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Research Article

The Effectiveness of a Week-Long Free Weight Training Intervention for Grip Strength and Grip Endurance Time in Young Adults

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Abstract

The purpose of this study was to determine the effectiveness of a week-long free weight training intervention for grip strength and grip endurance time in young adults. Thirty-one healthy people (15 men and 16 women) volunteered for this study. During biceps curl exercises with dumbbells in supination, pronation, and neural forearm postures, free weights were used to perform 3 sets of 10 repetitions [10-RM] daily for a week. Experimental trials were randomly recorded for MVC grip strength and endurance at 50% MVC in three different levels of forearm posture. The results showed a significant effect of gender and exposure days on grip strength and endurance time ($p < 0.001$) for both participants. In addition, MVC grip strength was highest in the pronation of both participants. However, grip endurance time was highest in the pronation in male participants and neutral in female participants. Therefore, it can be concluded that free weight strength training may improve grip strength and endurance with respect to exposure days for both male and female participants.

Keywords: *Strength Training; Forearm Postures; Gender; Anthropometry; Maximal Voluntary Contraction*

Introduction

Grip strength is extensively recognized as a sign of maximal strength [1] and contraction of active muscles of hand and forearm. Therefore, grip strength delivers an objective measure of the integrity of hand function. Accurate measurement of grip strength is very important for assessing the effectiveness of surgery and rehabilitation and for designing manual tools and devices. This physical characteristic is very important as it affects the performance efficiency of both sports and occupational tasks [2]. In addition, engaging in strength training can significantly increase your strength [3]. Home strength training offers unique possibilities such as convenience of family environment, independent practice, involvement of family and friends, and flexibility of practice planning.

Strength training usually involves of muscle-building trainings performed using either free weights or machines (dumbbells, barbells, etc.) [4]. These exercises have been shown to have positive effects on many factors in the elderly, including a significant increase in muscle mass, strength, and power, and an overall improvement in quality of life. One of the topics that has been intensively discussed in the design of strength training programs is modality training, primarily through training with machines or free weights [5]. As is often the case, both modality has obvious strengths and weaknesses, depending on the target group and training objectives [2].

Free strength training (FWT) is widely considered to be superior to machine training (MT). This is due to the need for better motor control and muscle mobilization requirements, which can generate greater strength-to-power adaptations that turn into critical func-

tional tasks [2,5]. However, the quicker aspect of studies comparing FWT and MT does not support the above hypothesis [5]. In the literature, other methods such as whole body vibration [6-8], vibration therapy [9] and vibratory massage therapy [1,10,11] are also muscular strength training program. These results do not allow a clear statement about the "best" modality of the exercise. Therefore, the purpose of the current study was to determine the effectiveness of a week-long free weight training intervention for grip strength and endurance time in young adults.

Therefore, the alternative hypothesis envisioned in this study was that "free weight strength training had a significant impact on MVC grip strength and grip endurance time".

Methods

Experimental design

A full factorial design (2 levels (before bicep curl exercise and after bicep curl exercise) x 7 days of exposure with two levels of gender (male and female) and three different levels of forearm posture (supination, pronation and neutral) were used in this study. Experimental trials were randomly recorded for MVC grip strength and at 50% MVC endurance time at three different levels of forearm posture.

Participants

Thirty-one healthy right-handed participants (15 male (23.4 ± 2.4 years) and 16 female (22.5 ± 2.5)) volunteered for this study. No history of wrist and forearm dysfunction has been reported. Prior to the study, all participants were aware of the potential risks and benefits associated with participation. All the participants gave a written consent and research protocol was permitted by the Ethical Committee of the Department of Mechanical Engineering. All participants were informed that they were completely familiar with the procedure used in this study and could withdraw from the study at any time. Participant anthropometric measurements were recorded according to the protocol used in previous studies [1,9].

Apparatus and procedure for the experiment

During the training, each participant performed 3 sets of up to 10 repetitions [10-RM] daily with free weights for a week the biceps curl exercise with dumbbells. Each participant was given a two minute break, followed a succeeding 10-RM test. The speed of movement of workout was self-determined by the participants. However, the free weight was determined on the right arm using dumbbells [12]. Maximum grip development was tested before and after a biceps curl exercise. In addition, each participant was given a 5-minute break before measuring MVC grip strength after biceps curl exercise. In addition, the subject sat in a height-adjustable chair and adjusted the height of the chair according to the comfort of the subjects. Grip strength and endurance time were measured using an adjustable handle grip jammer dynamometer (model: G100; M/s Biometrics Ltd. UK) under all experimental conditions.

