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Original research article

COMPARISON OF THE EFFECT OF INTERSET DYNAMIC AND STATIC STRETCHING ON THE UPPER AND LOWER BODY PERFORMANCE OF MALE BODYBUILDERS

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Abstract. *The objective of this study is to determine the acute effects of interset dynamic and static stretching on the number of repetitions of four consecutive sets of the bench press and leg press in male bodybuilders. The participants in the study were 18 male bodybuilders.The exercise protocol lasted for 14 sessions, consisting of four consecutive bench and leg press exercises in which the participants rested between sets using dynamic stretching, static stretching and non-stretching that was done on counterbalance. For this purpose, two rest intervals of 3 and 5 minutes were included between sets. The results of this study indicated that, in the 3-minute rest, although the average number of repetitions in dynamic and static stretching was greater than in the non-stretching method, the difference was not statistically significant ($p< 0.05$). Also, in all these three resting methods the average number of repetitions from the first to the fourth was significantly reduced. On the other hand, during the 5-minute rest interval, the difference between the mean number of repetitions of 4 sets for all three resting methods of the bench press and leg press was not significant either. Also, there was no significant difference between the mean numbers of repetitions over consecutive sets. From the findings of this study it can be concluded that, in trained male bodybuilders, stretching between sets does not have a significant effect on the performance of the next sets. In these cases the rest interval is more important than the type of rest.*

Key words: *Bodybuilders, stretching between sets, number of repetitions, muscle performance.*

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INTRODUCTION

Today weight training has changed into a common physical activity for increasing strength, endurance and muscular power among members of the public (De Salles et al., 2009). Furthermore, many studies have shown that resistance training has a very important role in expanding athletic performance and the cure and prevention of many diseases (ACSM, 2002; ACSM, 2009). The efficiency of resistance training programs depends on many factors such as intensity, volume, number of sessions per week, movement speed during training, method of training, duration and type of rests between sets (ACSM, 2009). Researchers have indicated that the duration of rest intervals between sets is a very important factor that affects short responses and long adaptations caused by training (De Salles et al., 2009). One important point about short responses of training is that when the training load is between 50 and 90 percent of 1RM, if the rest periods between sets are 3 to 5 minutes, it can decrease the drop in the number of repetitions during several consecutive sets (De Salles et al., 2009). Moreover, another important issue in the short-term responses induced by exercise is that resting periods of 3 to 5 minutes result in greater muscle strength and finally an increase in the intensity and volume of training. In addition, studies have shown similar results on muscle power (De Salles et al., 2009). Some studies have claimed that when the aim in weight training is to maintain the number of repetitions over several consecutive sets, resting time between sets should not be less than 3 minutes (De Salles et al., 2009). On the other hand, Willardson & Burkett (Willardson et al., 2006b) reported that in trained people, resting time of 30 seconds, 1 and 2 minutes is not enough to maintain the number of repetitions in the bench press and squat movements.

Kraemer (Kraemer, 1997) studied the effects of 1- and 3-minute rest intervals on the total number of repetitions performed during three consecutive sets of the bench press and leg press using (10RM) load in 20 American football players who had experience in weight training of up to two years. The results of their study showed that 3 minutes are sufficient for completing 10 repetitions in three sets. Contrary to these findings, Richmond & Goddard (Richmond et al., 2004) observed that neither 3- or 5-minute rest intervals could maintain the number of repetitions during two consecutive sets with 12RM load. Probably the reason for these differences was due to the fitness level of the participants of these two studies. The participants in Kraemer's study were trained athletes while Richmond and Goddard studied individuals who trained recreationally. Also Willardson and Burkett (Willardson & Burkett, 2006a; Willardson & Burkett, 2005) showed that in men who did weight training recreationally and regularly for at least three years prior to the study, three times a week, two rest times of 3- and 5-minutes could not maintain the number of repetitions. Ratamess et al. (Ratamess, et al., 2007) studied the effect of different rest frequencies (30 seconds, 1, 2, 3 and 5 minutes) on metabolic response and training volume of the bench press. The participants in the study were 8 trained men with 3 years of weight training experience. They reported that in the 3-minute rest interval, training volume in the fourth and fifth sets reduced significantly compared to the first set. However, in 5-minute rest interval only the fifth set had a significant drop compared to the first set. Overall, they concluded that in less than a 1-minute rest interval, performance loss is significant, but in the 3- and 5-minute resting times, in the first 3 to 4 sets, performance is maintained. Jambassi Filho et al., (Jambassi Filho et al., 2010) studied the effect of two resting times of 1.5 and 3 minutes in biceps in trained women, and finally reported similar results.

