行政院國家科學委員會專題研究計畫　成果報告

下肢肌力強化訓練運動劑量最佳化之研究

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ABSTRACT

Background and Purpose. One repetition maximum (1RM) for leg press is used to be a clinical reference for resistance training of lower extremities. However, the Western standard was built on “bilateral” leg press test from “full” hip and knee joint flexion to extension regardless of race and clinical application. **Subjects and Methods.** Two hundred and twenty healthy sedentary volunteers(105 males and 115 females) aged 20-80 years old and 17< BMI< 31 performed as many repetitions of unilateral leg press from 90˚knee flexion to extension as possible. **Results.** 1RM strength for leg press was correlated with body weight, age and gender (p<.05). The regression equation was: unilateral 1RM= 8.6+ 1.0 x BW (kg)- 8.3 x Age (1-3, representing 20-39, 40-59, 60-80 y/o, respectively) + 10.2 x Gender (female=1, male=2), R^2=0.74 .**Discussion and Conclusion.** The ability to perform leg press increases with weight, decreases with increasing age, and females do not perform as well as males. The present study provides a more realistically reference for clinical applications.

Key words: One repetition maximum, leg press, lower extremity strength

INTRODUCTION

Resistance training has been shown to be one of the most effective methods for strength training of lower extremities. It can not only promote the strength of lower extremities, but also improve the functional performance of jumping and running in the youth. In addition, it could help the elderly to maintain or increase cardiopulmonary fitness, prevent cardiovascular disease, improve muscle strength, maintain joint flexibility and walking balance, prevent falls, decrease anxiety, depression, and promote their social activities, as well as quality of life.

One repetition maximum (1RM) for leg press is used to be a clinical reference for resistance training of lower extremities. According to the past research report, it was proved that the 1RM of male or female was related to their weight. However, the Western standard was built on bilateral leg press test from full hip and knee joint flexion to extension. It is hard for therapists to apply it to clinic directly, because the body figures, life styles, and exercise habits of people in Taiwan differ from Easterners. And bilateral leg press is not suit for unilateral injured case, because therapists can not know how much effort the affected side does make, and can not control the appropriate training dosage also. Furthermore, leg press from full hip and knee joint flexion to extension is not suit for some case such as patients with

patellofemoral pain syndrome, because the joint stress increases gradually with increasing knee flexion angles in closed kinetic chain exercise. And it is also hard for elderly people to make effort in such a situation that full flex the hip and knee joints.

In order to approach a more realistically assessment of leg-press 1RM strength for further clinical uses, the purpose of the present study was to investigate unilateral 1RM strength for leg press from 90° knee flexion to extension in different genders and age groups.

METHODS

Participants

Healthy participants aged 20 to 80 years old without lower limb lesions or injuries involving hip, knee, or ankle joints, and free of low back pain and cardiopulmonary diseases were recruited from Taipei city, Taiwan using advertisement. The exclusion criteria were inability to walk continuously more than 30 minutes without joint pain, or preservation of less than 70% range of motion of hip, knee, or ankle joint, or being engaged in some regular exercise (defined as physical activity at least three times per week, and exercise of more than 15 min after warm-up exercise), or BMI$\geqq$31,$\leqq$17. The reason to exclude people with regular exercise habits and abnormal BMI are that only 20.5% people in Taiwan exercise regularly and people with abnormal body figures are relatively smaller population than usual ones. Thus we think they can not present mostly healthy people in Taiwan.

All participants were volunteered to participate in this study. Initially 240 healthy participants (113 males and 127 females) were recruited. Subsequent exclusion were based on an inability to walk continuously more than 30 minutes without joint pain (n=4), presence of regular exercise habits (n=11), and BMI$\geqq$31 or $\leqq$17(n=5). Finally a total of 220 participants (105 males and 115 females) involved in the study.

All participants aged 20 to 80 years old were initially recruited from 6 decades. Since no statistical differences of leg-press 1RM strength were found between these adjacent decades (p>.05), all participants were than re-grouped into 3 groups: 20-39, 40-59 and 60-80 for further statistical analyses.