To record variables dependent on forearm posture, the subject sat in a height-adjustable chair with the forearm (supination, pronation and neutral), resting horizontally on a platform. The platform height is adjusted according to the elbow posture, trunk and shoulders. Subject's right arm was in the coronal plane with 0° abduction and maintaining a 90° - 120° elbow angle. In addition, the subjects squeezed the handle grip jammer dynamometer at its extreme capacity (twofold, with a rest of 2 minute prior to record the grip MVC) [1,9] till they felt unbearable discomfort and could not continue the exertion at the target level. The grip Jammer handle (model: G100; M/s Biometrics Ltd. UK) was interfaced directly using Data LINK software with a laptop. Thereafter, a rest of 5 minutes, measure the grip endurance time at 50% MVC (taking maximum value of the two tests) for further analysis. In addition, the forearm postures were randomly selected during the trials and a 2 minute rest was granted between each experimental condition.

Follow-up questionnaire

After the intervention, all subjects were asked to evaluate eight questions about individual perceptions of strength training using a 7-point Likert scale from 1 (= fully disagree) to 7 (= fully agree) [4]. The questions are listed below:

- Q1. I find it safer with my training partner during strength training.
- Q2. Strength training is fun.
- Q3. My training motivation has been greatly improved by strength training.
- Q4. I think strength training is very difficult.
- Q5. I will continue to do strength training in the future.
- Q6. Strength training makes my daily life easier for me.
- Q7. Proper care and good coaching are very important to me in strength training.
- Q8. Strength training builds confidence in my physical performance.

Data analysis

Table 1 and 2 summarizes data on MVC grip strength and endurance time of male and female participants in three levels of forearm posture before and after exercise. Multi-variate analysis of covariance was performed using IBM SPSS 25.0 to investigate the key factors and the impact of their interactions (Table 3) on the covariates.

Results

Effect on grip strength and endurance time by gender

Grip strength and endurance time differed significantly ($p < 0.001$) by gender and days of exposure before and after bicep curl exercise (Table 3). MVC grip strength was highest in the pronation forearm posture (male: 76.1 ± 11.3 kgf and female: 38.1 ±10.9 kgf) after FWST (Figure 1 and table 1). However, grip endurance time was highest in the pronation forearm posture in male participants (57.5 ± 13.5 seconds) and neutral forearm posture in female participants (43.9 ± 8.3 seconds) after FWST (Figure 2 and table 2). The highest grip strength and endurance time of female participants showed a decrease of 56.7% in supination and 28.3% in pronation respectively compared to that of male participants (Table 1 and 2).

		MVC grip Strength (mean ± SD) (kgf)			
		Male		Female	
		Before exercise	After exercise	Before exercise	After exercise
Fore-arm Posture	Supination	69.1 ± 13.3	71.6 ± 8.7	29.3 ± 8.8	32.4± 8.7
	Pronation	73.9 ± 12.2	76.1 ± 11.3	33.4 ± 9.2	38.1 ±10.9
	Neutral	68.6 ± 8.2	72.1 ± 13.1	29.4 ± 8.2	32.8 ± 8.1

Table 1: *The summary of data on MVC grip strength as a function of dependent variables.*

		Grip endurance time (mean ± SD) (seconds)			
		Male		Female	
		Before exercise	After exercise	Before exercise	After exercise
Forearm Posture	Supination	47.1 ± 10.3	55.6 ± 11.2	33.2 ± 9.3	40.8 ± 11.7
	Pronation	47.3 ± 12.8	57.5 ± 13.5	33.7 ± 9.9	41.2 ± 8.4
	Neutral	49.3 ± 11.3	55.9 ± 13.1	31.7 ± 7.6	43.9 ± 8.3

Table 2: *Summary of data on grip endurance time as a function of dependent variables.*

