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THE INFLUENCE OF LOADING DURING FORWARD LUNGE EXERCISE TRAINING ON STRENGTH, POWER AND AGILITY

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ABSTRACT

This study was conducted to determine and compare the effects of low loads (30% 1RM) versus high loads (70% 1RM) forward lunge exercise training on physical abilities. Thirty recreationally active, resistance-untrained men (mean age = 22.21 ± 1.59 years old) were recruited and divided into two training groups that were 30% 1RM forward lunge (30FL) and 70% 1RM forward lunge (70FL) and a control group (CG). Lunge 1RM, vertical jump, standing broad jump and agility t-test were tested pre and post training intervention as indicators of physical abilities. Results showed both treatment groups (30FL and 70FL) had significantly greater scores in all tests compared to CG during the post-test. 70FL had significantly higher improvement in 1RM lunge compared to 30FL group. However, the improvement for the vertical jump, standing broad jump and agility-t-test were found to be significantly greater in the 30FL. Results demonstrated the importance of training loads in determining the adaptations obtained.

Keywords: Loadings, forward lunge, physical abilities, untrained

INTRODUCTION

As a way to enhance performance in sports, apart from in-field or in court training, athletes are recommended to adopt strength training into their training routine. Resistance training was vastly found to help individuals to achieve positive adaptation such as improvement in strength (Kadir et al., 2014; Schoenfeld et al., 2014; Shultz et al., 2015; Manolopoulos, Gissis al., 2015) and agility (Johnson et al 2013; Sole et al., 2013).

The concept of specificity in training has received considerable mention and attention over the past decade (Fleck & Kraemer, 2014). Thus, it is important to analyse the movements been performed in a specific sport as the more similar the training activity is to the actual sport movement, the greater the likelihood of positive carryover to performance (Fleck & Kraemer, 2014; Nadzalan et al 2018; Nadzalan et, al.,2017). As most movements in sports involve an athlete to do a forward step so that one foot is in front of the other lunge was suggested to be one of the most frequently performed movement in sports.

Research on the chronic effects of lunge as single exercise training was not well established (Nadzalan et al., 2017; Nadzalan et al., (2018). It is important to note that strength training need to be well planned as it has been shown that different training programs might stimulate different adaptations (Nadzalan et al., 2017; Earp, 2013; Bloomquist et al., 2013; Farup et al.,2012; Nadzalan et al., 2016; Nadzalan et al., 2018).For example, study by Jönhagen et al (2009) have found that six weeks training with walk forward lunges improved hamstring strength, whereas training with jump forward lunges improved sprint running performance. Our previous study (Nadzalan et al., 2017) found that jumping forward lunge increased muscle thickness, pennation angle and fascicle length to a greater extent compared to step forward lunge.

One of the variations that could be implemented is by manipulating the loadings carried or lifted during the exercise. Different loadings can cause different movement biomechanics, and this might affect the body adaptation (Nadzalan et al., 2018; Nadzalan et al., 2017). Higher loadings will cause the movement to be slower while lower loadings will cause the movement to be faster (Mohamad et al., 2014). In several previous studies, a low load, high volume training program has been shown to improve sprint time performance in the 40 m and increase vertical jump test performance (Chelly et al., 2010; Chimera et al., 2004).

Several previous studies have also shown the effectiveness of low load, high volume training in improving sprint time in a 100 m sprint or a 40-yard shuttle run when compared to, or in combination with, a high resistance training program (Delecluse et al.1995; Faigenbaum et al., 2007. In spite of that, some previous comparative studies showed high-intensity programs were more conducive for increasing strength (Schoenfeld et al., 2014; Brandenburg & Docherty, 2002; Mangine et al., 2015).

It is currently unknown how the body adapts to different loadings during lunge exercise training, and this will cause uncertainty in choosing the right loadings to be implemented during training. Thus, it is the aim of this study to determine and compare the effects of low loads (30% 1RM) versus high loads (70% 1RM) forward lunge training on lunge 1RM, agility and jumping abilities.

