ORIGINAL ARTICLE

Suspension training versus free weight training: effects on explosive power, dynamic balance, and discus throwers performance

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Abstract

Background and Study Aim This paper aims to compare the effects of two types of resistance training programs (suspension training and free weight training) on the explosive power, dynamic balance, and discus throwers performance.

Material and Methods Twenty-four male discus throwers (with an average age: 19.17 ± 0.99 years; body mass: 99.87 ± 3.63 kg; height: 177.23 ± 3.16 cm) were assigned into three groups (eight subjects in each group); suspension training (STG), free weight training (FWTG) and control (CG). For eight weeks, subjects underwent training consisting of three sessions a week. Prior to and after the training period, explosive power, dynamic balance, and discus throwing distance variables were measured. The explosive power was measured using the medicine ball throw (SLJT) and standing long jump (MBTT) tests. The dynamic balance was measured using the Y excursion balance test (YBT). The discus throwing distance was measured according to the IAAF rules (DTT).

Results The results showed that both experimental groups had a significant effect on MBTT, SLJT, and DTT compared to the control group. There was a significant difference in YBT favoring STG when compared to the FWTG and CG, and also, favoring FWTG when compared to CG in the three directions (anterior, posterolateral, and posteromedial). All three groups improved the tests from pre- to post-test.

Conclusions We can conclude that suspension training and free weight training have created almost the same improvements in explosive power. Also, suspension training was more effective than free weight training for improving dynamic balance.

Keywords: TRX training, resistance training, functional training, discus throwing distance, athletics.

Introduction

One of the explosive athletics events is the discus throw. It belongs to the four throwing competitions (discus throw, shot put, javelin throw, and hammer throw), which demand the production of high muscular power[1]. The discus throwing technique is divided into four consecutive phases; preparation, momentum building, delivery, and recovery [2]. The discus throw is a tremendously technically and physically demanding sport because of these phases that must be completed quickly inside a circle with a diameter of 2.5m [3, 4]. Performing the discus throw skill requires increasing the release velocity and throwing power, which was crucial for the measurement of a tool's maximum distance after landing. The distance of the throw indicates the thrower's proficiency [2, 5, 6]. Hence, the dominant element in discus throw is explosive power. Explosive power is the result of combining strength with the concreted speed in the form of muscular ability when making the throw. This is started by holding the discus, swinging it, twisting the body 1.5 circles, and then reversing the body to throw it explosively [2, 7]. The strength increases the speed of the object from the beginning of the movement until the throwing. Also, the speed appears during the short kinematic path in which the movement is accomplished. Thus, the thrower does not perform well without developing the speed and strength together, where the speed is transferred to the object during throwing as a co-factor [8]. Stated that excellence in throwing events requires strong muscles, and fast white muscle fibers [9]. According to the literature, throwing velocity is a crucial factor in an overhand throwing power athlete's performance [10].

The discus throw movement depends not only on explosive power but also on balance. The capacity to retain one's center of gravity within the base of support required to move in a coordinated and controlled manner with minimal sway is known as balance [11]. Balance involves the synchronization of many muscles of the body and the incorporation of sensory information [12]. The body situation dynamism is justified by this difficult motor skill, which also keeps the body from falling [13]. Balance is thus quite important in the discus throw and optimizing performance [12]. Dynamic balance refers to a person's ability to retain poise or

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equilibrium when moving or transitioning from one situation to other [14]. The sensory data gathered by the somatic sensory, vestibular, and visual systems as well as the motor reactions that impact coordination, joint range of motion, and strength are variables that contribute to maintaining balance [15]. Dynamic Balance is profound in sports players as they are frequently exposed to situations where balance is dynamically challenged [16]. Many sports need dynamic balance as a basic skill as football, basketball, and throwing events. Each sport has different balance requirements and demands on the players according to their physical tasks and environmental conditions [17]. In actuality, sportsmen encounter circumstances where their equilibrium shifts with each motion, they make during throwing performance. So, dynamic balancing is very important to improve discus throwers' performance, reduce the risk of injury, and maintain rules. As a result, resistance training should be included in conditioning programs to promote Explosive power and dynamic balance.