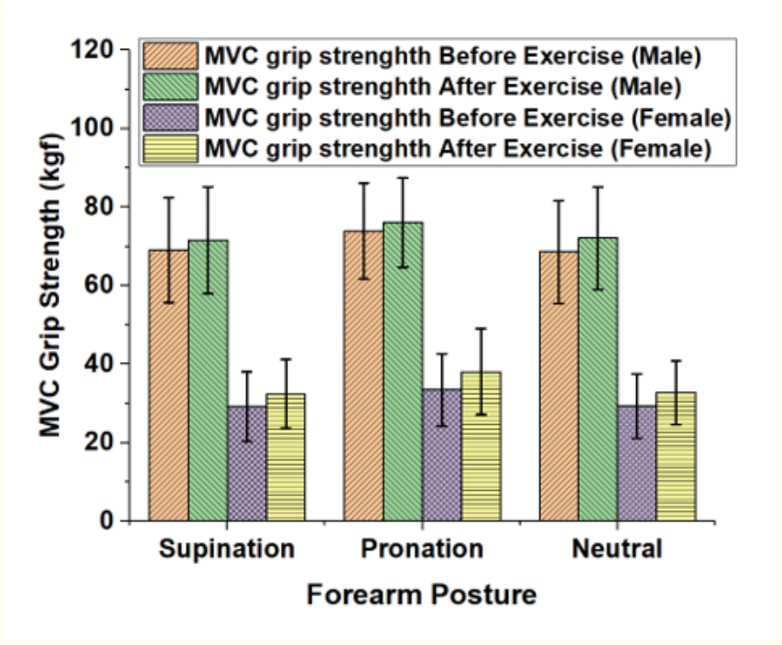

Figure 1: *MVC grip strength values in different forearm postures for both the participants.*

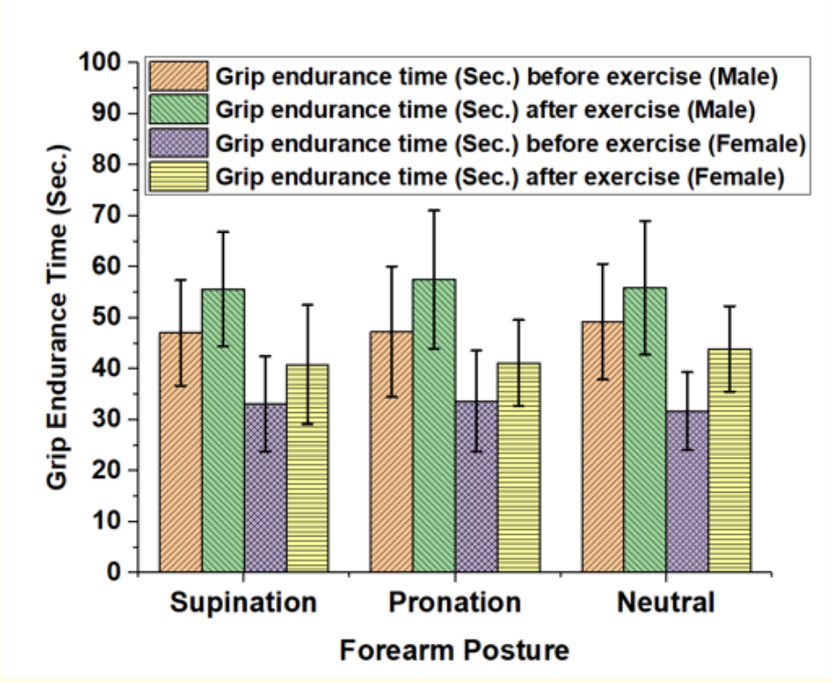

Figure 2: *Grip endurance time values in different forearm postures for both the participants.*

Effect on grip strength and grip endurance time by anthropometric variables

Age, weight, palm length and palm circumference ($p < 0.05$) had a significant effect on grip strength before and after the bicep curl exercise for both participants; however, grip endurance time was not significant affected by anthropometric variables (Table 3). In addition, results showed no significant effect of different levels of forearm posture on grip strength and grip endurance time.

