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RESEARCH ARTICLE

The Effect of Velocity-Based Training on Some Performance Parameters in Football Players

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Abstract
The aim of the study was to investigate the effects of velocity-based (VBT) and traditional strength training (TST) methods on vertical jump, dynamic balance, agility, 10 m acceleration and 20 m sprint performances. Twelve volunteer men randomly divided into two groups participated in the study. After 1 Repetition Maximum (1RM) was determined, the TST group performed 3 sets of 10 repetitions with 40-60% of their maximum weight, while the VBT group performed 3 sets of strength training at a velocity range of 0.75-1.0 m/s for 6 weeks, 2 days a week. In the VBT group, a significant difference was found between 55.16±6.17 cm in the pre-test and 59.16±4.99 cm in the post-test of vertical jump and 4.05±0.27 in the pre-test and 1.72±0.27 in the post-test of balance ($p<0.05$). There was a significant difference between 48.33±3.98 cm in the pre-test and 53.66±4.03 cm in the post-test; between 4.29±0.29 in the pre-test and 3.65±0.48 in the post-test. Optimising the speed while lifting load in VBT enables athletes to react faster to sudden position changes by improving dynamic balance. Although 6 weeks of VBT training increased vertical jump, the difference was not statistically significant, which may be due to sample size, training duration or individual differences. As a result, the increase in vertical jump and balance in both strength training exercises can be explained by the fact that squat exercise activates the quadriceps muscles by activating the knee joint and increases leg strength, endurance and knee stabilisation.

Keywords
Velocity-Based Training, Traditional Strength Training, Football

INTRODUCTION

In an elite football match, players run an average of 10-12 km at moderate intensity (Rampinini et al., 2007). In the aerobic environment in which the game takes place, the most important events are represented by high-intensity training, since most goals are preceded by linear sprints, vertical jumps, or changes of direction by the player who scores or assists (Faude et al., 2012). These movements require lower body muscles to produce high power and strength (Meylan et al., 2009). In this context, it has been reported that jump height, 10 m sprint and 30 m sprint performance are related to maximum muscle strength in professional football players (Wisloff et al., 2004). The positive effects of resistance training on strength, jumping and sprinting abilities in adult football players have been extensively studied (Helgerud et al., 2011; Hoff et al., 2004). Resistance training is necessary to improve athletic performance, including velocity, agility, strength, and even athletic skills (Andersen et al., 2010; Comfort et al., 2012; Ronnestad et al., 2008; Suchomel et al., 2016; Spiteri et al., 2013). Traditional resistance training prescriptions are usually designed based on an individual's 1RM (one repetition maximum) before starting a resistance training session (Zhang et al., 2021; Zhang et al., 2022). However, an athlete's

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training status or performance is constantly changing depending on numerous variables such as daily biological changes, training fatigue, nutrient intake, and sleep. These factors can cause 1RM to fluctuate by up to 36% (Orser et al., 2024). As traditional resistance training programmes rarely account for daily fluctuations (Weakley et al., 2021), pre-designed training loads can be inappropriate, which can reduce the effectiveness of training and even lead to degeneration or injury. Therefore, some regular and flexible resistance training methods called autoregulation methods have been developed to overcome the shortcomings of traditional resistance training.

Velocity-based resistance training (VBT) is a modern resistance training method that uses movement velocity to determine the load and intensity of exercise, allowing for a more personalised and dynamic training programme (Weakley et al., 2019). This method, called velocity-based training (VBT), allows 1RM% to be estimated based on actual velocity for each repetition without the need to perform the most demanding tests to adjust the training load. This method estimates daily readiness (or daily 1RM) and tracks the decrease in velocity per set to manage fatigue accumulation (González & Sanchez, 2010). Repetition rate has been extensively studied as a means of monitoring exercise intensity (Gonzalez et al., 2011). Studies show that resistance training performed at a certain velocity increases muscle strength, so controlling the velocity of movement during training is important (Dalleau et al., 2010). Furthermore, the use of velocity-based training programmes that monitor and prescribe exercises based on velocity outputs has been shown to be effective in increasing strength and power in elite athletes (Włodarczyk et al., 2021). Monitoring barbell velocity during resistance training by methods such as velocity-based training (VBT) can provide valuable feedback on the effectiveness of the training programme and help optimise performance (Achermann et al., 2023).

