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Effect of Difference in Warm-Up Intensity During 75%1RM Bench Press Exercise on Number of Repetitions, Total Work, and RPP

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Abstract

The purpose of this study was to investigate the effect of the intensity of warm-up exercise on the physiological response and exercise performance during resistance exercise. For this purpose, 8 male college students with at least 1 year of experience in resistance movement were selected. The warm-up condition was set to NON condition (preparatory exercise not performed), 3 set condition, 6 set condition, and 9 set condition, and the intensity was different for each set. After warm-up, 75% 1RM of main exercise was performed, and blood pressure and heart rate were measured immediately after exercise to measure RPP. The number of repetitions and total work for each condition were measured as the number of repetitions and momentum during the main exercise. The measured data were analyzed by repeated measures two-way ANOVA. As a result, although there was no difference in Rate Pressure Product according to the warm-up conditions, the number of repetitions and total amount of exercise showed the highest in the 3-set condition. Therefore, it is thought that the number and intensity of warm-up exercises should be set appropriately during resistance exercise, and warm-up of 3 sets or more during resistance exercise is thought to decrease exercise performance.

Keywords: *Resistance Training, warm-up, Total Work, Rate Pressure Product(RPP)*

1. Introduction

In general, Warm-Up(WU) exercises increase body temperature by activating the functions of the respiratory and circulatory system by securing the flexibility of major joints in the body. WU exercise is an essential process that must be properly performed before various physical activities such as competitions or training. It physiologically stimulates the central nervous system to increase the heart rate and respiration volume, thereby activating the regulation of the autonomic nervous system and increasing the internal temperature of the muscles. It increases the flexibility and elasticity of the joints and facilitates the blood supply to the extremities of the body so that the muscles can exert greater force by supplying nutrients and removing wastes [1]. In other words, WU exercise before exercise is recognized as an important factor in preventing injuries as well as having a positive effect on exercise performance by flexing nerves and muscles and facilitating the respiratory circulation system activity [2, 3].

As such, WU is an important exercise process that must be performed before exercise, and it is known that

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when it is performed at an appropriate intensity, it has a positive effect on not only exercise performance but also the body's reaction. [4] reported that the WU group showed a positive response as a result of comparing the heart rate and blood lactate concentration by dividing the WU group and the control group. [5] showed that the appropriate intensity and time of WU had a positive effect on improving muscular endurance, muscle power, and muscle strength, and[6] measured ventilation and heart rate during running to investigate the effect of WU intensity on exercise performance. As a result, the ventilation rate 1 minute before the main exercise was 50-60% of the maximum ventilation and the intensity of 70-80% of the maximum heart rate was the most positive for exercise performance. As a result of comparing muscle function after WU at the % and 50% levels, it was reported that the intensity of 30% of the maximum oxygen intake was the most effective [7]. As such, various positive effects of WU exercises have been identified and are used in various ways in the sports field. In addition, it is recommended to perform a combination of aerobic exercise, stretching, resistance exercise(RE), and sports specific exercise according to the type of physical activity to be performed for WU exercise [8], Resistance WU exercises are being emphasized to improve strength [2]. In addition, WU exercise increases blood flow to the skeletal muscle and raises the temperature of the muscle to induce a positive physiological change in this exercise [9].

The improvement in performance after resistance WU is related to Post-Activation Potentiation (PAP)[10], which increases muscle strength expression due to muscle contraction during WU [11]. In addition, it is related to the activation of biochemical functions such as phosphorylation of Myosin Light Chain, increase in Ca sensitivity and concentration [12], and changes in muscle structure such as increase in the length and right angle of the muscle fiber bundle [13].

In a previous study on the intensity of WU exercise through RE, [14] reported that 80-90% 1RM intensity was performed, and [15] reported that performance improvement was found with 65% 1RM WU bench press. [16] reported that as a result of performing back squats using three strengths of 56% 1RM, 70% 1RM, and 93% 1RM, the vertical jump was increased by post-activation synergy at the strengths of 70% 1RM and 93% 1RM. reported to be as mentioned above, it seems that studies on the intensity of WU during weight training, stretching methods, and aerobic WU have been conducted in various aspects. However, studies considering the difference between the intensity of WU exercises and the number of sets for weight training are insufficient. Therefore, in this study, considering the difference in WU intensity and number of sets, the effect of 75% 1RM bench press exercise on Total Work(TW) and Rate Pressure Product(RPP)was investigated, and the appropriate number of WU sets before weight training was presented.

2. Experiment Materials and Methods

2.1 Subject

The subjects of this study were eight male college students who were enrolled in the physical education department of C and D University. Subjects were selected as those who had no health problems as a result of the medical examination, had more than 6 months of weight training experience, and were familiar with the contents and methods of the exercise test in advance. In addition, they fully understood the significance of this study, and voluntarily expressed and signed the consent form for research on human origins. The characteristics of the subjects are as shown in Table 1.