Suspension training is a contemporary kind of resistance training performed by using two handles and straps that may be readily fastened in several environments [18, 19]. Many exercises in it make use of the body's weight as resistance by selecting a point of contact with the ground [20], which allows for the performance of exercises of various intensities based on stability and load [19]. The level of training intensity is changed by altering the "working angle" while using TRX belts, which produce a steady force that, together with body weight, gains resistance [19, 21]. The principle of stability is the fundamental idea of this sort of exercise, it asserts that the size and placement of the support base about the center of mass, determines the stability of the exercise [20]. Suspension training is used to train all components of physical fitness, either as a standalone training regimen or as a part of workout regimens [22, 23]. In recent years, TRX's beneficial effects on strength, power, speed, agility, and balance have drawn increased attention from academics and sportsmen [24].

Free weight training is a popular kind of resistance training that aims to develop strength, explosive power, and balance. It focuses on certain muscle groups and movement patterns using specialized equipment. To counteract the power produced by the muscle, it employs the force of gravity in the form of weighted bars, barbells, dumbbells, sandbags, medicine balls, and kettlebells [25, 26, 27, 28]. The objectives of the individual completing the exercise determine the precise combinations of repetitions, sets, exercises, and weights [26, 28].

Numerous studies have compared suspension training with traditional training and plats training and others. It has been shown that suspension training is just as effective as other forms of exercise, producing comparable gains in muscle strength, core muscular endurance, and balance [29], and improvements in power, muscular strength and functional performance have been observed regardless of age and gender [30, 31, 32, 33, 34]. For example, when non-athlete underweight women trained for eight weeks using two various techniques, traditional training, and suspension training, both training methods almost equally improved physical fitness factors, leading researchers to conclude that suspension training can be considered an equally effective choice alongside traditional training or as its substitute [35]. Another research found that ballet swimmers, who underwent 12 weeks of combined or hybrid resistance exercises and suspension training, improved in terms of fitness and body composition despite the disparities between the two forms of exercise [36]. Similar to conventional resistance training, suspension training has been shown to increase muscular fitness in both kids and adults [37]. One study found that, compared to unsuspension resistance training, TRX training after eight weeks seems to be more beneficial in children›s physical fitness components and may be developed as a fitness training approach for young athletes [19]. Another research found that suspension training, when compared to other training techniques, significantly improves several physiological parameters for such cardiovascular systems[38]. Also, suspension exercise has been shown to increase muscular activation compared to other traditional training [39]. Physical fitness, strength, physiologic impacts, injury rehabilitation, biomechanical analysis, and EMG activity are all areas of suspension training research that have drawn a lot of researchers' attention [22, 30, 40, 41, 42, 43, 44]. However, there is little data on how suspension training for discus throwers compares to free weight training in terms of its impact on dynamic balance and explosive power.

Purpose of the Study. The study purpose was to compare the effects of two types of resistance training programs (suspension training and free weight training) on the explosive power, dynamic balance, and performance of discus throwers.

Materials and Methods

Participants

The subjects consisted of Twenty-four male discus throwers selected from Al Ghrbia Athletics region Clubs. They were divided into two experimental groups (suspension training group (STG) and free weight training group (FWTG)) and one control group (CG). With eight participants in each group. The following inclusion criteria were met: all participants (willingness to participate and continued in the training; (ii) had skill with more than four years of training; (iii) personal best record must not be less than 27m; and (iv) none had any medical conditions or musculoskeletal injuries that could affect training or test outcomes.

The subjects' descriptions were presented in Table 1 that showd the participants' homogeneity concerning the previous aspects. All participants were fully apprised, both verbally and in writing, of the study's purpose and any possible risks and benefits before the study's start. Each participant completed a written permission form before the pre-test. The study was approved by Mansoura University (code: 202209011).