Due to these advantages, VBT can be applied to athletes who often participate in various training regimes and frequent competitions, especially athletes playing rugby, football, basketball, and baseball (Toby et al., 2015; Hrysomallis et al., 2012; Argus et al., 2009). As controlled studies involving athletes often struggle to find sufficient numbers of participants, more experimental studies are needed to address the controversies and support the efficacy of VBT in athletes.

The unique value of this study is that it investigated the effects of two different strength training methods (traditional strength training and Velocity Based Training) on various athletic performance measures for the lower extremities. The prominent unique aspects of the study are as follows: The research evaluates the effects of both training methods in a holistic manner, examining different components of athletic performance such as maximal strength as well as jumping, sprinting, agility and balance. While traditional strength training gradually increases the load, VBT is speed-oriented and aims to optimise the speed of load lifting. By systematically examining the differences between both methods, this study helps us to understand which performance measure is more effective. The research findings provide practical information for athletes, coaches and sports scientists to determine which training method is more effective in which situations. The study provides important data for developing effective strategies for leg strength and mobility by targeting lower limb muscles.

MATERIALS AND METHODS

Study Model

Experimental method was used in the study. The aim of the study was to investigate the effects of traditional (1RM) strength training and velocity-based strength training on vertical jump, dynamic balance, agility, 10 m acceleration and 20 m sprint performances.

Study Group

In the study, the participants were randomly divided into two groups: Traditional strength training group (n=6) and the velocity-based strength training group (n=6). A total of 12 male volunteers with at least 1 year of football playing history were included After descriptive measurements were taken, 1 Repetition Maximum (1RM) values were measured and then participants were randomly assigned to perform knee dominant trap bar deadlift, squat and hip dominant hip thrust exercises. Descriptive characteristics of the participants are provided in Table 1.

Ethical Implications

This study followed ethical standards and received approval from the Sinop University Human Research Ethics Committee, dated

28/04/2023 and numbered 2023/92. In addition, this study was supported by Sinop University Scientific Research Coordination Unit. Project Number: SBF-1901-23-002, 2023. Participant provided informed consent, with the volunteer form covering research details, risks, benefits, confidentiality, and participant rights. The research strictly adhered to the ethical principles of the Declaration of Helsinki, prioritizing participant's rights and well-being in design, procedures, and confidentiality measures.

Study Design

Before the study, 2 familiarisation exercises were performed. Before these training sessions, the participants were informed about the content of the study, the movements to be performed, the number of repetitions, and the use of trap bars and Olympic bars. Movement techniques were explained and strength training was performed 2 days a week for 6 weeks with the correct technique. After familiarisation, 1 maximal repetition in deadlift, hip thrust and squat were taken 5 days before the study. In the warm-up section before the maximal test, 5 minutes of low-intensity flat running was performed, followed by flexibility exercises and 2 sets of 10 repetitions of warm-up lifts at 40% intensity. Performance test data were collected 3 days before the start of the study. On the day of the performance tests, height and body weight measurements were made before starting the test. For performance tests, 5 minutes general warm-up and 10 minutes special warm-up protocol was applied. After warm-up, dynamic balance, vertical jump, 10 and 20 metres acceleration-sprint run and agility test were performed. At the end of the study, the same protocol applied at the beginning was applied again for the post-tests.

Velocity-Based Strength Training

In velocity-based strength training, movements were performed at a velocity range of 0.75-1.0 m/sec. If the weight lifted was not within this velocity range, the set was terminated.

Figure 1. Enode Pro Velocity-Based Training

Traditional Strength Training

In traditional strength training, participants performed 3 sets of 10 repetitions with weights equivalent to 40-60% of their maximum weight.