Measurement of 1RM strength for leg press

We used EN-Dynamic Track leg press machine for 1RM strength measurement. The initial testing position was sitting with 90˚knee flexion with foot on force plate and hands on the seat's handles. We defined leg press movement as forward and backward movement, indicating knee flexion to full extension, than back to initial position. The dominant limb and non-dominant limb were tested by climbing stairs then tested for 1RM in a random order. The initial resistance setting depended on the gender and age of the participants. For male participant, the resistance was set at 1.0, 0.8, 0.6 times of their body weight, and 0.9, 0.7, 0.5 times of body weight for female participants. All participants were encouraged to do their best to repeat unilateral leg press continuously with the first second and the following second pressing the leg forward and backward until they could press no more ones or failed to complete a full range of motions again, thus the test discontinued. In addition, during the test the therapists would remind the participants to avoid Valsalva maneuver and forcefully lock out the

knees during extension. Finally, the resistance loadings and repetition times of each participant were recorded for 1RM calculation using Holten Diagram.

To assess the intra-rater reliability of these measurement protocols, 16 participants were repeatedly measured 3 to 5 days apart. The ICC value was 0.98, suggesting a high intra-rater reliability of 1RM strength for leg press test.

Statistical Analyses

SPSS 11.0 software was used for the statistical analyses. Descriptive statistics were used to depict the subjects' characteristics, such as age, body height, and body weight. 3x2 two-way independent ANOVA was used to compare gender and age differences in 1RM strength. The significant level was set at α =.05. If any significance was found *post hoc* comparisons were further tested with Bonferroni adjustment. The stepwise regression was then performed to analyze the association of 1RM strength with gender, age, body height (BH), body weight (BW), body mass index (BMI), and limb dominance to find out the relationships.

RESULTS

Table 1 presents the demographic information of the healthy participants. Among all participants 96.8% were right-leg dominant. The normalized 1RM strength for leg press was presented as 1RM/BW of dominant or non-dominant limb for further comparison between participants. There was no significance between limbs (p>.05), and the unilateral 1RM strength for leg press in different genders and age groups were shown in Table 2. Female participants' unilateral 1RM strength were about 1.2, 1.1, and 1.0 times of their body weight for 20-39, 40-59, and 60-80 age groups while male participants' were about 1.3, 1.2, and 1.1 times of body weight.

----------Insert Table 1 and Table 2 about here----------

Figure 1 and Figure 2 present the gender and age differences in unilateral 1RM strength for leg press. Female participants' 1RM strength were always less than those of male participants despite the age (all p<.05). And 1RM strength decreased with increasing age in both female and male groups (all p<.05).

----------Insert Figure 1 and Figure 2 about here----------

The means and standard deviations (SD) of unilateral 1RM strength for leg press were then used for grading strength value into 5 grades: excellent, good, average, fair, and poor. We defined average grade as mean value plus or minus a SD (mean±SD), good and fair grade as mean value plus or minus 1 SD to 2 SD, excellent and poor grade as above or below mean value plus or minus 2 SD, shown in Table 3.

----------Insert Table 3 about here----------

Stepwise regression analysis showed that unilateral 1RM strength for leg press was correlated with body weight, age and gender (p<.05). The regression equation was: unilateral 1RM= 8.6+ 1.0 x BW (kg)- 8.3 x Age (1-3, representing 20-39, 40-59, 60-80 y/o, respectively) + 10.2 x Gender (female=1, male=2), R^2=0.74 .

DISCUSSION

The present study reveals the performance of unilateral leg press from 90° knee flexion to extension in healthy adults. We recognize the unilateral 1RM strength for leg press in different genders and age groups. These values provide therapists some information while comprising with clinical patients or frail elderly.

Our finding that there was no significance between dominant and non-dominant limbs in 1RM strength for leg press was consistent with previous studies that had reported no differences between torque, maximal power and endurance generated by left and right knee extensors and flexors. Although the previous studies used the isokinetic machines and tested only a single muscle group of lower extremities that differed from our study that measured the closed kinetic chain performance of multiple muscle groups of lower extremities that was more closely to our life style, we got the same results that the dominant limb tended to be better than the non-dominant limb in functional use, but not in exertion performance for a short time.