Many studies have examined the effect of the rest interval between training sets on short and long term responses induced by training sessions. However, little research has

been done on the effect of type of activity between sets on performance. The few existing studies have considered the effects of massage (Caruso & Coday, 2008) or low-intensity pedaling between sets (Corder, Potteiger, Nau, Figoni & Hershberger, 2000). Since either the people who do weight training professionally or ones who participate in this type of training recreationally do stretching between sets to relieve muscle fatigue, in the present study the effect of this factor on performance in subsequent sets during four consecutive bench press and leg press exercises was studied. For this purpose, the effects of dynamic and static stretching which are common among athletes were used. In a similar study (Garcia-Lopez et al., 2010), the effect of static and ballistic stretching on performance in untrained men and women was studied during two consecutive bench press exercises. It was revealed that the type of extension does not have a significant effect on the performance of the person in the next set. Also it was suggested that static stretching between sets can be avoided or ballistic stretching be replaced. But in previous studies in which the effect of dynamic stretching in three repetitions of the bench press (Nasiri, Damirchi & Mirzaei, 2011) and leg presses (Nasiri, Damirchi, Mirzaei & Jahanmahin, 2013) in untrained men were studied, it was observed that in both intended movements, dynamic stretching compared to complete rest, significantly increased the number of repetitions in the next set. Despite this, in both methods the number of repetitions significantly decreased from the first to the third set. Therefore, in this study we tried to answer the question whether the type of rest affects the performance of trained participants in the next sets, or if the rest intervals will be sufficient, and the relaxation method does not matter. Since the findings of some studies considered 3 minutes and some others 5 minutes as sufficient rest time between sets, these two resting periods were selected for rest intervals between sets. Theoretically, it is believed that stretching as a resting method between sets accelerates the muscle recovery process by decreasing lactate and hydrogen ions.

METHOD

Participants

The sample comprised 18 male bodybuilders who did weight training regularly for at least 4 years. The participant's age, height and weight were 24.13±4.06 years, 178.17±5.55 cm and 86.22±5.26 kg respectively. All of the participants postponed their training programs one week before the beginning of the study. Moreover, none of the participants in the study had physical injuries. To control hormonal changes of the participants, all the sessions were conducted at the same time. During the study period, the participants were asked not to alter their nutritional and sleep habits. Also according to the participants, they had not used nutritional supplements at least for six months prior to the study.

Data collection

The experimental exercise program took place over 14 sessions. When the readiness of the participants to cooperate was announced, in the first session, the methodology was explained to them. Then they signed a consent form for participation in the study and finally their height, weight and age were recorded. In the second session one repetition maximum (1RM) of the bench press and leg press were determined. Then they were divided into three groups of six. After 48 hours, the main test consisting of 4 consecutive bench and leg

press exercises to the extent of fatigue with an intensity of 80% of 1RM was initiated, which lasted for 12 sessions (24 hours of rest between sessions). At the beginning of each session, 10 minutes of jogging and stretching was conducted by the participants to warm up and after 2 minutes of rest, two sets of the bench or leg press with 30 and 50% of 1RM intensity respectively, with a one-minute rest interval, were performed. Then the participants rested again for 3 minutes and then conducted 4 consecutive bench and leg press exercises at 80% of one repetition maximum (Ratamess et al., 2007; Willardson et al., 2006a) with 3 and 5 minute rest intervals. The following three methods were used as a counterbalance in order to rest between the sets:

1. Non-stretching method
2. Static stretching method
3. Dynamic stretching method

In each set, the number of repetitions was recorded to finally calculate the average of 4 sets. A schematic view of the general exercise design is fully presented in table 1.

