FREE WEIGHT TRAINING VS. ELASTIC BAND TRAINING: WHAT IS A MORE EFFECTIVE STRATEGY FOR INCREASING MAXIMAL VELOCITY ABILITY DURING HANDBALL THROWS?

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Abstract:

The aim of this study was to assess the effectiveness of two resistance training (RT) programs (free weight [FW] and elastic band [EB]) on velocity variables (handball throwing velocity [HTV] and maximal theoretical velocity [V_0]) using load-velocity (L-V) relationship modelling. Both programs lasted 6 weeks and consisted of performing bench press and overarm dumbbell pull-over using free weights (FW group) or elastic bands (EB group). Nineteen male sports science students were randomly assigned to EB (n=10) or FW group (n=9). Both RT programs increased HTV and V_0, although the increment was greater in the FW (>2 m·s^{-1}) compared to the EB group (<1 m·s^{-1}). RT programs had selective effects on the strength variables being FW more effective in increasing 1-repetition maximum, while EB in increasing maximal isometric force. Very large correlations were observed between two-point (L-V relationship modelled through two pairs of L and V data) and multiple-point methods (L-V relationship modelled through six pairs of L and V data) (V_0: r=0.96; HTV: r=0.93). All coefficients of variation showed high validity both for V_0 and HTV (≤6.2%). Altogether, FW training should be used for increasing the velocity of the throwing performance, while the two-point method for following training-induced changes.

Key words: *load-velocity relationship, resistance training, two-point method*

Introduction

Overhead handball throwing is a complex, discrete, fast movement and the key technical element for successful handball performance (Cuevas-Aburto, Janicijevic, Pérez-Castilla, Chirosa-Ríos, & García-Ramos, 2020; Saavedra, Halldórsson, Kristjánsdóttir, Þorgeirsson, & Geir, 2019). The handball throwing velocity (HTV) has been identified as the crucial variable that can distinguish between skilled and less skilled handball players (Alves & Marques, 2013). It is not surprising then that many researchers have been trying to find the optimal training procedure for increasing HTV. It has been suggested that even short resistance training (RT) programmes are effective at improving throwing ability of different athletes (Baena-Marín, et al., 2022). Many variables should be taken into consideration when programming RT, such as intensity, volume, frequency of training sessions, order of exercises, duration of the rest periods, etc. (Grgic, Schoenfeld, Skrepnik, Davies, & Mikulic, 2018; Mangine, et al., 2015; Wilk, Zajac, & Tufano, 2021). However, there is another variable that is less frequently considered but can significantly influence the outcomes of the RT programmes and it is the resistance type.

Specifically, previous studies have shown that RT programmes of similar characteristics (i.e., a similar number of repetitions and sets, relative load, and pauses between repetitions) performed using different resistance types led to different musculoskeletal adaptations (Andersen, Fimland, Kolnes, & Saeterbakken, 2015; Rivière, Louit, Strokosch, & Seitz, 2017; Shoepe, Ramirez, & Almstedt, 2010). Nevertheless, free weights (FW) are the most frequently used resistance type for increasing HTV as their utility have been confirmed in many previous studies (Chelly, Hermassi, & Shephard, 2010; Gorostiaga, Izquierdo, Iturralde, Ruesta, & Ibáñez, 1999; Hermassi, Chelly, Fathloun, &

Shephard, 2010; Marques, van den Tilaar, Vescovi, & Gonzalez-Badillo, 2007). To our knowledge, only Cuevas-Aburto et al. (2020) reported that neither FW nor ballistic bench press (BP) RT programme were effective in increasing HTV. Although it is certainly useful and oftenly used RT type, its effectivness should be compared to the other less frequently implemented RT programmes.