Data Collection Tools

Anthropometric Measurements

The height of the football players participating in the study was measured with Seca 213 device and body weight was measured with Inbody 120 Bioimpedance analyser. Body weights were recorded in kilograms and body mass (BMI) were calculated using the formula BMI (kg/m²) = Body Weight (kg) / Height² (m²) (Celgin & Arslanoğlu, 2024).

Vertical Jump

In the study, the vertical jump performances of the athletes were measured using a digital vertical jump device (Takei 5406 Jump-MD Vertical Jumpmeter, Tokyo, Japan). In the vertical jump test, the value of the athlete's jump upwards from the standing position in the squatting position with knees flexed at 90° and hands on the waist was recorded. A 1-minute rest period was given between trials. Each measurement was repeated twice and the best value was recorded (Mor et al., 2022).

Balance Test

Togu Challenge Disc 2.0 (Germany) was used to measure the balance of the footballers. This device has a mechanism that connects an upper platform with a diameter of 44 cm and a lower platform of the same size with 4 rubber rollers of 8 cm in the centre. The platform has a maximum movement of 12° in each direction and has an unstable floor. It detects the balance movements of the person standing on it with three-dimensional sensors and transfers them to the application via Bluetooth. The device has a scoring system from 1-5 (1: very good, 5: very poor), with a lower score indicating better balance. During the test, the athlete stood barefoot on the platform and tried to maintain balance for 20 seconds. The test was repeated twice and the best score was recorded (Mor et al., 2022).

10m Acceleration and 20m Sprint Test

The 10-metre and 20-metre sprint test values of the football players were determined using a photocell on a FIFA approved football field. After the warm-up protocols were applied to prevent any injury during the measurements, they were asked to repeat the 20-metre test track once individually with light jogging. The test start location was determined to be one metre behind the photocell. When the participants felt ready, they started the test with high output. The measurements were made by means of photocells placed at a running distance of 10 and 20 m. The measurement was taken twice, and the best degree in seconds and split seconds for each subject was evaluated. Complete rest (3 minutes) was given between measurements (Celgin & Arslanoğlu, 2024).

T-Agility Test

After a full rest for the T-agility test, they were allowed to practice the test track at low velocity in order to get used to the track. Four funnels were placed at point B, 9.14 m from the start funnel A and the other two funnels were placed in a T-shape, funnels C and D, 4.57 m to either side of funnel B (Figure 4). As shown in Figure 4, the athletes start running directly from cone 'A' towards cone 'B' which is 9,14 m ahead and touch the cone. They then run sideways to the left side of the 4.57 m cone and touch the cone with their left hand, then run to the rightmost cone and touch it with their right hand. From here they run sideways to cone 'B,' touch it with their left hand, then run back to cone 'A' and complete the test. Trials were cancelled if the footballers did not touch the designated funnels, did not perform the side-slip steps correctly and did not constantly look forward. The duration of the test was recorded by means of a photo-eye system placed in the starting cone. The measurement was performed twice and the best value in seconds and milliseconds for each subject was evaluated. Complete rest (3 minutes) was given between measurements (Celgin & Arslanoğlu, 2024).

1RM Tests

1RM was measured separately in the deadlift with trap bar and hip thrust and squat with Olympic bar. The participants were made to warm up by doing 5-10 repetitions between 40-60% of the estimated 1RM value. The participants were asked to perform 3-5 repetitions with a weight of 80% of the estimated 1RM. Rest was given for 5 minutes until 1RM was found and continued with a 5% increase until 1RM was found. 1RM was found with a maximum of 3 attempts. The weight that can be done with 1 repetition and the 2nd repetition cannot be done is recorded as 1RM.

Velocity-Based Strength Training Method

'Enode Pro' velocity-based training device was used to determine the velocity of the weight lifted in velocity-based strength training. Movements were performed with deadlift, trap bar (hex bar) and hip thrust and squat movements were performed with Olympic bar. In velocity-based strength training, movements were performed at a velocity range of 0.75-1 m/sec. If the weight lifted was not within this velocity range, the set was terminated.