1RM testing

One Repetition Maximum (1RM) of the participants was assessed in one session. To accelerate the process, the participants were divided into three groups of six. In all three groups, at first one repetition maximum of the bench press was assessed, then they rested for 1 hour. After that, 1RM of the leg press movement was assessed. The method of calculating one repetition maximum for both the bench press and leg press was such that at first the participants chose a load based on their previous experience and understanding to their maximum power, then performed the intended movement. If the number of repetitions exceeded five, they rested for 5 minutes, then the movement was done again so that they were able to implement the maximum of five movements properly. Finally, one repetition maximum for each person was calculated according to the formula. During training they performed the movements over the entire range of motion slowly and without any interruption. If the participants paused at the beginning or end of the movement, it was stopped and only the correct number of repetitions was recorded (Garcia-Lopez et al., 2010; Wagner, Evans, Weir, Housh & Johnson, 1992).

The method used for the bench press and leg press

Each test session consisted of four consecutive sets of the bench press or leg press to failure. In each session, one of the 3- or 5-minute rest intervals was implemented between sets. These times were chosen because previous studies had suggested that 3- to 5-minute rest intervals between sets are appropriate for maintaining the number of successive repetitions during consecutive sets. On the other hand, enough time is provided to do stretching for each muscle group. The warm up in each session included 5 to 10 minutes of jogging and stretching, then two sets of the bench press and leg press (it depends on the fact whether the bench press or the leg press was conducted in the test session) with an intensity of 30 and 50 percent of one repetition maximum, with one-minute rest intervals between sets. Then the participants rested for 2 minutes, and finally performed the main test including four consecutive sets of the bench press or leg press. In this study, failure or the finishing point was when the participant performed the movement to the

final extent. At that point, they either paused for more than a second or could not fully perform the movement and were stopped in the middle of performing the movement (Izquierdo et al., 2006; Garcia-Lopez et al., 2010).

Table 1 Exercise protocols

Rest intervals between sets	Session	Groups		
		First	Second	Third
3 min	1	Bench press / dynamic stretching	Bench press / static stretching	Bench press / non-stretching
	2	Leg press / dynamic stretching	Leg press / static stretching	Leg press / non-stretching
	3	Bench press / static stretching	Bench press / non-stretching	Bench press / dynamic stretching
	4	Leg press / static stretching	Leg press / non-stretching	Leg press / dynamic stretching
	5	Bench press / non-stretching	Bench press / dynamic stretching	Bench press / static stretching
	6	Leg press / non-stretching	Leg press / dynamic stretching	Leg press / static stretching
5 min	7	Bench press / dynamic stretching	Bench press / static stretching	Bench press / non-stretching
	8	Leg press / dynamic stretching	Leg press / static stretching	Leg press / non-stretching
	9	Bench press / static stretching	Bench press / non-stretching	Bench press / dynamic stretching
	10	Leg press / static stretching	Leg press / non-stretching	Leg press / dynamic stretching
	11	Bench press / non-stretching	Bench press / dynamic stretching	Bench press / static stretching
	12	Leg press / non-stretching	Leg press / dynamic stretching	Leg press / static stretching

The methods used for static and dynamic stretching

The four main muscles involved in the bench press movement (right pectoralis major, right triceps, left pectoralis major and left triceps) and four main muscles involved in the leg press movement (Right quadriceps muscle, right gluteus muscle, left quadriceps and left gluteus muscle) respectively, were each stretched twice. Thus during the 3-minute rest interval, each muscle was stretched for about 17 seconds each time. The method of dynamic stretching was such that moving each muscle group was done in 17 seconds through its full range of motion. However, static stretching is used to stretch muscles while the body is at rest. After each stretch, a 5-second rest interval was considered. Then, the next muscle was stretched. At the rest interval of 5 minutes, stretching time increased to 32 seconds for each muscle. Thus each muscle group was stretched twice for a total of 34 (during a 3-minute rest interval) or 64 (during a 5-min rest interval) seconds (Garcia-Lopez et al., 2010). When stretching each muscle group, the point where muscle pain began was considered the endpoint of stretching (Unick, Kieffer, Cheesman & Feeney, 2005). In the complete rest method, the control group did not engage in any activity between the sets of the bench press and leg press, and only relaxed.