Research Design

A nonrandomized trial research was carried out on three groups: suspension training group (STG), free weight training group (FWTG), and control group (CG) using a plan with the pre- and post-test. This paper was broken up into four phases: (i) phase 1 represented a preparation study that lasted one week that was carried out to familiarize the participants with the exercises and tests. Also, this phase was used to check for the reliability of the tests and tools used in this search; (ii) phase 2 consisted of three days for pre-testing; (iii) phase 3 the participants completed eight weeks of concurrent training; and (iv) phase 4 consisted of three-days for post-testing. All participants were tested before and after eight weeks of training (pre-test and post-test). Pre-testing occurred on three different days separated by at least 48 hours. On the first day, presented measurements of the medicine ball throw test were conducted to measure the explosive power of the upper limb followed by a standing long jump test to measure the legs' explosive power. While the second day included the Y excursion balance test to measure the dynamic balance. The third day included the discus throw test to measure the throwing distance. A prescribed 10-minute warm-up period with low-intensity exercises, including running and stretching, was done before the testing began. One week before the collection of data, each participant had two trials to become used to the testing procedures. Post-tests followed the same protocol as the pre-tests. A familiarization session and a succinct explanation of the ideal technique were conducted before each exam. The tests had been done as follows.

Medicine ball throw test (MBTT): The participants sit on the floor with their legs fully extended, with the back against a wall. The sitting participants grasp the medicine ball with both hands and push the ball explosively from the chest as far straight forward as possible at forty-five degrees. The back should stay in touch with the wall the whole time the throw is being made. The distance from the front of the seating line to the spot where the ball landed was used to calculate the score. The measurement is recorded to the nearest centimeter. Three measurements of these tests are taken using a 3-kg medicine ball and were recommended based on the previous studies [45, 46]. Of the three measurements, the best result is the one that will be taken into account. Magnesium carbonate chalk powder is sparingly sprinkled over the medicine ball to help with a firm grip on the ball and absorb perspiration. The talc also leaves a mark on the ground where the ball fell, making it possible to calculate the throwing distance precisely [46].

The standing long jump test (SLJT): The athletes stand behind a starting line without touching the line, with their feet slightly apart, and explosively leap as far forward as possible. Three trials should be measured, with a 5 min break between trials. From the takeoff line until the closest point of touch on the landing, the measuring distance in cm is obtained (line of the heels), as used in previous studies [19, 23]. The standing long jump is regarded as a solid and trustworthy field-based indicator of muscle fitness and is included in the Eurofit test battery [23, 47, 48, 49].

The Y balance test (YBT): A common clinical dynamic balance assessment technique is this test. The ability to maintain balance while completing a maximum reach in three designated directions is a real and precise measure of balance success, these directions are: anterior (YBTanterior), posteromedial (YBT posteromedial,) and posterolateral (YBTposterolateral) [50, 51, 52, 53]. The participants stand in the middle and place both hands on the waist. Participants are instructed to maintain the non-dominant foot in the middle, while their dominant foot reached as far as possible to each of the three excursions. They are also instructed to reach with their opposing leg as far as they can along the excursion of their choice. They used the most distal portion of their

Table 1. Anthropometric data of subjects (mean±SD)) and p-value between groups.

Variables / Groups	STG (n=8)		FWTG (n=8)		CG (n= 8)		P	Sig
	Mean ± SD	CV	Mean ± SD	CV	Mean ± SD	CV		
Age (year)	19.2 ± 1.03	5.38	19.3 ± 0.95	4.92	19 ± 1.05	5.55	0.573	NS
Height (cm)	177.9 ± 3.18	1.79	176.7 ± 3.65	2.07	177.1 ± 2.81	1.58	0.703	NS
Body mass (kg)	100.7 ± 3.77	3.75	100.2 ± 3.29	3.29	99.87 ± 3.63	3.84	0.829	NS

n = sample size; CV = coefficient of variation; P= P-value; Results are given no significant between groups reach foot to make the furthest and lightest contact possible along a predetermined excursion. After then, the subjects were told to revert to a bilateral position while keeping their balance. When the other leg is moving, the support leg must not be raised or moved. The subject's dynamic balancing scores were determined after practicing six times in each excursion, taking a two-minutes break, and measuring the average of three trials for each excursion [53, 54].

Discus throw test (DTT): Participants were asked to perform six trials within a legal throwing circle and throw the discus at maximum power. The greatest correct throwing distance is calculated according to the IAAF rules [55].