For example, another training type frequently used for improving HTV and generally as a part of the strength and conditioning routine is RT using elastic bands (EB) (Bauer, Schwiertz, & Muehlbauer, 2021). Although fewer studies explored the effectiveness of the EB RT on the HTV, their general conclusion was that EB RT programmes were also a feasible solution for incrementing HTV. Of note, only Andersen, V. Fimland, M., Cumming, K., Vraalsen, Ø., & Saeterbakken, A. (2018) found no differences in the magnitude of HTV between the control (i.e., the group that performed regular handball training) and the experimental EB group (i.e., the group that performed regular handball plus additional EB training). The possible reason why Andersen et al. (2018) did not find any difference between the control and experimental group might be due to the very general nature of exercises implemented in the experimental group (i.e., six different whole-body exercises). Although the majority of the studies have demonstrated increments in HTV following the EB RT, it is still not clear which characteristics of one EB RT programme should be present to most efficiently increase HTV. And most importantly it is not known whether EB RT is a more effective strategy for increasing HTV than FW RT, or vice versa, although there are some indications that FW could be somewhat more effective for increasing maximal strength, while EB for maximal power development (Djuric, et al., 2016).

Although HTV has been shown to be an important predictor of successful handball performance (Raeder, Fernandez-Fernandez, & Ferrauti, 2015), previous studies have suggested that there is a method that allows assessing the velocity ability of the overhead throwing activity more comprehensively (Sreckovic, et al., 2015). Specifically, Garcia-Ramos et al. (2018c, 2019) and García-Ramos and Jaric (2018) demonstrated that the load-velocity (L-V) relationship modelled using two (i.e., two-point method) or more pairs of loads (multiple-point method) and corresponding velocities were a valid and reliable methods for exploring the maximal theoretical velocity ability during multi-joint movements. This means that recording the throwing velocity performed against two or more different weights allows not only exploring the effectiveness of different training protocols on the HTV (i.e., estimating the velocity associated with the handball ball weight) but also on the maximal theoretical velocity (V_0; intercept of the L-V with the x-axis). However, to our knowledge, no study has explored the possibility of assessing HTV and V_0 using L-V relationship modelling following different RT types.

Therefore, our main aim was to assess the effectiveness of the two most commonly used RT programmes (FW and EB) on velocity variables (HTV and V_0) through the assessment of the L-V relationship. Our additional aims were: (1) to explore the effects of FW and EB training programmes on the strength variables (i.e., maximal isometric force [Fmax] and bench press 1-repetition maximum [BP 1RM]) since the L-V relationship modelling is not a reliable procedure for exploring maximal theoretical force and power characteristics of throwing activity (based on our unpublished laboratory data) (Marques, et al., 2007), (2) to explore the validity of the two-point method with respect to the multiple-point method for detecting changes in HTV and V_0. We hypothesized that (1) both training programmes will increase the velocity ability while this increment will be more accentuated in the FW group, (2) both FW RT and EB RT will increase HTV and V_0, although it is not known which RT type will provoke higher increments, and (3) V_0 and HTV will not be systematically different when obtained using two- and multiple-point methods.

Methods

Participants

Nineteen male sports science students were randomly assigned to either the EB group (n= 10, age = 20.7 ± 1.1 years, body mass = 77.5 ± 5.2 kg, body height = 1.82 ± 0.39 m) or FW group (n= 9, age = 22.1± 1.5 years, body mass = 84.5 ± 12.7 kg, body height = 1.84 ± 0.87 m). All participants were healthy and physically active in a minimum of 10 hours of moderate physical activity per week. They have completed the mandatory curricular course in handball during which they acquired an advanced level of specific handball throwing technique. They completed the study experimental protocol without missing any session and were instructed not to perform additional upper-body strength training over the course of the study. None of them had any arm injury that could have compromised training and testing protocols, nor were they former or present handball players. Participants were informed about research purposes, procedures, and gave their written consent before the start of the study. The study protocol adhered of the Declaration of Helsinki and was approved by the University Review Board (Approval number: 02-1550/20-1).