Statistical analysis

All the results obtained in this study were analyzed using SPSS 19. Due to the small sample size, the Kolmogorov-Smirnov test (with the significance level set at $p< 0.01$) was used to assess the normality of data. To determine the difference between the groups, the one-way ANOVA was used, and if there was a significant difference, the LSD Post-hoc test was used. Also, the paired t-test was used to compare repetitive measurements for dependent samples at the pre- and post-tests of each group. The level of significance up to 0.05 ($p\leq0.05$) was accepted as the statistical significance for differences in the results of the variables between two measurements.

RESULTS

The results indicate that although during the 3-minute rest interval both the bench press and leg press movements were used, the average number of repetitions in four sets for both the dynamic and static stretching method was higher than in the non-stretching method, but the difference was not statistically significant (Figure 1 and 2). Also, during these rest intervals the number of repetitions of the bench press and leg press decreased significantly from the first to the fourth set. Also during 5-minute rest intervals, the difference between the mean number of repetitions of the bench press and leg press in four sets of the three rest methods was not significant. Moreover, at this time, the number of repetitions from the first set to the fourth was reduced slightly, and the difference was not significant (Figure 3 and 4).

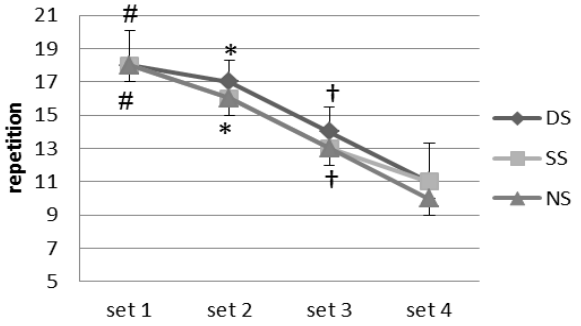

Fig. 1 Effect of 3 minutes rest intervals on the number of Leg press repetitions
(*): Significant difference ($P < 0.05$) from the second set;
(#): Significant difference ($P < 0.05$) from the third set;
(†): Significant difference ($P < 0.05$) from the fourth set.
NS: non-stretching, SS: static stretching and DS: dynamic stretching

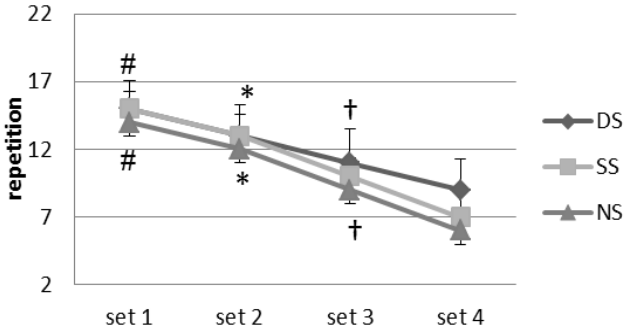

Fig. 2 Effect of 3 minutes rest intervals on the number of Bench press repetitions
(*): Significantly different from the second set (P <0.05);
(#): Significantly different from the third set (P <0.05);
(†): Significantly different from the fourth set (P < 0.05).
NS: non-stretching, SS: static stretching and DS: dynamic stretching

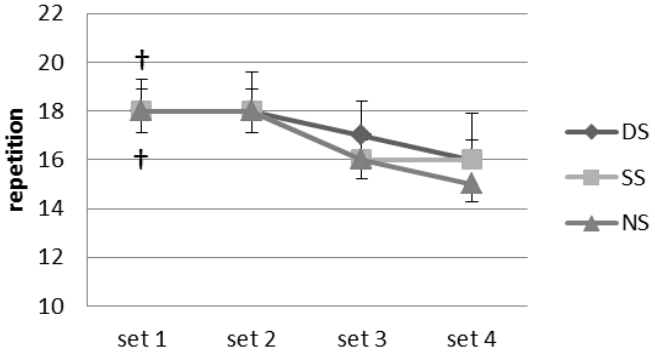

Fig. 3 Effect of 5-minute rest intervals on the number of Leg press repetitions
(†): Significant difference from the fourth set (P < 0.05).
NS: non-stretching, SS: static stretching and DS: dynamic stretching