The training program

The training program was started on 18/09/2022. Experimental groups performed training for eight weeks, 3 sessions per week. Each training session lasted about 90 min and was carried out on the same days of the week (on Sunday, Tuesday, and Thursday) at the same time of the day. The Participants started each session with a warm-up consisting of 10 to 15 min of easy running, dynamic flexibility, and muscular stretching drills. Then, suspension exercises or free weight exercises were carried out in four 10 to 15 - repetition sets in circuit design lasting from 25 to 30 min. Each exercise was carried out in 10 -repetitions during weeks 1 to 4 and 15 -repetitions during weeks 5 to 8. The rest interval was two to three min between sets. After that, participants trained in discus throwing skills and technique for 30 to 35 minutes, and the last 5 to 10 min of the session was devoted to cool-down. During the same period, the control group continued their normal training routine.

Suspension training protocol

The TRX equipment was used to carry out the suspension training program. TRX device is connected with a rod of 2.44 meters above the ground. This made it possible for the participants to perform exercises just below the connecting point. In general, progress in training levels for the suspension group was as distance placed closer to the connection point, alter of two feet to one foot, and an increase in body angle to maintain intensity within the specified range. The 10-rating Borg scale, as utilized in earlier research, was employed to consider a one-unit increment to exert overload every two weeks [35]. According to the Borg scale and depending on increasing load, exercise intensities were in the range of 4-5 for the first and second weeks, 5-6 for the third and fourth weeks, 6-7 for the fifth and sixth weeks, and 7-8 for the seventh and eighth weeks. Suspension exercises included: TRX Chest Press (a), TRX biceps curl (b), TRX triceps extension (c), TRX row (d), TRX T deltoid fly (e), TRX squat (f), TRX lunge (g) (right and left), TRX hamstring curl (h), TRX single leg RDL (j) (right and left) and TRX single leg squat (k) (right and left) (See Fig. 1- a to k).

Free weight training protocol

The Free weight training program was performed using dumbbells, barbells, and kettlebells. According to the Borg scale based on increasing load, the intensity of the free weight training program was as follows: 60-65% of 1RM for the first and second weeks, 65-70% of 1RM for the third and fourth weeks roughly 70-75% of 1RM for the fifth and sixth weeks, and 75-80% of 1RM for seventh and eighth weeks, as used in previous studies [35]. The movement of the free weight exercises, number of sets, times, and intensity were similar to suspension training. Free weight exercises included: Dumbbell flat bench press (l), standing dumbbell biceps curl (m), two dumbbell triceps extensions(n), bent-over two dumbbell row (o), dumbbell rear deltoid fly (p), squat with a barbell (q), lunge with a barbell (r) (right and left), dumbbell leg curl (hamstring) (s), dumbbell single leg RDL (t) (right and left) and kettlebell single leg squat (u) (right and left) (See Fig. 1- l to u).

Statistical Analysis

IBM SPSS Statistics version 26.0 software as a computer-aided software system was utilized, which had a significant role in interpreting the results and their derivatives to handle and analyze the outputs accurately and with high efficiency in this paper. To verify the assumptions of normality and equal variance, the Shapiro-Wilk and Levene tests were run on each variable, respectively. The pre-post change was examined using one-way analysis of variance (ANOVA) with Tukey post hoc testing to spot any group differences. By using paired sample t-tests, it was possible to determine significant differences in each group between pre- and post-tests. Effect sizes were estimated as partial eta-squared values ($\eta 2$) and classified as "small" if they were < 0.2, "medium" if they were between 0.2 and 0.5, and "large" if they were > 0.8 (56). Change ratio (Δ%) was used to verify differences between groups. For all findings provided, the significance level $p \leqslant 0.05$ was utilized.

Results

Baseline data

One-way ANOVA revealed no significant baseline differences in any of the variables between the groups at pre-test [F= .335 to 1.343, p= .278 to .718 (P>0.05)]. All participants completed an eight-week training period with a mean training attendance of 100%.