Study design

This study aimed to compare the effects of two different RT programmes on the maximal velocity ability of the arm muscles involved in handball throws and to explore the validity of the two-point method with respect to the multiple-point method for assessing changes in HTV and V_0. For this purpose, participants were randomly assigned either to the FW training group or EB training group. Both training programmes lasted six weeks and were performed in the same faculty gym. All participants came to the laboratory for 18 training sessions (i.e., three sessions per week). The main difference between the training programmes was in the type of resistance (free weight *vs.* elastic bands), while the movement patterns of the exercises were similar for both groups (i.e., the FW group performed bench press and overarm dumbbell pull-over against free weight, while the EB group performed the same exercises using elastic bands). In order to evaluate the effects of the different training programmes, the pre-test was organised a week before the first training session, while the post-test was performed a week after the last training session. Testing protocols consisted of measuring maximal isometric overarm pull, recording throwing velocity against six medicine balls that weighted from 0.5 to 3 kg, and determining BP 1RM.

Procedures

Both pre-RT and post-RT testing sessions were performed in the university research laboratory. Upon the entrance to the laboratory, the participants' height and body mass were measured, which was followed by the general warm-up consisting of five minutes of cycling, three sets of 10 push-ups and 10 minutes of calisthenics and dynamic stretching (Cuevas-Aburto, et al., 2020; Markovic, Suzovic, Kasum, & Jaric, 2016). After the warm-up, participants had a 5-minute rest before the testing protocol, which was organised in the following order:

– *Maximal isometric overarm pull-over:* This test was used for assessing the maximal voluntary isometric force ability (Fmax) of the arm muscles involved in the handball throw. Participants performed this test lying on their back on a flat bench, while their feet were resting on the floor. They were holding a metal extension of the dynamometer having their arm abducted and flexed in the elbow joint at 90° (i.e., the typical position of the handball throw). The hand was positioned 5-cm below the horizontal edge of the bench. Participants were instructed to maintain their arm in the initial position and relaxed until the same experienced researcher gave an instruction to perform a maximal voluntary isometric contraction (i.e., the maximal force of the muscles involved in throwing activity against an immovable resistance). The given instruction was to perform the described action as strongly and as quickly as possible during a period of 3-5 seconds (Wilson & Murphy, 1996). Participants performed one probatory attempt and two experimental attempts. The rest between two consecutive attempts was two minutes (Suzovic, Nedeljkovic, Pazin, Planic, & Jaric, 2008), while the attempts performed using an incorrect technique (i.e., lifting the elbow, etc.) were repeated. The attempts with greater muscle force were selected for statistical analyses.
– *Handball throwing test:* This test was used for exploring the maximal velocity ability of the participants. The test consisted of performing a basic overhead handball throw against six Thera Band Balls (standard men circumference), that weighted 0.5, 1.0, 1.5, 2.0, 2.5, and 3 kg. The actual testing started with a specific warm-up that consisted of five submaximal handball throws of the standard weight handball (0.425-0.475 kg and circumference 56-58 cm). Later, in a randomised order, participants performed three maximal handball throws with each ball (18 throws in total). The first throw with each ball was considered a probatory trial, while the two other throws were considered as experimental trials. The handball throw test was performed in the seated position with the extended legs, while the back of the participants was leaning on the hard, immovable support (see Figure 1 for the experimental set-up). The ball was thrown always with the dominant arm. The technique of the handball throw was considered correct if the participants kept their body still and used only their arm to throw the ball as powerful as possible after hearing the instruction "Go!". The pause between two consecutive throws was 30 s. The velocity of the ball was recorded using three cameras for kinematic analysis of the movement. A single reflective marker was positioned on the participant's dominant hand (at the *styloid process of the ulna*). The velocity data recorded during the fastest throw for each ball were later used for the L-V modelling. The trials were repeated in case of an incorrect throwing technique (e.g., having the elbow of the throwing arm lower than the shoulder line, moving the non-throwing arm, throwing the ball to the wrong direction, etc.) or if the participants separated their back from the back

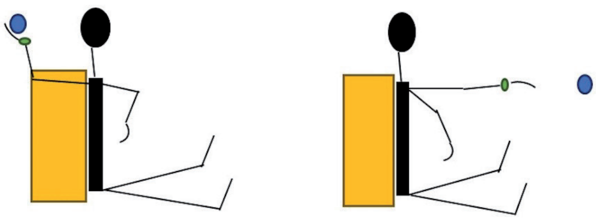

Figure 1. Illustration of the initial and final body posture together with the position of the attached reflective marker (green circle) and ball (blue circle).

support during the throw. The Doppler-radar gun (Sports Radar 3300, Sports Electronics) was used for providing velocity feedback since previous studies showed that it increased the motivation of the participants (Marques, et al., 2007; van den Tillaar & Marques, 2009).

