with rope	Assume standing while facing the device, ensuring a secure grip on both handles. Three distinct circular movements should be performed with the hands, with the body returning to its original position after each circular movement. Gradually rotate the body and raise hands to form a Y-shape above the head before lowering them to either side to create a fully extended T-shape. Finally, bring the arms to a lower position and adjacent to the thighs, resulting in a W-shape.	Deltoid, trapezius, and rhomboid muscles
Romanian deadlift (both legs)	Place a foot into both handles and away from the device's center. The lower back should be straight, and the involved leg should be slightly bent to hip level when bending over and lowering the upper body. Finally, return the body to its initial position.	Hamstring and serine
Triceps	Orient the body with its back towards the center of the device. Grasp both handles with fully extended arms positioned above the head. The body and elbows should be aligned in the same direction, with elbows at the shoulders. Proceed to bend the elbows to form a 90-degree angle before returning to the initial position with fully extended arms.	Triceps
Hamstring	Assume a supine position on the floor. Position the heels of both feet into the handles so that the back of the foot is in contact. Proceed to pull the heels towards the hips, creating a bridge-like position, and maintain this stance. During this process, execute the movement from the inside to the outside.	Hamstring
Plank (flat)	Rest the elbows on the floor to provide support, and lie on the back. Maintain this position continuously.	Rectus abdominis, transversus abdominis, side and loin muscles
Isometric side hold with Palov press and rubber band	Stand adjacent to the device to ensure the two handles are positioned at chest level. Angle the body accordingly. Proceed to elevate and lower the elastic bands using the hands, resulting in a corresponding body movement up and down.	Side, square lumbar muscle

being stopped. Examples of errors during the test include touching the ground using the heel of the non-supporting leg, disconnecting the non-supporting leg from the knee, swinging the non-supporting leg in any direction, and lifting the hand from the hip (22, 32). Two people observed and recorded the data of intervention and control groups. Female control group students who expressed interest in TRX exercises after this study were given the same exercises as those in the intervention group. The collected data were analyzed by SPSS software version 21.

4. Results

The average age of participants in the intervention group was 13.92 ± 0.81 years, while 14.08 ± 0.81 years in the control group, with corresponding standard deviations. Based on the independent *t*-test, there was no significant difference between the two groups regarding age (P = 0.49). The average weight of students in the intervention group was 36.64 ± 6.5 kg, while 38.6 ± 6.49 kg for those in the control group, with corresponding standard deviations. Based on the independent *t*-test, the two groups were not significantly different in weight (P = 0.32). The average height of students in the intervention group was 158.8 ± 5.3 cm, while 160 ± 6.52 cm for those in the control group, with corresponding standard deviations. The independent *t*-test revealed no significant difference between the studied groups regarding their height (P = 0.49).

The paired *t*-test on the control group before and after the intervention indicated no significant difference in terms of the static balance of the left leg (P = 0.56) and the static balance of the right leg (P = 0.19). The paired *t*-test on the intervention group before and after the intervention demonstrated a significant difference in both the static balance of the left (P < 0.01) and right leg (P < 0.01).

Furthermore, the independent *t*-test indicated no significant difference between the two groups before the intervention, the static balance of the right (P = 0.13) and left leg (P = 0.26). However, a significant difference was observed in the static balance of the right (P < 0.01) and left leg (P < 0.01) between the two groups (Table 2).

The ANCOVA test demonstrated that the TRX had a significant impact on enhancing the static balance of the right leg by eliminating the influence of the pre-test, as evidenced by a large effect size (Eta = 0.57) and significant result (P < 0.01) (Table 3).

The ANCOVA test, which accounted for the pre-test effect, demonstrated that the TRX effectively improved the static balance of the left leg. This conclusion was supported by a significant result (P < 0.01) and a moderate effect size (Eta = 0.46) (Table 4).

5. Discussion

Female students experienced an improvement in their static balance in the left and right legs as a result of engaging in TRX exercises. Sarabon and Kozinc found that muscle resistance exercises increase physical fitness and maintain balance (33). Shahrbanian and Hashemi argued that resistance exercise increases static and dynamic balance by strengthening the body's central muscles and maintaining balance (34). Alizadeh et al. concluded that muscle resistance exercises strengthen the strength of the lower muscles (35). In Assar et al. asserts that TRX training can reinforce and stabilize the central muscles within the body, ultimately leading to an improvement in the lower limb functions and the maintenance of balance (36). Implementing TRX exercises can significantly enhance balance and preserve body composition, given that balance requires both muscular and skeletal strength (37, 38). Strengthening the range of motion of the joint leads to muscle strength and balance in movement (39).

