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EFFECTS OF THE FRENCH CONTRAST METHOD ON MAXIMUM STRENGTH AND VERTICAL JUMPING PERFORMANCE

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INTRODUCTION: An athlete's ability to produce high rates of muscular force and power are two of the most important factors in sporting performance (Nuzzo et al., 2008). Variable Resistance (VR) is an advanced training method utilized to increase lower extremity strength and power (Ojeda et al., 2016). The most popular forms of VR that strength and conditioning coaches implement for power development are complex and contrast training (Alves, Rebelo, Abrantes and Sampaio, 2010). Complex training is a combination of resistance exercise followed by a matched plyometric exercise while contrast training is a set of heavy resistance repetitions followed immediately by an unloaded, explosive exercise utilizing the same movement pattern (Dietz and Peterson, 2012). Both of these training methods aim to increase the likelihood of Post Activation Potentiation (PAP) which is an increase in muscle force and rate of force development (RFD) that occurs as a result of previous activation of the muscle (Sale, 2002). French Contrast Method (FCM) was first created by French track and field coach Gilles Cometti. Anecdotally, FCM is widely utilized by strength and conditioning coaches in their programming for athletes. However, research on the effectiveness of this method is limited. One study concluded that FCM training improves vertical jumping and anaerobic conditioning to acutely enhance lower body force and power production (Hernández-Preciado et al., 2018).

Cal Dietz and Ben Peterson have reworked Cometti's original method and defined FCM as a combination of complex and contrast training methods that involves the following exercise protocol: heavy compound exercise, plyometric exercise, weighted plyometric exercise, and an assisted plyometric exercise (Dietz and Peterson, 2012). A fundamental component of the FCM proposed by Dietz and Peterson is the ability for athletes to uniquely train across the entire force-velocity curve, which is critical for both acute and long-term athletic development. No current studies have examined the long-term training effects of the FCM proposed by Dietz and Peterson. The purpose of this study was to determine the effects of six weeks of FCM on maximum strength and jumping performance.

METHODS: A pre-post design was used to examine the effects of FCM on maximum strength and vertical jumping performance. A total of 10 weight-trained males volunteered to participate in this study (Age: 21.84±2.38, Height: 175.37±4.94, Body Mass: 80.6±11.11 Training Age: 4.7±2.3, one repetition maximum (1RM) Back Squat: 136.9±37.14, 1RM Trap Bar Deadlift: 189±42.85). Written informed consent was obtained from each participant prior to initial testing. A thorough explanation of all protocols, possible risks involved and the right to terminate participation at will was given. The study was approved by the University's Institutional Review Board and all procedures were in accordance with the Declaration of Helsinki. All participants reported for an initial pre-training laboratory testing session, a six-week FCM training regimen and a post-training laboratory testing session. Pre and post-testing sessions consisted of static jumps (SJ), countermovement jumps (CMJ) and 1RM testing in both the back squat and trap bar deadlift. A standardized dynamic warm up was completed prior to testing. Participants completed a total of six weeks of training using FCM. Two training sessions were performed each week separated by a minimum of 48 hours. Participants refrained from outside resistance training or plyometrics 24 hours before their testing and training sessions. The progressive FCM training program can be viewed in Table 1. Each FCM training session included four exercises paired in a circuit format for a total of three sets. Limited rest (10 seconds) was given between exercises and five minutes of rest was given between each set. All data for vertical jumping was collected and analyzed using FD4000 dual force plates (Force Decks, Vald Performance, Newstead, QLS, AUS) sampling at 1000Hz and the force decks software (Force decks, Vald Performance, Newstead, QLS, AUS). The following variables were analyzed to measure vertical jumping performance: jump height, peak power, peak power allometrically scaled to body mass (PPa), peak force, peak force allometrically scaled to body mass (IPFa), and peak velocity. Descriptive statistics including mean and standard deviation were calculated. Data was analyzed by using a paired samples t-test for all dependent variables. Cohen's *d* effect sizes were calculated and Hopkins classification system were used to interpret effect sizes (ES) for each dependent variable to determine the magnitude of difference between pre and post FCM training. Effect sizes were based on a scale by Hopkins of 0-0.2, 0.2-0.6, 0.6-1.2, 1.2-2.0, and 2.0+ and was interpreted as trivial, small, moderate, large and very large (Hopkins, Marshall, Batterham and Hanin 2009). Statistical significance was set at $p \leq 0.05$ for all statistical analyses. All analyses were computed using SPSS 25 (IBM, New York, NY, USA).

TABLE 1. Training & Testing Protocol

Pre-Test: SJ, CMJ, 1RMBS, 1RMTBD			
Weeks 1 & 2			
Back Squat	CMJ	Trap Bar Jumps	Band Assisted Jumps
3 x 3 @85% 1RM	3 x 3	@30% 1RM 3 x 3	3 x 4
Weeks 3 & 4			
Back Squat	CMJ	Trap Bar Jumps	Band Assisted Jumps
3 x 2 @87.5% 1RM	3 x 4	@30% 1RM 3 x 4	3 x 5
Weeks 5 & 6			
Back Squat	CMJ	Trap Bar Jumps	Band Assisted Jumps
3 x 1 @90% 1RM	3 x 5	@30% 1RM 3 x 5	3 x 6
Post-Test: SJ, CMJ, 1RMBS, 1RMTBD			

Note: All exercises were completed as (sets x reps); SJ=Static Jump; CMJ=Countermovement Jump; 1RMBS=1 Repetition Maximum Back Squat; 1RMTBD= 1 Repetition Maximum Trap Bar Deadlift.