– *Bench press 1-repetition maximum (BP 1RM):* BP 1RM was evaluated in a Smith machine following a standardized protocol (for more details see García-Ramos et al. 2018d). The initial load was 35 kg for all participants, while the participants were encouraged to self-select the grip width. The load was increased by 10 kg until the mean concentric velocity did not reach 0.50 m·s-1 after which the load continued to be increased by 5-1 kg until the 1RM load was reached.

Training procedure

All the training sessions were completed at the faculty gym. Each training session started with the same warm-up (10 minutes of jogging at a self-selected pace, dynamic stretching, and three sets of 10 push-ups). The training programme consisted of 18 training sessions (three sessions per week), and it was supervised by the same experienced researcher. The specificities of the two resistance training programme are described below.

– *Free weight training group (FW group):* The participants from this group performed two exercises: bench press and dominant overarm dumbbell pull-over. The specific warm-up consisted of two sets of 10 repetitions at the intensity of 50% of individually determined BP 1RM (Sabido, Hernández-Davó, Botella, & Moya, 2016) and overarm pull-over. Participants were thereafter instructed to complete six sets of 10 repetitions of each exercise. The initial load for the BP was approximately 50% of the previously determined individual 1RM and was progressively increased each week, reaching approximately 60% in week two, 64% in week three, 68% in week four, 73% in week five, and 78% in week six. The initial load for the dominant overarm dumbbell pull-over was 4-kg for each participant, and was increased to approximately 5 kg week two, 5.6 kg in week three, 6.4 kg in week four, 7.1 kg in week five, and 7.8 kg in week six. The instruction given to the participants was to perform the concentric phase of the movement as rapidly as possible.
– *Elastic band training group (EB group):* Participants performed the overarm pull-over and BP exercises using resistive elastic bands. They were always using 1.2 m elastic bands that were attached to the wall with a free end. Both exercises were performed seated, with the elastic bands extended 15 cm at the initial position. The final position corresponded to the end of the movement (i.e., for overall pull-over the final position was the same as the final position of the arm during the handball throw [~90 cm], while the final position during BP was complete extension of both arms [~60 cm]. Resisting elastic force of the used elastic bands was increased from week to week. Initially, the elastic bands had resistive forces that corresponded to approximately 40% of the individual maximal force recorded during isometric overarm pull-over and isometric bench press. Then the resistance of the elastic bands was increased every week, corresponding to ~50% during week two, ~54% during week three, ~58% in week four, 62% in week five, and 66% in week six. They were performing exercises using the same elastic band until they could complete six series of 10 repetitions. At that moment, the elastic band was changed, and from the next training, they were performing exercises with the elastic band with a greater resistive force.

Data acquisition and analysis

Maximal isometric force during the overarm-pull was measured using the isokinetic dynamometer (Kin-Com Chatex Corp., Chattanooga, TN). The force-time curves were recorded at 500 Hz and low-pass filtered (10 Hz) applying the second-order (zero-phase lag) Butterworth filter (Sports Medical Solutions system Isometricus, SMS, All 4 Gym, Belgrade, Serbia). The force was directly recorded and the trial with the highest force value was used for statistical analyses. The velocity of the handball throw was recorded using the Qualisys Track Manager program package with 3D motion recording cameras (Qualisys Pro Reflex MCU120 Motion Capture System, Sweden). Later on, the obtained velocity and the actual weights of the balls thrown were used for L-V modelling (Garcia-Ramos et al., 2018a).