Total rResistance exercise, exercises can augment the duration of static balance while concurrently reducing the duration of dynamic balance in elderly men. This cost-effective exercise regime is deemed a productive exercise (40). Incorporating resistance exercise is essential, as it can effectively enhance the muscular strength within students' upper and lower limbs. Managers and health professionals must use these training methods to prevent girls' spine problems (41). Therefore, balance in the central area of the body can be increased by performing resistance exercises and increasing muscle strength. Since the coordination of trunk and thigh muscles plays a vital role in maintaining the optimal body position (42), resistance exercise increases stamina and balance (43). Resistance exercises cause balance and prevent physical injuries (40). Maintaining balance is an essential factor in preventing injuries (42). Total resistance exercises increase the spine's stability, retrain the sense of proprioception in the lumbopelvic region, and strengthen body muscles (44). Therefore, the utilization of care and rehabilitation models is crucial in elevating individuals' quality of life and health (45-47).

5.1. Limitations

One of the limitations of this research was the limited hours of the women's sports club.

5.2. Conclusions

Exercise plays a pivotal role in promoting both mental and physical well-being. Exercise improves interpersonal relationships, stress control, cognitive ability, health, and fitness. Total resistance exercise, exercise strengthens the tendons, hip muscles, and spine. The exercise also increases the range of motion of joints, the density of bones, and the maintenance of balance. The total rResistance exercise, exercise is a straightforward, pragmatic, and feasible approach, so it does not require

Table 2. The Static Balance of Students in Both the Intervention and Control Groups Before and After the Intervention

Variables	Before Intervention		After Intervention	
	Right Leg	Left Leg	Right Leg	Left Leg
Control	13.04 ± 3.18	12.72 ± 2.15	12.36 ± 2.46	13.01 ± 1.93
Intervention	14.26 ± 1.52	13.46 ± 1.82	17.32 ± 1.82	17.01 ± 9.08
P-value	0.13	0.26	< 0.01	< 0.01

Table 3. The Effect of Total Resistance Exercise, Exercise on the Static Balance of the Right Leg

Source of Variance	Sum of Squares	Degree of Freedom	Mean of Squares	F-Value	Significance Level	Eta
Modified model	367.23	2	183.61	50.92	< 0.01	0.68
Post-test separator	117.81	1	59.71	32.67	< 0.01	0.26
Group	227.84	1	227.84	63.18	< 0.01	0.57
Error	169.49	47	3.6			
Sum	11548	50				
Total	536.72	49				

Table 4. The Impact of Total Resistance Exercise, Exercise on the Static Balance of the Left Leg

Source of Variance	Sum of Squares	Degree of Freedom	Mean of Squares	F-Value	Significance Level	Eta
Modified model	230.75	2	115.27	30.59	< 0.01	0.59
Post-test separator	102.92	1	102.92	27.29	< 0.01	0.36
Group	176.36	1	156.26	41.46	< 0.01	0.46
Error	177.24	47	3.77			
Sum	11658	50				
Total	408	49				

intricate equipment or facilities. Resistance exercises strengthen muscle strength and balance and prevent physical injuries.

Footnotes

Authors' Contribution: Study concept and design: M. SH., and N. H. P.; analysis and interpretation of data: S. J. N., and M. SH.; drafting of the manuscript: F. J., M. S.; critical revision of the manuscript for important intellectual content: T. T. H., and M. S. A.; statistical analysis: F. H.

Clinical Trial Registration Code: IRCT20211212053363N1.

Conflict of Interests: Authors confirm this study has no relevant financial or non-financial competing interests.

Ethical Approval: The Ethics Committee of the Islamic Azad University of Chalus, Chalus, Iran, approved the study protocol (ethic code: IR.IAU.CHALUS.REC.1400.057).

Funding/Support: This study was supported by the Islamic Azad University of Chalus, Chalus, Iran.

Informed Consent: Verbal and written consent from the participants to participate in the present study.

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