METHODOLOGY

Sampling

Thirty (N = 30) recreationally active, untrained men, free from injury (mean age = 22.21± 1.59 years old) were recruited as study participants. Participants were screened prior to testing using PAR Q and had read and signed an informed consent for testing and training.

Procedure and Instrumentation

Participants were divided into three groups: i) 30% 1RM (30FL), ii) 70% 1RM (70FL) and iii) control group (CG). 30FL groups were required to perform the lunge training with 30% of their 1RM while 70FL were required to perform the lunge training with 70% of their 1RM lunge value that were obtained during the pre-test. All the participants performed the training for three sessions per week for eight weeks. To make sure the total work performed were the same between both training groups, during each session, participants in 30FL groups were required to performed six sets consisting of 14 repetitions per set (7 for each lower limb) while participants in 70FL were required to performed three sets consisting of 12 repetitions per set (6 for each lower limb). All the movement performed was required to be as fast as possible to mimic the real demands in sports action. Figure 1 shows the steps for 30FL and 70FL training. Participants were instructed to stand with their hands holding a weight loaded barbell consisting of 30% or 70% 1RM placed on their shoulder, feet shoulder width apart. Participants lunged forward with the dominant foot and lowered the thigh to be parallel with the ground, and then returned back to the starting position. The trunk was maintained straight.

Physical Activity

During this study, multiple-RM test was conducted as a way to predict 1RM score (Baechle & Earle, 2008). Participants were required to lift a load that they estimate can perform 8- RM. If the participants were able to lift more than 8RM, the load was increased 10% to 20% of that load based on the agreement of both participant and the instructor. Using vertical jump equipment, (Vertec, USA), participants were requiredto jump up and touch the highest possible vane. The jump height was measured as the difference between standing height and jumping height. Standing broad jump was used to measure horizontal jump among participants. Using standing broad jump mat (Trident, Malaysia), participants started withstanding behind a line marked with feet slightly apart. Participants were asked to jump as far as possible, landing on both feet without falling backwards. Agility t-test was conducted as a measure of agility. Four cones were set up and participants needed to run and touched all the cones. Three trials were given for the vertical jump, standing broad jump and agility t-test and the best score was taken.

Data Analysis

Descriptive statistics were used to measure the mean and standard deviation of the scores. Repeated measures multivariate analysis of variances (MANOVA) was used to examine differences in lunge 1RM, vertical jump, standing broad jump and agility t-test in the pre- and post- intervention within groups and the percentages changes between groups. Statistical significance was accepted at an α-level of $p \leq 0.05$. All statistical analyses were conducted using SPSS version 23 (IBM, New York, USA).

Statistical Analysis

Statistical significance was accepted at an α-level of $p \leq 0.05$. All statistical analyses were conducted using SPSS version 23 (IBM, New York, USA).

RESULTS

Descriptive Statistic

Table 1 showed the physical characteristics of participants which indicates average age of the participants 22 years old, body mass (kg) for pretest average 68.53 kg and posttest 69.95 kg. Height of participants average 170.46 cm.

Table 1. Physical characteristics of participants

Variables	Mean ± SD
Age (Years)	21±0.83
Body Mass (kg)	71.00 ± 1.88
Body Weight (N)	696.57 ± 33.08
Height (cm)	171.41 ± 2.55
1RM (kg)	70.97 ± 6.57
(1RM/BM)	1.00 ± 0.05