Statistical analyses

Descriptive data are presented as means and standard deviations (SD). Shapiro-Wilk test confirmed the normal distribution of HTV, Fmax and 1RM BP ($p>.05$). Between-within ANOVA with training group (FW vs. EB training group) as between- and time (pre-RT intervention vs. post-RT intervention) as within-participant factors was applied on the HTV, V_0 parameter, Fmax, and 1RM BP. In case of significant differences, *post-hoc* paired t-tests with Bonferroni corrections were used, while the Cohen's *d* effect size (ES) was used to evaluate the magnitude of the differences. The standard error of the estimate (SEE) expressed in absolute and relative values (coefficient of variation; CV%) were used to explore the validity of the two-point method with respect to the multiple-point method and also the validity of the two-point and multiple-point method for estimating HTV. The level of validity was defined as high and acceptable when the CV% was ≤ 5% and ≤ 10%, respectively (James, Roberts, Haff, Kelly, & Beckman, 2017). The scale used to interpret the magnitude of the ES was specific to training research: negligible (< 0.20), small (0.20–0.49), moderate (0.50–0.79), and large (≥ 0.80) (Cohen, 1988). All statistical analyses were performed using SPSS software version 20.0 (SPSS Inc., Chicago, IL, USA) and statistical significance was set at an alpha level of 0.05.

Results

Velocity ability (V_0 and HTV)

Between-within ANOVA performed on V_0 revealed significant main effect of time (F = 7.167, p≤.001) and interaction time × group (F = 5.159, p=.036), while the main effect of the group did not reach statistical significance (F = 0.010, p=.923). The significant interaction time × group revealed that the increments in V_0 were greater for the FW group (Figure 2). The overall magnitude of the differences between pre- and post- RT intervention was larger in the FW (ES = 1.34) than in the EB group (ES = 1.01). Pairwise comparisons showed that a significant increment in velocity output was achieved for all the experimental conditions and both groups, except for the handball throw-like movement pattern with the two heaviest loads in the resistance band group (Table 1). Similar results were found for HTV. The main effect of time (F = 27.574, p≤.001) and interaction time × group (F = 4.649, p=.046) were significant, while the main effect of the group did not reach statistical significance (F = 0.007, p=.936). The increase in HTV was greater in the FW group (2.30 m·s^{-1}) than in the EB group (0.96 m·s^{-1}).

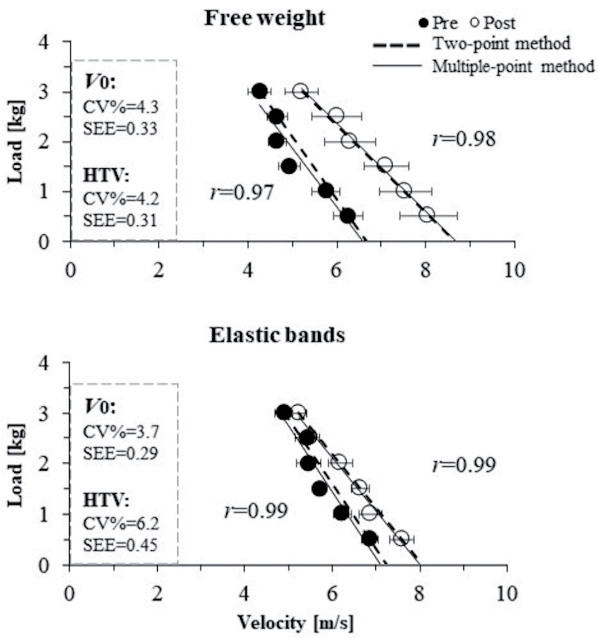

Figure 2. Load-velocity relationships of the handball throw pre (full circles) and post (empty circles) the free weight (upper panel) and elastic bands training (lower panel) modelled using multiple-point method (full line) and two-point method (two-point method). V_0, maximal theoretical velocity; HTV, handball throwing velocity; r, coefficient of correlation; CV%, coefficient of variation; SEE, standard error of estimate.