Table 1. Subject characteristics

	Age(yr)	Weight(kg)	Height(cm)	Career(month)
N=8	23.5±4.14	76.3±15.13	176.4±3.81	27.32±12.36

2.2 Study design

In this study, as a preliminary test, the subjects measured the strength of the bench press 1RM and the number of repetitions of 75% of the 1RM weight. There were 4 types of WU exercises before performing the bench press with 75% 1RM weight. During WU, the number of repetitions per set was the same as the number of repetitions performed during the 75% 1RM measurement in the pre-measurement, and the rest time between

sets was set to 2minutes. The type of WU was ① NON set, ② 3 sets, ③ 6 sets, and ④ 9 sets. The RPP was calculated by measuring blood pressure and heart rate before the main exercise (75% 1RM bench press) under all conditions, and blood pressure and heart rate after the end of the main exercise. The total amount of exercise was measured by multiplying the number of repetitions of this exercise according to each condition and the subject's 75%1RM weight.

2.3 How to perform bench press WU exercises for each condition

NON WU condition is without WU, 3 sets WU condition is [75% 30% of 1RM] × [75% 50% of 1RM] × [75%, 70% of 1RM], 6 sets WU condition is 【75% 30% of 1RM】×【75% 40% of 1RM】×【75% 50% of 1RM】×【75% 60% of 1RM】×【75% 70% of 1RM】×【75% of 1RM 80%] in that order, the 9 sets WU condition is [75% 10% of 1RM] × [75% 20% of 1RM] × [75% 30% of 1RM] × [75%, 40% of 1RM] × [75 % 50% of 1RM]× 【75% 60% of 1RM】×【75% 70% of 1RM】×【75% 80% of 1RM] ×【75% 90% of 1RM】 Afterwards, 75% 1RM bench press was used as the main exercise. The implementation method for each condition is shown in Figure 1.

Type1	75% 1RM								
Type2	30% of 75% 1RM	50% of 75% 1RM	70% of 75% 1RM	75% 1RM					
Type3	30% of 75% 1RM	40% of 75% 1RM	50% of 75% 1RM	60% of 75% 1RM	70% of 75% 1RM	80% of 75% 1RM	75% 1RM		
Type4	10% of 75% 1RM	20% of 75% 1RM	30% of 75% 1RM	40% of 75% 1RM	50% of 75% 1RM	60% of 75% 1RM	70% of 75% 1RM	80% of 75% 1RM	75% 1RM

Figure 1. The implementation method for each condition

2.4 Rate Pressure Product measurement

Heart rate was measured using a wireless heart rate monitor (Polar S610i, Finland). During WU, rest time between each set and 75% 1RM bench press were measured for 2 minutes. The wireless heart rate monitor sensor was worn around the chest muscle, and the electrical sensor part was placed on the xiphoid process. Measurements were taken every 10 seconds after the main measurement and during the rest period between sets. Blood pressure was measured using a blood pressure monitor (FT500R PLUS, Korea), resting at rest and between each set of WU exercises during the experiment, and after performing 75% 1RM bench press. The measurement was made based on the left upper arm, and was performed immediately after the bench press was performed while sitting on the bench. It was calculated as the product of the measured blood pressure and systolic blood pressure.

2.5 Statistical analysis

The number of repetitions, TW, and RPP for each condition were analyzed by repeated-measured one-way analysis of variance, and if significant differences were found, post-test was performed with tukey. The statistical significance level was set to (a) = .05.

3. Result

3.1 The difference in the number of repetitions according to the WU conditions

Table 2 shows the results of the repeated-measurement one-way analysis of the difference in the number of repetitions during the 75%1RM bench press exercise according to the WU conditions. The difference in the number of repetitions was significant, and as a result of post-hoc comparison, the NON set condition and the

3set condition were higher than the 9set condition.

Table 2. The difference in the number of repetitions according to the WU conditions

	①NON	②3set	③6set	④9set	F	P	contrast
Repetition	9.63±2.07	12.00±3.51	8.38±4.21	5.13±2.64	15.326	0.000	①>④** ②>④**

3.2 Differences in TW according to WU conditions

Table 3 shows the results of repeated measurement one-way analysis of the difference in TW during 75%1RM bench press exercise according to WU conditions. The difference in TW was significant, and as a result of post-hoc comparison, the 3set condition was higher than the 9set condition.

Table 3. Differences in TW according to WU conditions

	①NON	②3set	③6set	④9set	F	P	contrast
TW	677.50 ±199.82	871.88 ±337.90	609.38 ±376.30	372.50 ±238.90	14.600	0.000	②>④**

3.3 Differences in RPP according to WU conditions

Table 4 shows the results of repeated measurement one-way ANOVA on the difference in RPP during 75%1RM bench press exercise according to WU conditions. There was no difference in TW.