Table 2 showed the pre and post-test data of the physical abilities' variables investigated in this study. Analysis on each group had shown that significant main effects were found for all physical performances data for 30FL thus showed that 30FL group has managed to significantly improved in all tests in the post test when compared to the pre-test: i) lunge 1RM, $F(1,9) = 1417.469$; $p < 0.001$, ii) lunge relative 1RM, $F(1,9) = 330.484$; $p < 0.001$, iii) vertical jump, $F(1,9) = 283.500$; $p < 0.001$, iv) standing broad jump, $F(1,9) = 3240.101$; $p < 0.001$ and agility, $F(1,9) = 783.871$; $p < 0.001$. Similar to the 30FL group, significant main effects were also found in all the physical performance test among 70FL group thus showed 70FL group has also improved in all tests: i) lunge 1RM, $F(1,9) = 778.702$; $p < 0.001$, ii) lunge relative 1RM, $F(1,9) = 213.072$; $p < 0.001$, iii) vertical jump, $F(1,9) = 202.500$; $p < 0.001$, iv) standing broad jump, $F(1,9) = 1521.000$; $p < 0.001$ and agility, $F(1,9) = 567.707$; $p < 0.001$. No significant main effects were found thus showed no significant difference of performance were recorded by the control group (CG): i) lunge 1RM, $F(1,9) = 0.578$; $p > 0.05$, ii) lunge relative 1RM, $F(1,9) = 0.811$; $p > 0.05$, iii) vertical jump, $F(1,9) = 5.492$; $p > 0.05$, iv) standing broad jump, $F(1,9) = 2.818$; $p > 0.05$ and agility, $F(1,9) = 1.499$; $p > 0.05$. Pairwise comparison has shown that both treatment groups (30FL and 70FL) had significantly greater score in all performance tests compared to control group, $p < 0.001$ in the post-test. 70FL had significantly higher improvement in lunge 1RM ($p < 0.001$) and lunge relative 1RM ($p < 0.001$) while 30FL was shown to have significantly greater gains in vertical jump ($p < 0.01$), standing broad jump ($p < 0.001$) and agility ($p < 0.001$).

Table 2. Pre- and post-test scores

Tests		30FL	70FL	CG
Lunge 1RM (kg)	Pre-test	69.15 ± 3.98	68.98 ± 4.33	69.51 ± 4.11
	Post-test	80.03 ± 3.68*	83.69 ± 2.92*	69.34 ± 4.74
	% Differences	15.81± 1.87^{bc}	21.52 ± 3.51^{ac}	-0.29 ± 1.01^{ab}
Lunge 1RM (relative)	Pre-test	1.00 ± 0.01	1.01 ± 0.02	1.01 ± 0.01
	Post-test	1.13 ± 0.02*	1.19 ± 0.03*	1.01 ± 0.02
	% Differences	12.35 ± 2.26^{bc}	17.91 ± 4.06^{ac}	-0.30 ± 1.03^{ab}
Vertical jump (cm)	Pre-test	41.30 ± 1.42	42.60 ± 1.58	43.00 ± 1.25
	Post-test	45.50 ± 1.18*	45.60 ± 1.17*	41.80 ± 0.79
	% Differences	10.21 ± 2.15^{bc}	7.09 ± 1.79^{ac}	-2.71 ± 3.64^{ab}
Standing broad jump (cm)	Pre-test	2.42 ± 0.05	2.43 ± 0.05	2.43 ± 0.05
	Post-test	2.60 ± 0.05*	2.57 ± 0.05*	2.39 ± 0.05
	% Differences	7.39 ± 0.47^{bc}	5.89 ± 0.50^{ac}	-1.25 ± 2.36^{ab}
Agility t-test (s)	Pre-test	10.95 ± 0.31	11.07 ± 0.21	10.82 ± 0.34

	Post-test	10.05 ± 0.27*	10.39 ± 0.16*	11.19 ± 0.55
	% Differences	-8.21 ± 0.81[bc]	-6.13 ± 0.74[ac]	12.60 ± 1.68[ab]

[a] = significantly different from 30FL
[b] = significantly different form 70FL
[c] = significantly different from CG
* = significantly different from pre-test

DISCUSSIONS

In this study, participants underwent eight weeks of either high (70% 1RM) or low (30% 1RM) loadings forward lunge exercise training. Multiple lunge repetition maximum test was conducted before and after eight weeks of training as a predictor of lunge one repetition maximum (lunge 1RM). The lunge 1RM was also calculated relative to participants' body mass.