Strength ability (Fmax and 1RM BP)

Between-within ANOVA performed on Fmax revealed a significant main effect of time (F = 17.866, p≤.001), while the main effect of the group (F = 1.869, p=.189) and interaction time × group (F =

Table 1. Changes in peak throwing velocity outputs following the resistance training interventions

Training group	*Variable*	*Pre (ms^{-1})*	*Post (ms^{-1})*	*ES*	*p*
Free weight	V_0	6.81	9.00	1.33	**.004**
	$V_{0.5}$	6.25	8.06	1.25	**.005**
	V_1	5.76	7.55	1.30	**.003**
	$V_{1.5}$	4.97	7.11	1.96	**.000**
	V_2	4.66	6.29	1.38	**.009**
	$V_{2.5}$	4.66	6.00	1.15	**.023**
	V_3	4.26	5.21	1.00	**.029**
Elastic band	V_0	7.52	8.40	1.00	**.007**
	$V_{0.5}$	6.85	7.59	0.98	**.014**
	V_1	6.23	6.88	0.86	**.011**
	$V_{1.5}$	5.71	6.64	1.80	**.000**
	V_2	5.45	6.18	0.84	**.005**
	$V_{2.5}$	5.42	5.50	0.12	.798
	V_3	4.90	5.23	0.52	.193

Note. V_0, maximal theoretical velocity; $V_{0.5}$, velocity achieved against 0.5 kg; V_1, velocity achieved against 1 kg; $V_{1.5}$, velocity achieved against 1.5 kg; V_2, velocity achieved against 2 kg; V_2, velocity achieved against 2 kg; $V_{2.5}$, velocity achieved against 2.5 kg; V_3, velocity achieved against 3 kg; ES, effect size. Bolded numbers represent significant differences (p≤.05).

Table 2. Changes in strength outputs following the resistance training interventions

Training group	*Strength variable*	*Pre*	*Post*	*ES*	*p*
Free weight	Fmax	308 ± 182 N	360 ± 195 N	0.27	**.007**
	BP 1RM	84 ± 16 kg	93 ± 14 kg	0.58	**≤.001**
Elastic band	Fmax	215 ± 91 N	279 ± 61 N	0.84	**.019**
	BP 1RM	67 ± 19 kg	19 ± 17 kg	0.44	**.003**

Note. Fmax, maximal isometric velocity; BP 1RM, bench press 1-repetition maximum; ES, effect size. Numbers in bold represent significant differences (p≤.05).

0.203, p=.658) did not reach statistical significance. Another between-within ANOVA performed on BP 1RM revealed a significant main effect of time (F = 46.560, p≤.001) and the group (F = 5.509, p=.031), while the interaction time × group (F = 0.119, p =.661) did not reached statistical significance. Pairwise comparisons are depicted in Table 2.

Validation of the two-point method

Very large correlations were observed between the magnitudes of the V_0 and HTV obtained between the two-point and multiple-point methods (V_0: r=0.96 and HTV: r=0.93). All CVs showed high validity both for V_0 and for HTV (all CV ≤ 6.2%), while all SEE were always lower than 0.45 m·s^{-1}.

Discussion and conclusions

The aim of this study was to explore the effectiveness of the FW and EB RT programmes for the enhancement of the handball throw maximal velocity ability as well as the possibility to quickly estimate HTV and V_0 ability through the two-point method. The main findings showed the following: (1) both training methods improved maximal velocity ability, although, the magnitude of this increment was higher for the FW group, (2) the magnitude of HTV and V_0 did not differ when obtained by the two- and multiple-point methods, and (3) both training methods significantly increased strength ability of the participants, although the magnitude of the changes was small for Fmax in the FW group and 1RM BP in the EB group, moderate for 1RM BP in the FW group, and large for Fmax in the EB group. Summing up, FW is a more effective resistance type for increasing the maximal velocity ability of the arm muscles involved in the handball throw, while the L-V relationship can be confidently used for estimating HTV and V_0 through the two-point method.

