# Effects of 4-week Olympic Weightlifting Training on Speed and Power Performance in Recreational Athletes

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## ABSTRACT

Olympic weightlifting (OW) is sport with high strength and power demands where athletes need to explosively lift heavy weights. It is consisted of barbell lifting snatch and clean and jerk disciplines. In the strength and conditioning training, OW techniques are often used as a method for speed and power development. The aim of this study was to determine effects of 4-week OW training intervention on speed, agility and power performance among young recreational athletes. The sample of participants consisted of 12 Kinesiology students (average 23 years old). They attended the Olympic Weightlifting course. The training intervention lasted 4 weeks and with 3 training sessions per week in which participants practiced OW training based on learning OW techniques and auxiliary lifts execution. Before and after the intervention, measurement was conducted and included power, speed and agility tests. Squat jump (SJ), countermovement jump (CMJ) and drop jump (DJ) were used to estimated lower body power and medicine ball throw (MBT) for upper body power. Sprinting on 5 meters (S5) and 15 meters (S15) were conducted as power and speed tests, while 20 yards test (20Y) measured nonreactive agility performance. All variables were descriptively analysed and T-test for dependent samples was used to determine possible effects of training intervention. Results showed improvement in jumping capacities, with statistically significant difference noted only for CMJ ($p>0.01$). Upper body power and agility performance did not show any significant changes, while a decline in sprinting performance was found for both S5 ($p>0.01$) and S15 ($p>0.01$). While the results in jumping variables are expected and in accordance with current scientific knowledge, the results in sprint tests are somewhat confusing. Possible explanation for this can be found in the fact that the participants worked for four weeks the tasks that biomechanically are not similar to the structure of sprinting movement. This could suggest that athletes who want to improve their explosive speed capacities should include specific sprint stimuli in their training program in addition to OW training program. In the future, more variables and longer treatment duration need to be applied.

**Keywords:** weightlifting, intervention, speed, agility, power

## INTRODUCTION

Olympic weightlifting (OW) is sport with high strength and power demands where athletes need to explosively lift heavy weights. It is consisted of barbell lifting snatch and clean and jerk disciplines in which athletes need to produce high levels of strength and power (Helland et al., 2017; Santos et al., 2021). In the OW competitions, athletes try to lift highest possible load, in maximum of three attempts, in both techniques.

Besides the sport itself, these lifting techniques gained big popularity as specific training method. In particular, in the strength and conditioning training, OW techniques are often used as a method for speed and power development (Chaouachi et al., 2014; Hackett, Davies, Soomro, & Halaki, 2016a, 2016b; Helland et al., 2017). These two major techniques, along with supplementary exercises like hang clean, hang snatch, power clean, power snatch, high pull and similar, are very popular and useful training modalities for the development of whole spectre of speed-power abilities (Morris, Oliver, Pedley, Haff, & Lloyd, 2022). Speed, power and agility demands are present in most sports, including team sport games, combat sports and many other individual sport and disciplines. They are manifested with jumping, sprinting, change of directions and similar movements and actions (Morris et al., 2022; van der Kruk, Van Der Helm, Veeger, & Schwab, 2018).

Comparing to traditional strength training with heavy lifts, OW training produces less improvement in strength and muscle gains but generates highest possible power outputs (Channell & Barfield, 2008; Hedrick & Anderson, 1996; Semenick & Adams, 1987; Zaras et al., 2020). Studies report that power output during OW is approximately four to five times greater than that during basic strength exercise like the squat or deadlift (Channell & Barfield, 2008). For these reasons, it has been suggested that these kind of training methods should be emphasized in the strength and conditioning programs in the power-based sports (Semenick & Adams, 1987).

This has been confirmed in multiple studies that investigated effects of the OW training and compared it with different training modalities (Arabatzi, Kellis, & De Villarreal, 2010; Chaouachi et al., 2014; Hoffman, Cooper, Wendell, & Kang, 2004; Tricoli, Lamas, Carnevale, & Ugrinowitsch, 2005). Studies regularly confirm positive effect of the OW training on the power of the lower extremities (Arabatzi et al., 2010; Berton, Lixandrão, Pinto e Silva, & Tricoli, 2018; Chaouachi et al., 2014). For example, study on the sample on young male students of physical education showed significant improvement in the vertical jump height after OW intervention (Arabatzi et al., 2010). These improvements were also found in the younger athletes, as the study on the kids from 10 to 12 years showed positive effects on both horizontal and vertical jumping performance (Chaouachi et al., 2014). Similar to this, several studies also studied the effects on sprint performance and confirmed the positive transformations that followed OW training (Chaouachi et al., 2014; Hermassi, Schwesig, Aloui, Shephard, & Chelly, 2019; Hoffman et al., 2004; Tricoli et al., 2005). For instance, Hofmann et al. (2004.) analysed OW effects on collegiate football team and found significantly better results on 40-yard sprint after 15-week intervention (Hoffman et al., 2004).