		Dependent Variables			
		Before Exercise		After Exercise	
		Grip Strength	Grip Endurance Time	Grip Strength	Grip Endurance Time
Independent Variables	Gender	$p < 0.001$**	$p < 0.001$**	$p < 0.001$**	$p < 0.001$**
	Days of Exposure	$p < 0.001$**	$p < 0.001$**	$p < 0.001$**	$p < 0.001$**
	Forearm Posture	$p = 0.104$	$p = 0.988$	$p = 0.098$	$p = 0.826$
	Gender* Forearm Posture	$p = 0.967$	$p = 0.701$	$p = 0.962$	$p = 0.742$
Co-Variates	Age	$p = 0.003$*	$p = 0.541$	$p = 0.010$*	$p = 0.430$
	Weight	$p = 0.010$*	$p = 0.906$	$p = 0.009$*	$p = 0.430$
	FL	$p = 0.932$	$p = 0.793$	$p = 0.942$	$p = 0.635$
	FC	$p = 0.340$	$p = 0.967$	$p = 0.250$	$p = 0.462$
	PL	$p < 0.001$**	$p = 0.445$	$p = 0.002$*	$p = 0.254$
	PC	$p = 0.012$*	$p = 0.260$	$p = 0.037$*	$p = 0.160$

Table 3: *The summary of the results of multi-variate analysis of co-variance.*

*Note: **p < 0.001, *p < 0.05, FL-forearm length, FC-forearm circumference, PL-palm length, PC-palm circumference.*

Evaluation of the training

A follow-up survey analysis shows that the demand for proper care is increasing and proper coaching is very important for the safety of strength training. After that, strength training builds confidence in my fitness was rated higher. However, from the perception of a FWST partner, the fun, motivation, future, and benefits of everyday life are also highly valued. In, addition, exploratory factor analysis yielded four factors with factor loadings accounting for 72.6% of the variance of the eight questions ranging from 0.563 to 0.894. The Cronbach's alpha factor for this scale was 0.667.

Discussion

The purpose of current study was to determine the effectiveness of a week-long free weight strength training intervention for grip strength and endurance time in young adults. The result of the study showed that grip strength and endurance time differed significantly ($p < 0.001$) by gender and days of exposure before and after bicep curl exercise for both participants. In addition, consistent with current results, previous studies have shown that grip strength is higher in men than in women of comparable age groups [13-15]. In addition, with forearm pronation, MVC grip strength was significantly reduced compared to the neutral and supine forearm postures [16]. De Smet., *et al*. [17], also establish that the pronation showed weaker grip strength than neutral and supine postures in both men and women. However, present study shows that MVC grip strength was highest in the pronation forearm posture for both participants. However, grip endurance time was highest in the pronation forearm posture in male participants (57.5 ± 13.5 seconds) and neutral forearm posture in female participants (43.9 ± 8.3 seconds) after FWST.

Alam., *et al*. [10] showed that anthropometric factors such as palm length, forearm length and palm circumference had a significant effect on grip strength. Similarly, in the current study, age, weight, palm circumference and palm length ($p < 0.05$) was significantly affected the grip strength before and after bicep curl exercise in both participants. However, it does not significantly affect the grip endurance time. Nicolay and Walker [18] concluded that, unlike strength, anthropometric variability is independent of the grip endurance time. In addition, Wu., *et al*. [19] reported in a study of grip strength in 482 adults in Taiwan that age, gender and palm length had a significant differences on grip strength. Further, they added that gender and palm length after age are the most influential factors influencing grip strength. Lee and Hwang [13] presented that grip strength was statistically different by posture, gender and dominant hand. In line with current findings, Alam., *et al*. [1] also presented that age and palm length were significantly affecting grip strength, with palm length being the greatest decisive factor on grip strength ($r = 0.357$, $p < 0.001$). In addition, the follow-up questionnaire used is not a validated tool, but a closer look at the results provides interesting insights. Evaluation of the follow-up questionnaire shows highest rating for proper care and proper coaching is very important for the safety of strength training. After that, strength training builds confidence in my fitness was rated higher. Therefore, high degrees of freedom can increase the risk of injury and generally require proper care and safety.

Conclusion

I can be concluded that grip strength and endurance time are affected by gender and anthropometric variables. Therefore, anthropometry and posture-related strength data are vital for clinical and engineering applications. In addition, free weight strength training may improve grip strength and endurance time with respect to exposure days for both participants.

Limitations and Future Scope

This study did not examine the effects of different age groups on hand grip strength. Future studies may gather grip strength data from a different range of age groups. Second, the effects of hand dominance (left and right hands) were not taken into account. Future studies may use the same number of left-handed and right-handed subject groups to investigate the effects of hand dominance.

Conflict of Interest

None to report.

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