Six-weeks of the upper-body RT programmes significantly improved the maximal velocity ability of our participants, which is in line with previous studies applying RT programmes of similar duration (6-9 weeks) (Aloui, et al., 2019, 2021; Bauer, et al., 2021; Gorostiaga, et al., 1999; Mascarin, De Lira, et al., 2017a). However, many of the previous studies implemented RT programmes in addition to the main handball programme, and that is why Mascarin et al. (2017b) argued that it could be attributed to a generally greater training volume in groups that were involved in the additional RT programme. The main novelty of our study is that it directly compares the effectiveness of two commonly used RT programmes on HTV and V_0. What is also interesting is that we observed greater increments in HTV and V_0 following the FW RT compared to the EB RT, similarly as reported in the study of Dilshan Priyadarshana, Keerthirathne, and De Silva (2021). The possible explanation for this result may be the actual mechanics of the handball throwing movement. Specifically, when the participants performed exercises using EB, the actual loading went from lower to higher as the elastic band elongated, which is the mechanism opposite to an actual throw during which the muscles need to develop more force at the beginning of movement pattern execution compared to the end of the movement.

Both the FW and EB training modalities increased the magnitude of strength variables, although the participants belonging to the FW group incremented 1RM BP more, while the participants belonging to the EB group incremented Fmax more. These findings corroborate the hypothesis regarding the selective effect of strength training (Djuric, et al., 2016), meaning that the participants who were lifting free weights incremented their ability to lift free weights, while the participants that were experiencing isometric contractions at the end of each repetition (final part of the movement produced against EB) increased more their Fmax. Moreover, similar to previous studies (Marques, et al., 2007), increments in velocity ability in our study were not followed by the same increments in the strength ability, and vice versa. All these findings speak in favour of the necessity to explore the strength ability of the muscles involved in the throwing action separately from velocity assessment.

Confirming our third hypothesis, the two-point method showed a higher validity with respect to the multiple-point method. Previously, the two-point method has shown to be valid for exploring all theoretical maximal mechanical capacities during different multi-joint tasks (Garcia-Ramos, et al., 2018a; Garcia-Ramos et al., 2019; Janicijevic, García-Ramos, Knezevic, O.M., & Mirkov, D.M, 2019; Janicijevic, et al., 2020). However, to our knowledge, this is the first study that validated the two-point method for exploring HTV and V0 during a unilateral throwing activity, which is very important from the testing perspective. The downside of the two-point method for throwing assessment is that it is unsuitable for assessing maximal force and power capacities since the maximal load that can be implemented during the unilateral handball throw is relatively small. This means that the maximal load applied during the testing is far from y-intercept jeopardising the reliability of maximal theoretical force and power estimation. Possible limitation of the present study is that we did not include handball players as participants due to their dense schedule during the competitive season. Future studies should explore if the same methodology (i.e., two-point method) can reliably be applied for assessing HTV and V_0 of the amateur and professional handball players and whether the FW training will be a more effective strategy also in this population.

This study carries several important practical applications. Firstly, the FW RT type was found to be more effective than the EB type for increasing HTV and V_0. Secondly, the two-point method is a feasible solution for estimating HTV and V_0. In order to model the L-V relationship using two-point method, sports practitioners should record throwing velocity against two weights (i.e., a very light load [i.e., ball lighter than 0.5 kg] and the heaviest load that does not compromise the throwing technique [i.e., it will depend on the participants; 3 kg in our study]). In this manner, the two-point method will reveal both HTV and V_0, and, therefore, provide more comprehensive information about participants' velocity ability than it would be done by assessing only HTV. Thirdly, both the FW and EB interventions were more effective for increasing velocity ability against lighter loads, which can also be explored by implementing the two-point method (i.e., examining the slope of the L-V relationship; see Figure 2). Fourthly, implemented strength training programmes had selective effects on our variables—the FW training increased 1RM BP more, while the EB training increased Fmax more. Although improvements in the HTV were found also after implementing the EB RT programme, the FW training should be preferably used for incrementing the maximal velocity ability of the arm muscles involved in unilateral throws, while the two-point method should be used to systematically follow those changes.

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