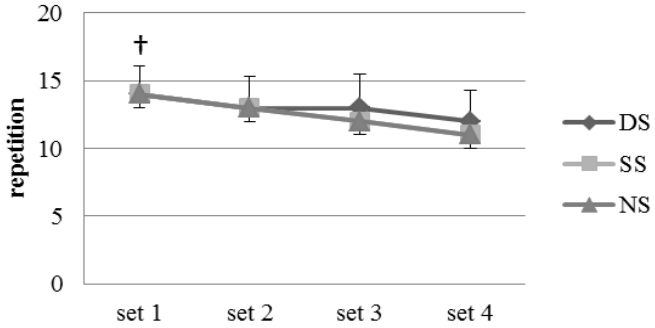

Fig. 4 Effect of 5-minute rest intervals on the number of Chest press repetitions
(†): Significant difference from the fourth set (P < 0.05).
NS: non-stretching, SS: static stretching and DS: dynamic stretching

DISCUSSION

Different parts of the training session, as a result of its short-term responses, can be influenced by various aspects (duration and type of rest) of rest intervals between consecutive sets (Garcia-Lopez et al., 2010). Therefore, the aim of this study was to investigate the effect of time (3, 5 minutes) and rest type (dynamic and static stretching) between sets on upper and lower body muscular performance of male bodybuilders (mean number of repetitions of four consecutive sets of the bench press and leg press to failure, as well as the drop in the number of repetitions from the first to the fourth set) during a weight training session. In each movement, three methods of dynamic stretching, static stretching and non-stretching were used to rest between sets. In order to compare the performance of various sessions, the mean number of repetitions of four sets was used. The most important finding of this study was that in male bodybuilders who have at least 4 years of experience in weight training, when several consecutive sets are carried out to the extent of fatigue, the type of rest between sets has no significant effect on the performance of the next sets. The 5-minute rest period in all three resting methods was sufficient to maintain the number of repetitions during four sets. Also, during the 3-minute rest interval, the number of repetitions reduced significantly from the second set to the fourth set, but during the 5-minute rest interval such a trend was not observed. Theoretically, stretching between consecutive sets accelerates the recovery process and helps the muscle return rapidly to its initial length (Garcia-Lopez et al., 2010).

When several sets with a given load are performed to the extent of fatigue, the resting time between sets has a key role in the performance of the next sets and the total volume of the training session (García-López, Herrero, Abadía, García-Isla & Izquierdo, 2008; Miranda et al., 2009; Rahimi, 2005; Willardson et al., 2006b). It has been shown that doing resistance training with a moderate to high intensity at different speeds will increase strength and athletic performance (Gurjão et al., 2012; Tschopp, Sattelmayer & Hilfiker, 2011). On the other hand, studies have shown that exercise protocols including low to moderate intensity loads that have a greater number of repetitions result in an increase in muscle size, oxidative capacity, mitochondrial density and muscle strength (Harris, De Beliso, Spitzer-Gibson & Adams, 2004).

However, short rest times may cause an accumulation of various ions (Ca^+, K^+, Na^+, H^+, Mg^+, Cl^-), which finally leads to a decrease in intramuscular pH and maximum muscle contraction velocity (De Salles et al., 2009). Probably, fewer repetitions at shorter rest intervals are associated with high levels of fatigue. In a similar study that included running at a distance of 20 meters, it was shown that doing static stretching between sets will negatively impact performance (Beckett, Schneiker, Wallman, Dawson & Guelfi, 2009). As it has been suggested in the relevant literature, performance degradation after stretching is probably due to the changes in neural and mechanical mechanisms (Rubini Costa & Gomes, 2007). Neural changes after static stretching are associated with a decrease in the level of neuromuscular activity (Behm, Button & Butt, 2001; Cramer et al., 2004; Power, Behm, Cahill, Carroll & Young, 2004). Mechanical changes that occur in a short period of time due to tension may be related to the reduction in viscosity of the muscle-tendon (De Salles et al., 2009; Kraemer, 1997).