RESULTS: Descriptive data and results of paired samples t-test for body mass and maximum strength variables can be found in Table 2. Statistical significance was found for all variables in Table 2. Trivial to Small ES were present (0.15-0.32) for all variables. Descriptive data and results of paired samples t-test for squat jump and countermovement jump variables can be found in Table 3. Statistical significance was found for Jump Height, Peak Power, PP, and Peak Velocity. Small to Moderate effect sizes were present (0.36-0.68). Statistical significance was found for Jump Height and Peak Velocity. Trivial to Moderate effect sizes were present (0.12-0.78).

TABLE 2. Body Mass and Maximum Strength

Variable	Pre		Post		*p*	*d*	Descriptor
BM (kg)	80.6	± 11.11	82.24	± 10.67	0.014*	0.15	trivial
1RM Squat (kg)	136.9	± 37.14	145.4	± 33.7	0.001*	0.24	small
1RM TBDL (kg)	189	± 42.85	203.6	± 39.1	0.001*	0.36	small
SQ/BM Ratio	1.68	± 0.32	1.76	± 0.3	0.035*	0.26	small
TBDL/BM Ratio	2.35	± 0.44	2.48	± 0.37	0.006*	0.32	small

Note: *=$p \leq 0.05$. BM=Body Mass; kg=kilograms; 1RM=1 Repetition Maximum; TBDL=Trap Bar Deadlift; SQ=Squat; Descriptor indicates increase

TABLE 3. Squat Jump and Countermovement Jump Performance

Variable	Jump Type	Pre		Post		*p*	*d*	Descriptor
JH (cm)	SJ	33.85	± 4.22	37.6	± 7.35	0.024*	0.63	moderate
	CMJ	38.34	± 5.86	41.6	± 7.27	0.015*	0.49	small
PP (W)	SJ	4090.7	± 782.3	4490	± 930.5	0.007*	0.46	small
	CMJ	4261.8	± 797.7	4363	± 867.5	0.362	0.12	trivial
PPa (W/kg)	SJ	50.08	± 5.71	54.4	± 7.01	0.007*	0.68	moderate
	CMJ	52.2	± 5.2	52.9	± 6.38	0.514	0.12	trivial
PF (N)	SJ	1756.7	± 247.7	1857	± 305.7	0.067	0.36	small
	CMJ	1931.6	± 293.4	2032	± 317.6	0.101	0.33	small
IPFa (N/kg)	SJ	21.6	± 1.3	22.54	± 1.43	0.085	0.69	moderate
	CMJ	23.4	± 1.5	24.7	± 1.8	0.095	0.78	moderate
PV	SJ	2.68	± 0.19	2.8	± 0.23	0.048*	0.57	moderate
	CMJ	2.79	± 0.2	2.88	± 0.22	0.002*	0.43	small

Note:*=$p \leq 0.05$; JH=Jump Height; PP=Peak Power; PPa=Peak Power allometrically scaled to body mass; PF=Peak Force; IPFa=Peak Force allometrically scaled to body mass; PV=Peak Velocity; Descriptor indicates increase

DISCUSSION: The purpose of this study was to determine the effects of six weeks of FCM on maximum strength and jumping performance. Following the FCM training regimen, subjects improved both lower body maximum strength and power. Maximal strength increased absolutely and relatively in the back squat and trap bar deadlift. Additionally, subjects had increases in performance for both the SJ and CMJ. Jump height, and peak velocity increased in both SJ and CMJ types from pre to post. Peak power and peak power to body mass ratio increased for SJ only. The results of this study agree with previous literature that long-term strength training utilizing the barbell back squat improves lower body maximum strength and vertical jumping ability (Cormie et al., 2010). Weighted jumping with a trap bar has been shown to increase jump height, peak force, RFD and peak power at loads from 20-60% of 1RM (Swinton et al., 2012). Assisted jumping (10-30% reduction of BM) with the form of elastic bands reduces impact forces while improving peak acceleration and velocity, relative peak power and vertical jump height (Sheppard et al. 2011).

CONCLUSIONS AND PRACTICAL APPLICATIONS: Maximal strength and jumping performance underpin an athletes' ability to produce high rates of muscular force and power, which are critical for successful performance in sport. For athletes who are limited to restricted training times, using the FCM in training may be an effective means of improving lower body strength and power. Further research is needed to identify the specific mechanisms for these improvements. Strength and conditioning coaches should consider implementing FCM during the pre-season phase for their athletes as the specificity of training increases and there is limited time in the weight room due to the priority of sport specific skill practice.

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