Perceived Difficulty Level (PDL)

The Borg (RPE) scale is a frequently used method for determining subjective training load (intensity) based on participants' feelings (Borg, 1988). A 20-point Borg scale was used to determine the perceived difficulty after each training session.

Data Analysis

In the study, SPSS 26.0 package programme was used for all statistical analyses. Descriptive statistics such as mean and standard deviation were used to evaluate the data. Shapiro-Wilk test was used to determine whether the data showed normal distribution and it was determined that the data showed normal distribution. In this context, the paired sample t test was used for intra-group pre-test-post-test comparisons and the independent samples t test was used for inter-group pre-test-post-test comparisons. Significance level was accepted as $p<0.05$ in statistical analyses.

RESULTS

Table 1. Descriptive characteristics of the participants

Variables	VBT Group n=6 mean±sd	TST Group n=6 mean±sd
Age (year)	21.66±2.16	20.83±0.40
Height (cm)	170.50±6.41	174.00±-3.16
Body Weight (kg)	69.61±7.76	78.00±7.61
Sport Age (years)	9.66±1.03	10.16±1.72
BMI	23.88±1.65	25.75±2.27
RPE	4.93±0.66	5.41±0.42

N= Number of Participants; X= Mean; SD= Standard Deviation; RPE= Perceived Difficulty Level; VBT= Velocity-Based Training; TST= Traditional Strength Training

When Table 1 is examined, the mean perceived difficulty level value of the velocity-based training (VBT) group was (4.93±0.66), the mean height was (170.50±6.41) cm, the mean body weight was (69.61±7.76) kg, the mean BMI value was (23.88±1.65) kg/m², the mean age was (21.66±2.16), and the mean sport age was (9.66±1.03) years. The mean perceived difficulty level value of the traditional strength training (TST) group was (5.41±0.42) p, the mean height was (174.00±3.16) cm, the mean body weight was (78.00±7.61) kg, the mean BMI value was (25.75±2.27) kg/m², the mean age was

(20.83±0.40) and the mean sport age was (10.16±1.72) years

Table 2. Performance parameters of the participants

Groups				
VBT Group				
Performance Tests	**Pre-Test** (n=6) **mean±sd**	**Post-Test** (n=6) **mean±sd**	**t**	**p**
Vertical Jump (cm)	55.16±6.17	59.16±4.99	-2.449	0.058
20 m sprint (m)	3.05±0.07	3.15±0.11	-2.517	0.053
10 m Acceleration (m)	1.78±0.04	1.86±0.06	-2.519	0.053
Agility (sec)	9.67±0.33	9.55±0.38	0.604	0.572
Balance (p)	4.05±0.27	1.72±0.27	12.57	0.001*
TST Group				
Performance Tests	**Pre-Test** (n=6) **mean±sd**	**Post-Test** (n=6) **mean±sd**	**t**	**p**
Vertical Jump (cm)	48.33±3.98	53.66±4.03	-5.219	0.003*
20 m sprint (m)	3.14±0.09	3.23±0.04	-2.264	0.073
10 m Acceleration (m)	1.83±0.07	1.88±0.04	-1.153	0.301
Agility (sec)	10.12±0.38	9.92±0.36	0.908	0.405
Balance (p)	4.29±0.29	3.65±0.48	3.580	0.016*

N= Number of Participants; X= Mean; SS= Standard Deviation; VBT= Velocity-Based Training; TST= Traditional Strength Training

According to Table 2, the first vertical jump measurement of the velocity-based training (VBT) group was 55.16±6.17 cm and the last measurement was 59.16±4.99 cm. A significant difference was found between the first measurement of balance 4.05±0.27 p and the last measurement 1.72±0.27. The first vertical jump measurement of the traditional strength training (TST) group was 48.33±3.98 cm and the last measurement was 53.66±4.03 cm. A significant difference was found between the first measurement of balance 4.29±0.29 p and the last measurement of 3.65±0.48 p.