The effects of training intervention

The effect on explosive power

A significant difference in change between the groups was observed for MBTT (F= 20.559, P= .000, η2= .604) and SLJT (F= 16.089, P= .000, η2= .544). Post hoc comparisons demonstrated that there were significant differences in favor of both suspension training and free weight training groups compared to the control group in both tests. While there were no significant differences between the suspension training and the free weight training groups for MBTT and SLJT. Both training groups significantly increased MBTT from Pre (STG 5.87±.27 m; FWTG 5.83±.3 m) to Post (STG 6.87±.389 m, 16.95%; FWTG 6.65±.325 m, 14.06%; P=.000 <.05 for both (see Fig.2). Also, the training groups significantly increased SLJT from Pre (STG 2.18±.058 m; FWTG 2.17±.052 m) to Post (STG 2.45±.085 m, 12.08%; FWTG 2.42±.081 m, 11.12%; P=.000 <.05 for both (see Fig. 3). No significant differences were found in MBTT and SLJT from Pre (5.73±.174 m and 2.16±.051 m, respectively) to Post in CG (5.91±.326 m, 3.15%, and 2.25±.09 m, 3.87%, respectively) ; P>.05 for both (See Fig. 2 and 3).

The effect on dynamic balance

There were a significant difference between the groups was observed for YBTanterior (F= 54.379, P=

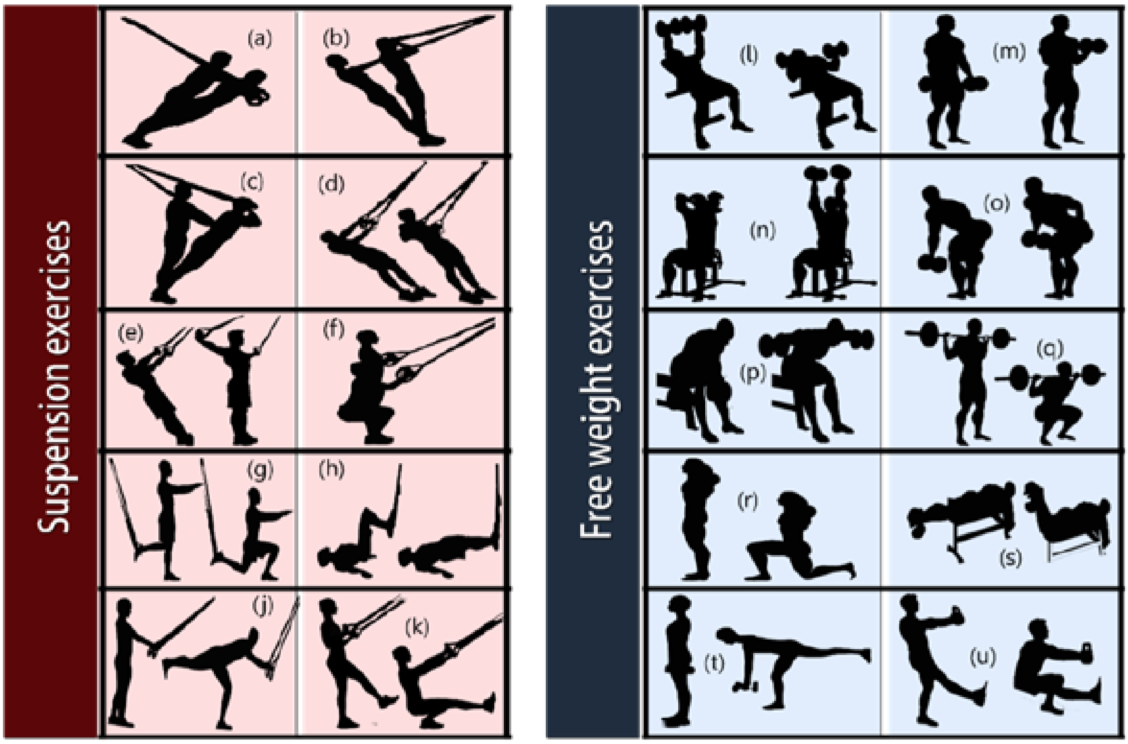

Figure 1. Exercises in different training programs (suspension training VS free weight training)