In general, muscle strength differs in men and women, and weakens with increasing age due to different muscle structure and function. The present study results supported these finding. We also found that there were no differences of leg-press 1RM strength

between adjacent decades that the same as another study that tested the strength of the ankle plantar flexors using manual muscle test. There were two common sides of these two tests, first we both tested the anti-gravity muscle groups of lower extremities, and second both studies gave their participants a constant load to test the repetition times as the results to calculate strength performances, thus the outcomes are reasonable and acceptable .

The present study first used the unilateral leg press test from 90° knee flexion to extension to test the 1RM performance because the practical concerns in clinic. Due to the effects of unilateral limb performance, different joint position angle, race and culture, we could not compare our study results with the reported values of other studies directly. However we build a new reference for Easterners. We can estimate one's leg 1RM strength by regression equation and grading of his or her strength for further comparison with people in the same age group and with the same gender. When generating the results to populations, there is a caution that they might meet some criteria such as sedentary lift style and normal body figures (17< BMI< 31), this is also the area where we can make further efforts to establish the normative data for different populations.

CONCLUSION

“Unilateral” 1RM strength for leg press “from 90° knee flexion to extension” provide clinicians to view the 1RM performance of lower extremities more practically.

Leg-press 1RM strength was varied with body weight, age and gender. The ability to perform leg press increases with weight, decreases with increasing age, and females do not perform as well as males. The present study provides a more realistically reference for clinical applications.

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Table 1.

Demographic Data of Study Participants (mean±SD)

Subjects	N	Age (yr)	Body height (cm)	Body weight (kg)
20-39y/o				
Male	38	27.9±5.2	171.6±5.4	69.0±10.0
Female	39	26.4±4.2	160.4±5.9	52.8±7.5
40-59y/o				
Male	35	50.6±6.1	171.2±4.7	72.7±8.9
Female	39	52.7±4.4	156.1±3.9	56.6±6.8
60-80y/o				
Male	32	68.2±5.0	165.0±5.9	65.5±9.1
Female	37	66.8±5.0	155.1±4.6	56.8±5.4
Total				
Male	105	47.8±17.4	169.4±6.1	69.1±9.7
Female	115	48.3±17.4	157.2±5.4	55.4±6.8

Table 2.

Unilateral Leg-Press 1RM /BW in Males and Females among Three Age Groups

	Male (mean±SD)	**Female (mean±SD)**
20-39y/o	1.37±0.12	1.20±0.17
40-59y/o	1.22±0.14	1.11±0.18
60-80y/o	1.08±0.17	0.97±0.19

Table 3.

Grades of Unilateral Leg-Press 1RM /BW in Males and Females among Three Age Groups

	Male			**Female**		
	20-39y/o	**40-59y/o**	**60-80y/o**	**20-39y/o**	**40-59y/o**	**60-80y/o**
Excellent	>1.61	>1.50	>1.42	>1.54	>1.47	>1.35
Good	1.50-1.61	1.37-1.50	1.26-1.42	1.38-1.54	1.30-1.47	1.17-1.35
Average	1.25-1.49	1.08-1.36	0.91-1.25	1.03-1.37	0.93-1.29	0.78-1.16
Fair	1.13-1.24	0.94-1.07	0.74-0.90	0.86-1.02	0.75-0.92	0.59-0.77
Poor	<1.13	<0.94	<0.74	<0.86	<0.75	<0.59