Table 3. 1 repetition maximal values of the participants

Groups				
VBT Group				
Movements	**Pre-Test** (n=6) **mean±sd**	**Post-Test** (n=6) **mean±sd**	**t**	**p**
Squat	85.00±10.48	116.66±10.32	-10,304	0.001*
Deadlift	90.83±10.20	126.66±12.11	-8.600	0.001*
Hip Thurst	115.00±23.45	158.33±22.86	-7.769	0.001*
TST Group				
Movements	**Pre-Test** (n=6) **mean±sd**	**Post-Test** (n=6) **mean±sd**	**t**	**p**
Squat	78.33±7.52	96.66±16.32	-3.841	0.012*
Deadlift	78.33±11.69	90.00±18.97	-2.150	0.084
Hip Thurst	100.00±8.94	126.66±10.32	-8.000	0.001*

N= Number of Participants; X= Mean; SS= Standard Deviation; VBT= Velocity-Based Training; TST= Traditional Strength Training

According to Table 3 , a significant difference was found between hip thrust values in both groups. There was no difference in squat and deadlift movements in both groups.

DISCUSSION

Velocity-based training (VBT) is a contemporary resistance training method that allows precise prescription of training intensities and volumes (Weakley et al., 2019). Velocity-based training is a method that allows the percentage of one repetition maximum (1RM%) to be estimated from the actual velocity of each repetition, without the need for demanding maximal tests to adjust training loads (Guerriero et al., 2018). The main aim of this study was to investigate the effect of velocity-based strength training on the development of vertical jump, 20 metres sprint, 10 metres acceleration, agility, and balance by comparing velocity-based strength training with traditional strength training. In our study, the effects of velocity-based strength training and traditional strength training on some motoric characteristics were analysed for six weeks. The results of the velocity loss method and traditional strength training methods were compared with each other. In our study, statistically significant differences between the two groups were found in balance and vertical jump test values.

When the literature is examined, there are findings that VBT has positive effects on sprint performance. In particular, fast movements with load have been shown to increase explosive strength and velocity performance (Liao et al., 2021). VBT has been found to increase the capacity to move at maximum velocity and thus improve the sprint performance of athletes (Jiménez-Reyes et al., 2021). Banyard (2020) applied traditional training method and velocity-based training method to a total of 24 male participants who received resistance training for 6 weeks and 3 times a week. The effects of HTA and GA methods on changes in counter movement jump (CMJ) and sprint performance were compared. As a result, it was reported that the HTA group sustained faster training repetitions with less perceived difficulty and achieved better sprint results compared to the GA method group. In their study with 24 male subjects, Jiménez-Reyes et al., (2021) performed 16 training with squat movement in 8 weeks with the daily adjustment of the load with one group of subjects divided into 2 groups and the other group with the constant load method. As a result of the study, it was observed that both groups improved in 10-metre and 20-metre sprint performances and active jumping performances. However, it was found that the group with constant load adjustment showed more improvement in active jump performance and 20-metre sprint performance than the group with daily load adjustment method. The VBT training type can also lead to significant improvements in sprint performance. Styles, et al., (2016) showed that strength training increases velocity in short-distance sprints. Traditional strength training may not have a direct effect on velocity performance. However, increased muscle mass and strength have been found to improve performance, especially in short-distance sprints (Cormie et al., 2011). Although there was a statistically significant difference in 10 m and 20 m acceleration-sprint tests in our study, the increase in sprint performance is not a desirable situation.

Although there is limited research suggesting that VBT training may be effective on agility, it has been shown that training with explosive movements and load changes generally have positive effects on agility (Brito et al., 2014). It is suggested that VBT can improve agility elements, especially the ability to change direction and acceleration. The effect of speed-based training on agility is directly related to the development of quick movements and the ability to change direction. Asadi et al., (2016) found that velocity-based training significantly improved agility performance. The effect of traditional strength training on agility is mixed. Anderson et al., (2005) stated that this type of training can improve performance by increasing muscle strength and stabilisation in movements that require agility. In our study, no statistically significant difference was observed in the agility test, but a mean decrease was found. Studies examining the effects of VBT directly on balance are limited. Therefore, a comprehensive review of the literature in this area may be useful for practitioners. Speed-based strength training increases the ability of the muscles to contract quickly while improving balance. Strength training seems to improve balance by increasing muscle stabilisation. Muehlbauer et al., (2012) showed that this type of training can improve especially static and dynamic balance. In our study, it was observed that VBT and TST increased body control in movements requiring balance and stability, and thus had a statistically positive effect on balance performance. There is evidence that VBT and TST have significant effects on vertical jump performance. Research has shown that VBT training specifically increases vertical jump height