Some studies have suggested that stretching has a smaller effect on athletes and trained people compared to untrained ones (Egan, Cramer, Massey & Marek, 2006; Unick et al., 2005). Although there are still different opinions about the duration of stretching needed to

improve athletic performance, most researchers have agreed on the positive effects of stretching on athletic performance (Behm & Chaouachi, 2011). As the findings of this study showed, in trained men who have a long experience of weight training, the type of activities between sets (stretching between sets) does not have a significant effect on their performance in the next set. The difference between these findings and those of previous studies (Nasiri et al., 2011; Nasiri et al., 2013) is probably due to the participant's fitness level. The participants in this study were trained men with a high level of fitness, whereas the participants of those two studies were untrained men. Also, the findings of this study are countercurrent with the findings of Garcia-Lopez et al., (2010) who reported a loss in performance after static stretching. A possible reason for this difference may be participant's fitness level and speed of movement. The participants in that study performed the bench press as quickly as possible, whereas in this study speed was controlled and the participants performed the bench press and leg press gently and in a controlled fashion. On the other hand, the findings of this study are consistent with the results of Unick et al., (Unick et al., 2005) and Egan et al., (Egan et al., 2006) who showed that stretching in trained athletes with a high fitness level has no significant effect on their athletic performance.

CONCLUSION

Based on the analysis of the obtained results, we can conclude that in men who have experienced periods of prolonged and regular weight training, stretching between sets does not have a significant effect on their performance in the next sets. However, stretching, especially of the dynamic type, can relieve fatigue and accelerate the recovery process to some extent.

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POREĐENJE UTICAJA DINAMIČKOG I STATIČKOG ISTEZANJA IZMEĐU SETOVA NA IZVOĐENJE VEŽBI ZA JAČANJE GORNJIH I DONJIH EKSTREMITETA BODIBILDERA

Cilj ovog istraživanje bio je da se odredi uticaj dinamičkog i statičkog istezanja između setova na broj ponavljanja u okviru četiri uzastopna seta dizanja tegova sa klupe i potiskivanja nogama na primeru bodibildera. U ovom istraživanju učestvovalo je 18 bodibildera. Svi učesnici bili su pripadnici muškog pola. Istraživanje je obuhvatilo 14 treninga. Na svakom su ispitanici radili po četiri uzastopna seta dizanja tegova sa klupe i potiskivanja nogama, a između setova odmarali su se dinamičkim istezanjem, statičkim istezanjem ili se nisu uopšte istezali. Po dva intervala odmora uključeni su između setova. Rezultati ovog istraživanja ukazali su na to da nakon pauze od tri minuta, iako je prosečan broj ponavljanja u dinamičkom i statičkom istezanju bio veći nego u slučaja kada je istezanje izostalo, razlika nije bila statistički značajna ($p< 0.05$). Takođe, u okviru ove tri različite vrste odmaranja između setova, prosečan broj ponavljanja od prvog do četvrtog seta bio je značajno umanjen. Sa druge strane, tokom petominutnog odmora, razlika između broja ponavljanja u okviru četiri seta vežbi za sve tri vrste aktivnosti u koje su ispitanici bili uključeni prilikom perioda odmora, i za dizanja tegova sa klupe i potiskivanja nogama nije bila statistički značajna. Takođe, nije utvrđena statistički značajna razlika između prosečnnog broja ponavljanja tokom uzastopnih setova. Na osnovu rezultata ovog istraživanja, može se zaključiti da na primeru utreniranih bodibildera, istezanje između setova nema značajan uticaj na izvođenje narednih setova vežbi. U ovim slučajevima, dužina trajanja perioda odmora značajnija je od vrste aktivnosti tokom odmora.

Ključne reči: *bodibilderi, istezanje između setova, broj ponavljanja, izvođenje vežbi za jačanje mišića*