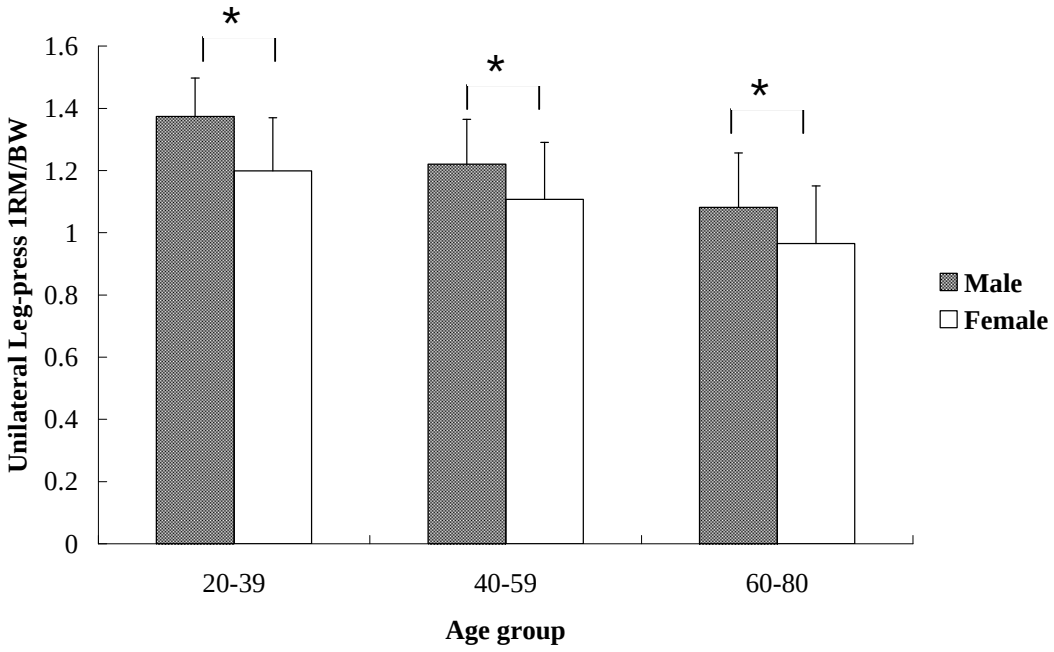

Figure 1.

Gender Differences in Unilateral Leg-Press 1RM /BW among Three Age Groups

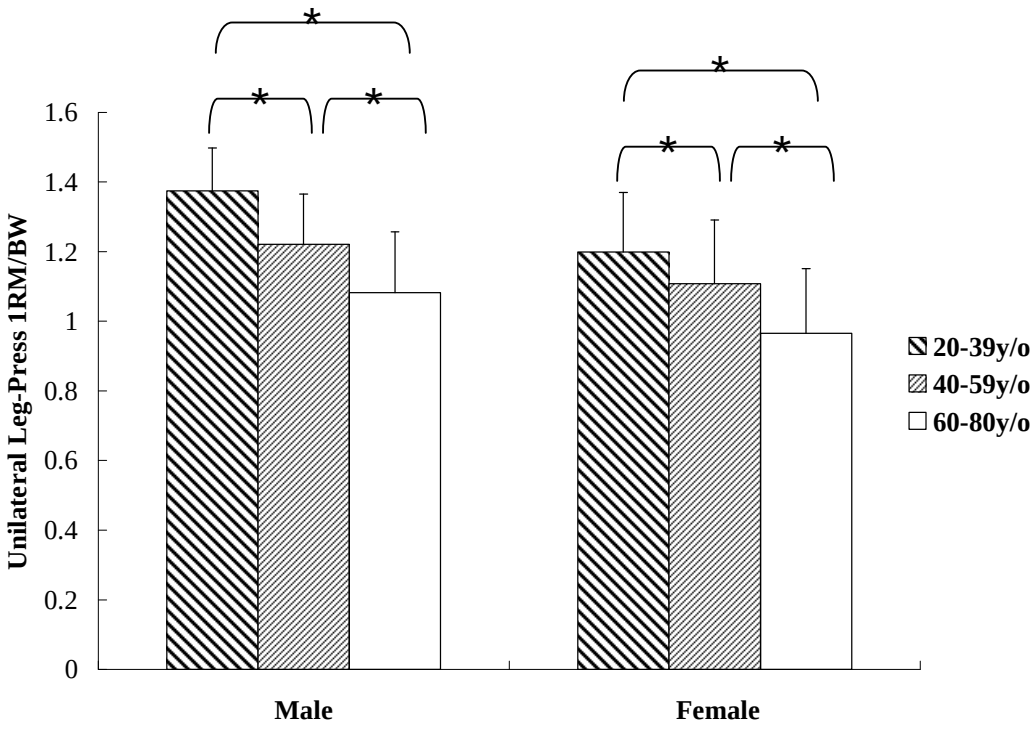

Figure 2.

Age Differences in Unilateral Leg-Press 1RM /BW among Male and Female Participants