Table 4. Differences in RPP according to WU conditions

	NON	3set	6set	9set	F	P
RPP	14562.65 ±2594.96	15344.4 0±2753.77	15618.50 ±3429.54	15644.36 ±4219.60	0.314	0.815

4. Discussion

For WU exercises, it is recommended to perform aerobic exercise, stretching, RE, and sports specific exercise according to the type of physical activity to be performed [8], and it is recommended to prevent musculoskeletal injuries and improve exercise performance. Resistance WU exercises are emphasized to improve them [2]. In addition, WU exercise increases blood flow to the skeletal muscle and raises the muscle temperature to induce positive physiological changes to this exercise [9]. The purpose of this study was to investigate the effect of differences in the intensity and amount of WU exercise on the main exercise during RE.

In this study, the number of repetitions of the NON condition and 3set condition were significantly higher than the 9set condition, and the 3set condition showed the highest number of repetitions on average.

[17] found that as the number of sets of weight training increases, the number of repetitions decreases because fatigue is accumulated due to the increased amount of exercise. Although the exercise intensity was lower than that of exercise, it is thought that the number of repetitions decreased due to accumulated fatigue. On the other hand, the condition in which no WU set was performed showed fewer repetitions and amount of exercise compared to the 3-set WU condition. The increased core temperature through WU exercise increases the blood flow to the active muscle, thereby increasing exercise performance [18].

Exercise performance without WU is performed in a state in which the body is not physiologically ready for respiratory and circulatory functions [19]. It is presumed that this would not have been done.

Rate pressure product(RPP) is also referred to as myocardial oxygen consumption. Factors that affect RPP include ventricular volume, size, contraction time, and coronary blood flow. It is the product of heart rate and

systolic blood pressure indicates. RPP in this study tended to be higher as the increase in heart rate and systolic blood pressure increased as the WU set increased, but there was no significant difference.

It is thought that the 3-set WU condition did not have a significant effect on the overall increase in heart rate because the exercise intensity applied to the heart was relatively lower than the 9-set WU condition, and the cardio load was not affected as well.

In addition, heart rate increases in proportion to exercise intensity, and the load applied to the heart during exercise is widely used as an objective indicator of exercise intensity, and it is known that the heart rate rises as the training load increases [20]. Therefore, it can be seen that the more sets and the higher the exercise intensity, the higher the increase in physiological variables.

Blood pressure is caused by an increase in cardiac output due to an increase in venous return of peripheral resistance, and blood pressure increases due to an increase in circulatory resistance at the extremity of the body during exercise [21]. Systolic blood pressure increases in direct proportion to exercise intensity during low-intensity exercise and exceeds 200 mmHg during maximum exercise. The increase in systolic blood pressure is related to the increased cardiac output to supply more blood to the active muscles as the exercise intensity increases, and increases in proportion to the RPP [9].

In previous studies, it is known that weight training sharply raises blood pressure. In addition, systolic blood pressure may rise to 160 mmHg during light activity and up to 200 mmHg during high-intensity exercise [22]. However, in this study, only the bench press in which the small muscles of the upper extremities were mainly expressed, not the large muscles of the lower extremities, were performed, and the number of repetitions that did not significantly reach the maximum repetitions for the load corresponding to the endurance strength was set..

After weight training for men in their 20s with normal blood pressure, they took a break for 1 hour and observed their blood pressure. As a result, there was no significant change in blood pressure [23].

There was no significant difference in cardio load when performing 75% 1RM bench press under different set WU conditions. During the WU exercise for bench press according to the number of WU sets, the physiological variables-centered core burden was higher in 6 sets and 9 sets than in 3 sets, showing a statistically significant difference. RPP within the exercise set showed a significant difference between the first and subsequent sets, and increased in proportion to the heart rate75% The difference in the cardio load just before performing the 1RM bench press is 75% in the NON condition 75% between the 1RM bench press and 3 sets WU condition 75% 1RM bench press between the 6 sets WU condition 75% 1RM bench press, showed a significant difference only between the 75% 1RM bench press between the 9 sets WU conditions.

During the 75% 1RM bench press exercise following WU exercise, heart rate, systolic blood pressure, and RPP did not show any significant difference, and the iEMG difference did not show any significant difference either.

As the exercise intensity increases, the kinetic energy also increases, and the amount of oxygen required increases, so the heart rate increases. Upon initiation of exercise, the heart rate increases until it reaches all-out and then reaches a plateau where it does not increase further [24, 25].

Exercise performance without WU is performed in a state in which the body is not physiologically ready for respiratory and circulatory functions [19]. It is presumed that this would not have been done.

5. Conclusion

This study tried to examine the degree of appropriate WU through exercise performance and physiological responses that appear according to the degree of WU during RE. The %1RM bench press was performed, and the number of repetitions, TW, and RPP were checked, and the following results were obtained. The first three sets showed the highest number of repetitions and TW. Second, there was no difference in RPP in any of the four WU conditions. Looking at these two results, there was no difference in RPP regardless of the intensity of the WU exercise and the number of sets, but the number of repetitions was the highest in the 3-set condition. It is thought that it is possible to perform an effective exercise according to the appropriate intensity of WU exercise and the number of sets.

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