Findings indicated that 8 weeks of higher-intensity, lower-volume lunge training (70FL) training stimulated significantly greater lunge 1RM compared to the lower intensity, higher-volume lunge training (30FL) in resistance-untrained men. This showed that training with greater forces production activity might cause muscle to adapt and have greater capability to lift more loads. These results are consistent with previous comparative studies showing high-intensity programs were more conducive for increasing strength (Schoenfeld et al., 2014; Brandenburg & Docherty, 2002; Mangine et al., 2015). Changes in strength are generally thought to be the result of a combination of neurological activation and skeletal muscle adaptation (Moritani,1979). Initial strength gains in previously untrained individuals have been associated with neurological adaptations that involve a more efficient activation pattern of activated musculature (Moritani,1979).

Strength gains between groups were consistent with the concept of a strength- endurance continuum (Weiss et al., 1999). Although 30FL did increase maximal muscle strength, 70FL resulted in greater increases in both lunge 1RM and relative lunge 1RM. The observation of increased improvement in strength with higher training loads is consistent with other comparisons of high- versus low-load training (Mitchell et al., 2012; Rana et al., 2008).

Multiple meta-analyses have identified that peak gains in strength occur with training above 60%-1RM in both trained and untrained individuals, although the optimal intensity needs to be greater for the trained individuals (Peterson et al., 2004; Peterson et al., 2005; Rhea et al., 2003). Additionally, this finding was in contrast to the notion that high loads were vital in improving maximal strength. Thus, just having intention to go explosive without heavy loads is adequate to increase strength although as not as effective as performing with heavier loads.

Vertical jump (VJ) and standing broad jump (SBJ) were conducted as jumping performance assessment and were compared between pre- and post-training interventions and between groups. Results showed that both treatment groups (30FL and 70FL) significantly improved their jump assessments in the post test and had significantly greater score in both jump assessments compared to control group, $p < 0.001$. 30FL had significantly greater improvement in both jump assessments compared to 70FL. Results demonstrated that 30 FL was more effective compared to 70FL. This was an interesting finding as the 30FL group did not lift as heavy as the 70FL group and the strength gains were significantly less compared to 70FL. 30FL training might be more effective as 30FL training in this study enables participants to move faster and might be more explosive. Thus, this condition might cause the body to still have explosive adaptation and have greater adaptation in producing greater jumping performance. Following training, both training groups in this study managed to improve vertical jump height and standing broad jump distance. Although training performed by 70FL was not as fast and explosive as 30FL, the stimulus was sufficient at eliciting similar changes to jump performance. This finding was in line with what has been found by Cormie et al., (2007) that found the effectiveness of less volume of power training (strength-power training) that was effective in improving maximum jump height and maximum power output in the jump squat and elicited greater improvements in jump height and power output through a wide range of loads in the jump squat compared to power training.

The agility t-test was conducted as agility performance assessment and was compared between pre- and post-training and between groups. Results showed that both treatment groups (30FL and 70FL) had significantly improved their agility performance and had greater score compared to control group, $p < 0.001$ in the post-test. 30FL had significantly greater improvement in agility compared to 70FL, $p < 0.001$.Results demonstrated that 30FL was more effective compared to 70FL in improving agility performance. This can be related to the principle of specificity in which training specific to the skills will be more effective. The fast movement performed during 30FL was taught to cause some neuromuscular adaptation for the joints and muscle to have faster contraction velocity thus enabling their body to adapt for faster movement. This finding contrasted with the several previous research that found low load training were no difference and some even found it to be more advantages for sprint and jump performance (Chelly et al., 2010; Chimera et al., 2004; Delecluse et al., 1995; Faigenbaum et al., 2004; Cormie et al., 2007). This finding urges future study to be conducted on different effects of exercises selection and loading lifted towards the physical abilities.

CONCLUSIONS

Results demonstrated the superiority of high load compared to low load lunge training in enhancing strength while low load was more effective in enhancing jumping and agility performance. Despite the superiority of high loading training on strength, practitioners were still advised to start their training program with low loads and proceed to greater loads after certain period of time. This is due to high kinetics and physiological demands of high load training which might impose greater risk of injury if performed without sound strength basis.

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DECLARATION OF CONFLICTING INTERESTS

Regarding the research, writing, and/or publishing of this paper, the authors reported that they had no possible conflicts of interest.

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