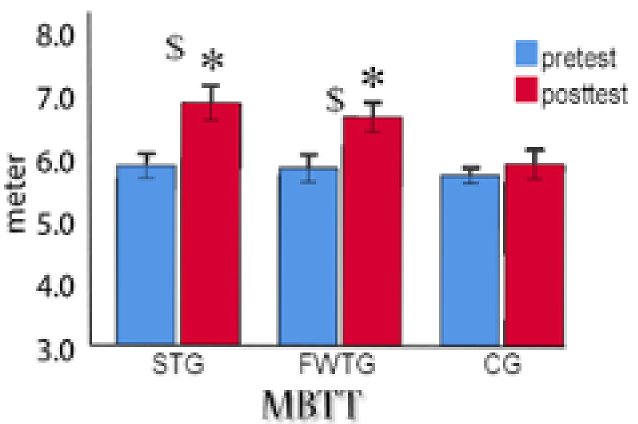

Figure 2. The effects of training intervention on MBTT. *significant difference from pre-test, $ significant difference from the CG.

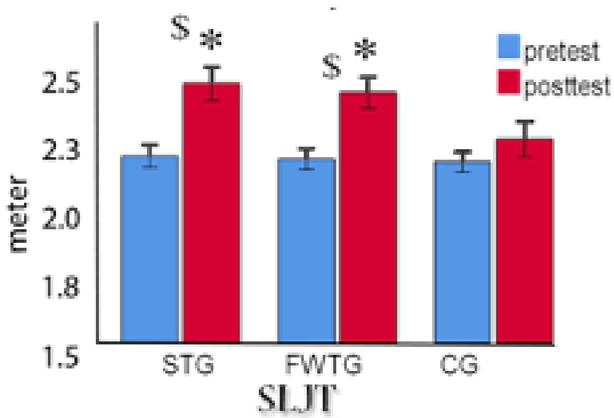

Figure 3. The effects of training intervention on SLJT. *significant difference from pre-test, $ significant difference from the CG.

.000, η2= .801), (F= 87.741, P= .000, η2=.867) and YBTposteromedial (F= 57.585, P= .000, η2= .81). The post hoc analysis showed that there were significant differences in favor of both suspension training and free weight training groups compared to the control group. Also, we found significant differences between the suspension training and the free weight training groups in the three directions in favor of the suspension training. The training groups significant increased YBT in the three directions (anterior, posterolateral and posteromedial) from Pre (STG 98.69±1.91, 109.94±2.38 and 92.09±2.64 cm; FWTG 98.08±2.97, 109.7±2.7 and 91.51±2.03 cm, respectively) to Post (STG 112.99±3.41, 126.5±2.1 and 106.66±2.97 cm with 14.49%, 15.09% and 15.86%; FWTG 108.68±2.28, 120.77±1.62 and 102±2 cm with 10.85%, 10.13% and 11.47%, respectively); P=.000 <.05. No significant differences in the three directions (anterior, posterolateral and posteromedial) from Pre (97.79 ±2.54, 108.61±2.66 and 90.7 ±2.49 cm, respectively) to Post in CG (100.1 ±2.63, 111.76 ±3.44 and 93.43 ±3.26 cm with 2.41%, 2.97% and 3.07%, respectively) ; P>.05 (See Fig. 4- A,B,C).

The effect on discus throw performance

There was a significant difference between the groups was observed for DTT (F= 19.443, P= .000, η2= .59). The post hoc test revealed significant differences in favor of both suspension training and free weight training groups compared to the control group. While there were no significant differences between the suspension training and the free weight training groups. The training groups significant increased DTT from Pre (STG 31.3±1.67 m; FWTG 30.74±2.02 m) to Post (STG 36.74±1.43 m, 17.54%; FWTG 35.42±1.95 m, 15.36%; P=.000 <.05 for both. No significant differences from Pre (30.01±1.55 m) to Post in CG (31.37 ±2.5 m, 4.51%); P>.05 (See Fig.5).