Banyard et al., (2020). It has been found that VBT improves vertical jump performance by increasing explosive strength and muscle power and this effect contributes to the overall athletic performance of athletes (Dorrell et al., 2020). Liu (2024) conducted a study comparing velocity-based strength training (VBT) with traditional training (CT) to analyse differences in lower extremity explosiveness for butterfly swimming. The study revealed that VBT leads to greater improvements in lower limb explosiveness that can positively affect performance. Similarly, Held et al., (2022) conducted a meta-analysis comparing the effectiveness of traditional and velocity-based strength training on explosive and maximal strength performance. The analysis further supported the benefits of velocity-based training by providing insights into the effect of both training methods on strength and power indices (Held et al., 2022). Speed-based strength training has been particularly effective in vertical jump performance, which requires explosive strength. Gonzalez-Badillo et al., (2010) reported that this training was more effective in increasing jump height compared to traditional methods. The positive effects of traditional strength training on vertical jump performance are associated with an increase in muscle strength and explosive power (Markovic & Mikulic, 2010). In our study, it was determined that there was a statistically significant increase in vertical jump performance for both groups. VBT is considered an effective method to optimise the maximal strength development of load training. VBT has been shown to improve performance by allowing the load to be adjusted according to the velocity of movement during training (Atabaş, 2022). Zhang et al., (2022) conducted a meta-analysis comparing velocity-based resistance training with percentage-based training in terms of maximal strength development. Meta-analysis suggested that velocity-based resistance training may be more effective in terms of maximal strength development, especially for in-season athletes. Velocity-based training (VBT) has gained attention in the field of strength training due to its potential benefits in improving explosive strength and performance. In fact, some studies have suggested the role of VBT in enhancing athletic performance, including power, countermovement jumping (CMJ) and sprinting ability (Banyard et al., 2020; Pareja et al., 2017a; Ramírez et al., 2015). However, some researchers have reported results related to VBT, including non-significant changes in CMJ, sprint and power test sense (Pareja et al., 2017b; Rodríguez et al., 2021; Orange et al., 2019). Research has emphasised the effectiveness of VBT compared to traditional 1RM-based resistance training in improving lower limb explosive strength (Held et al., 2022).

As a result, it was determined that velocity-based training and traditional strength training increased the vertical jump and balance performances of athletes in our study. Considering the reasons for the increase, squat movement, which is one of the lower extremity exercises, is a basic exercise targeting the quadriceps muscle group. This movement actively engages the quadriceps muscles by bending and extending the knee joint, which increases leg strength and endurance. In this context, the quadriceps muscles provide a powerful thrust in the vertical jump by extending the knee joint and are critical for higher jumps. It also helps to maintain balance by providing leg and knee stabilisation during standing and movement. Both strength training methods showed a significant increase in vertical jump and balance tests.

Conflict of interest

The authors declare no conflict of interest. Also, This study was supported by Sinop University Scientific Research Coordination Unit. Project Number: SBF-1901-23-002, 2023.

Ethics Committee

This study followed ethical standards and received approval from the Sinop University Human Research Ethics Committee, dated 28/04/2023 and numbered 2023/92.

Author Contributions

Design of the Study, EA, GSC, AM, CA and MB; Data Gathering, GSC; Statistical Evaluation, EA, GSC and AM; Data interpreting EA, GSC, AM, CA, MB; Writing of the Manuscript, EA, GSC, AM, CA and MB; and Search of the Literature, EA and GSC. Each author has reviewed the final draft of the manuscript and given their approval.

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