Discussion

Our main findings suggest that after eight weeks, both experimental groups showed better performance than the control group on explosive power, dynamic balance, and discus throw performance. Also, suspension training improves explosive power similarly to free weight training, while suspension training improves dynamic balance better than free weight training. Regarding explosive power, similar increases were found between suspension training and free weight training in MBTT and SLJT. Throughout the literature review

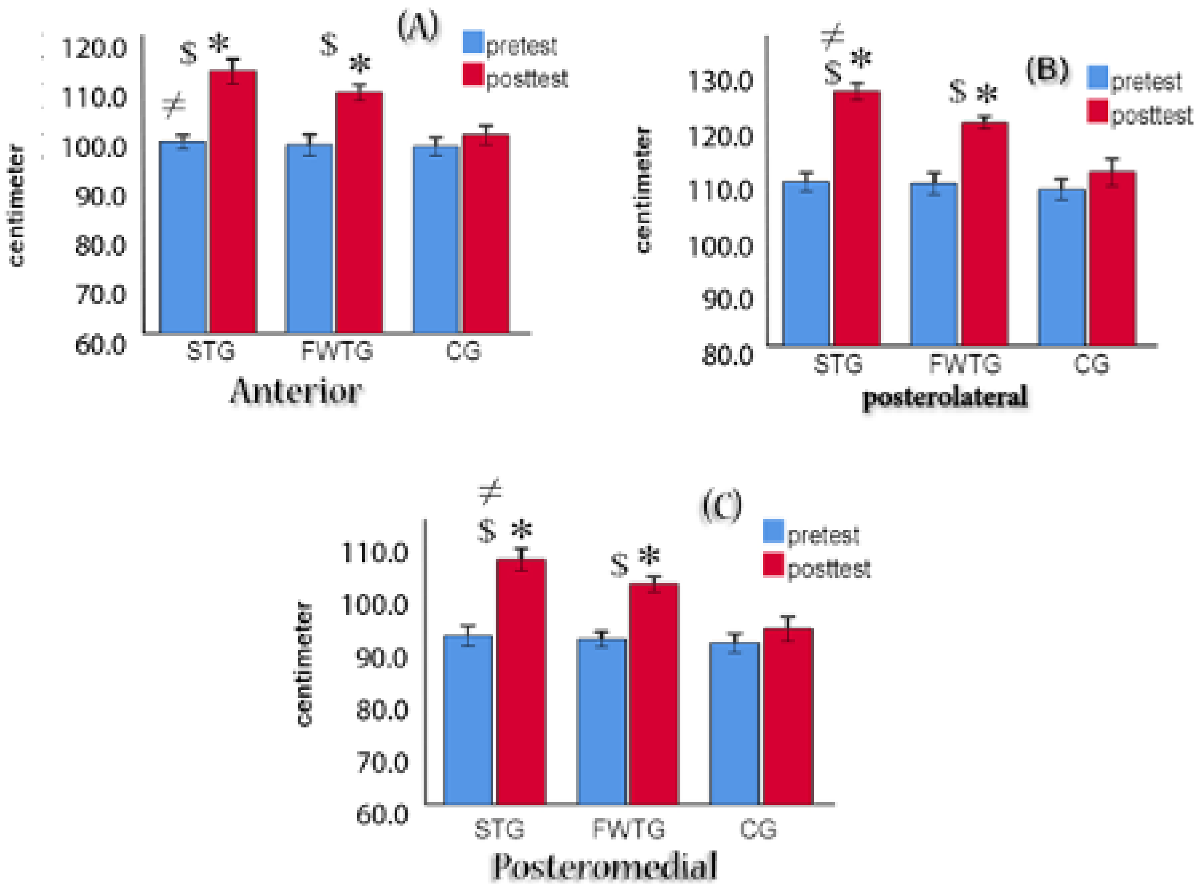

Figure 4. The effects of training intervention on YBT in the three directions; anterior (A), posteromedial (B), and posterolateral (C). *significant difference from pre-test, $ significant difference from the CG. ≠ significant difference from the FWTG. P value set at 0.05.

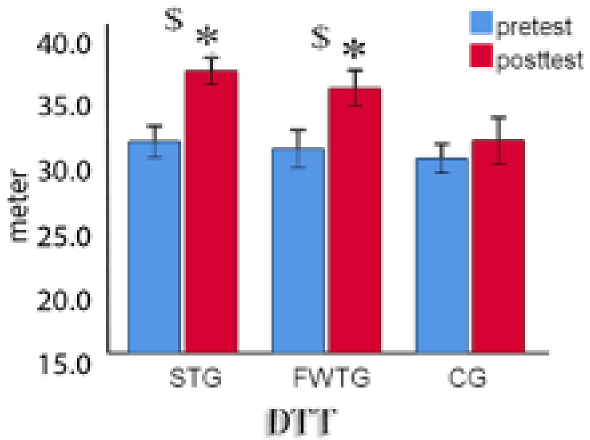

Figure 5. The effects of training intervention on DTT. *significant difference from pre-test, $ significant difference from the CG.

concerning the effects of resistance exercises. We encountered a study that was conducted by Maté-Muñoz et al., which reported increased power in upper and lower limbs after 7 weeks (three times weekly) in both resistance training groups, with no significant differences detected in the posttest variables recorded for the two experimental groups [34]. Yu et al. observed increased Physical fitness after 12 weeks of combined resistance training and suspension training. However, there were no differences based on training type. Therefore, both resistance training and combined resistance training with TRX improved physical fitness in athletic fin swimmers [36]. These results are parallel with the data we obtained after 8 weeks which could justify elevated explosive power in both experimental groups. Similar explosive power responses brought on by both types of training demonstrate that suspension training's body posture had an analogous impact on the production of external load during free weight exercise. The neurological adaptations support the advancement discovered in this paper [56]. Our findings are consistent with the theory of neural adaptation, which states that high muscular strength develops quickly during the first six to eight weeks of training. We could interpret the results of our study as suggesting that suspension training produces similar adaptations in explosive power to those of free weight training. Thus, exercises executed using suspension exercises could improve power in discus throwers in the same measure as free weight exercises.

Dynamic balance has significant improvement in both experimental groups, due to the impacts of eight weeks of suspension training and free weight training, demonstrating the benefits of both training regimens on the development of dynamic balance. In this context, Janot et al, reported increased Balance and Lower Body Strength following training for both the TRX and traditional groups after seven weeks of training [37]. However, suspension training caused higher improvement in dynamic balance in this paper. When the studies concerning dynamic balance in literature were reviewed, we encountered only the ones designed for suspension training and their effect on dynamic balance. Where Onur Demirarar et al., observed significant improvement in the dynamic balance of basketball players after 8 weeks of using suspension training [57]. The increase in dynamic balance in this paper is most likely a result of neural adaptations formed during the eight weeks of training. Since the nervous system is heavily involved in suspension training regarding the suspension condition. In this study, we found a statistical difference was observed when compared to FWTG. Suspension training, in our opinion, makes more motor units operate and maintain stability, while also more effectively activating the synergist muscle groups, so there is a good impact on balance parameters [57]. The issue with suspension training's effect that is raised in this study is one of many intricate issues that may be thought of as a reflection of an alternate free-weight training approach.

As to the discus throwing distance, we found similar increases were found between suspension training and free weight training in DTT with a very small relative increase for the suspension training. Where Δ% DTT (STG17.54%; FWTG15.36%; CG 4.51%). We believe this improvement was a result of improved explosive power and dynamic balance.

Conclusions

The purpose of this paper was to compare the effects of suspension training and free-weight training programs on the explosive power, dynamic balance, and performance of discus throwers. Our study indicated that suspension training and free weight training have created almost the same enhancement in explosive power. Also, suspension training was more efficient than free weight training for optimizing the dynamic balance. Suspension training include simple exercises, can be done in a small area, and are more cost-effective to employ at the practitioner's residence. Furthermore, a wide range of exercises may be completed with suspension training since it can be modified to the needs of the practitioners. It is concluded that suspension training seems to be associated with larger improvements in many aspects compared to free weight training. So, we recommended using suspension training alongside free weight training or as an alternative in the training for explosive power or dynamic balance or increasing the discus throwing distance. It is preferred to focus more on suspension training when developing dynamic balance.

Acknowledgement

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Conflict of interest

There was no declared conflict of interest by the authors.

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