Considering the importance of the speed and power abilities in sport, the main aim of this study was to determine effects of 4-week OW training intervention on speed, agility and power performance among young recreational athletes. We hypothesized that certain improvement in mentioned abilities would occur.

## METHODS

### *Participants and study design*

The sample of participants consisted of 12 male Kinesiology students (average 23 years old, average height 182.4cm, average body mass 81.91kg) that attended the Olympic Weightlifting course in summer semester of academic year 2021/2022. First two weeks of the classes were used for introduction to Olympic weightlifting and familiarization with specific techniques. After that, 4-week intervention was conducted with 3 training sessions per week in which participants practiced OW training based on improving OW techniques and performing supplementary lifting exercises. Every training consisted of four exercises that were performed 3-5 sets of 5-8 repetitions in the first two weeks and 3-5 repetitions in last two weeks. The concept of the trainings is briefly showed in the table 1.

**Table 1.** OW training

| WEEK | TRAINING 1 | TRAINING 2 | TRAINING 3 |
|---|---|---|---|
| 1 | Snatch | Clean and jerk, press | Basic strength |
| 2 | Snatch | Clean and jerk, press | Basic strength |
| 3 | Snatch, clean and jerk | Supplementary lifting exercises | Snatch, clean and jerk |
| 4 | Snatch, clean and jerk | Basic strength | Snatch, clean and jerk |

The study was conducted according ethical guideline and was approved by the Ethical Board of the Faculty of Kinesiology, University of Split (app number. 2181-205-02-05-22-029).

### *Variables*

Before and after the intervention, measurement was conducted and included power, speed and agility tests. Squat jump (SJ), countermovement jump (CMJ) and drop jump (DJ) were used to estimated lower body power and medicine ball throw (MBT) for upper body power. The height and the contact time of the jump were measured by the Optojump system (Microgate, Bolzano, Italy). All jumps were performed three times and the best results was considered as the final score. For all three jumps height was noted while reactive strength index (RSI) was calculated for the CMJ as ratio between jump height and contact time. Sprinting on 5 meters (S5) and 15 meters (S15) were conducted as running power and speed tests, while 20 yards test (20Y) measured nonreactive agility performance. All running test were performed with Powertimers 300 (Newtest Oy, Oulu Finland, Core serial number:08310013). In all three running tests, participants position was behind the photocells and they started with running when they were prepared and ready, without the signal from the measurer. MBT test was performed from sitting position, back placed on the wall and the goal was to throw the 3kg medicine ball with both hands as far as possible. Before both measurements, 15-minute warm up protocol was conducted and included dynamic stretching (3 minutes), jogging (4 minutes) and athletic exercises that consisted of running mechanic drills and innervation (8 minutes).

### *Statistics*

Descriptive statistic parameters were calculated for all measured variables and included arithmetic means and standard deviations. Normality of distribution was checked with Kolmogorov-Smirnoff test.

To determine possible differences between initial and final measurement, T-test for depended samples was used.

All calculations were conducted with Statistica v.13.0 (Dell Inc., Palo Alto, CA, USA) and with p-level of 95%.

## RESULTS

Descriptive statistic parameters are presented in the Table 1. Along with the results of the Kolmogorov-Smirnoff test that suggests that all variables are normally distributed.

**Table 2.** Descriptive statistics

| Variable | Initial | | | Final | | |
|---|---|---|---|---|---|---|
| | AM | SD | K-S (p) | AS | SD | K-S (p) |
| MBT (m) | 5.90 | 0.55 | p > .20 | 5.78 | 0.69 | p > .20 |
| SJ (cm) | 39.36 | 4.90 | p > .20 | 39.08 | 4.94 | p > .20 |
| CMJ (cm) | 38.52 | 4.25 | p > .20 | 40.44 | 4.91 | p > .20 |
| DJ (cm) | 51.31 | 6.33 | p > .20 | 54.25 | 7.33 | p > .20 |
| RSI (index) | 1.54 | 0.47 | p > .20 | 1.70 | 0.33 | p > .20 |
| 5M (s) | 0.89 | 0.05 | p > .20 | 1.10 | 0.07 | p > .20 |
| 15M (s) | 2.31 | 0.09 | p > .20 | 2.52 | 0.10 | p > .20 |
| 20Y (s) | 4.68 | 0.25 | p > .20 | 4.77 | 0.21 | p > .20 |

***Legend: MBT** – medicine ball throw, **SJ** – squat jump, **CMJ** – countermovement jump, **DJ** – drop jump, **RSI** – reactive strength index, **5M** – sprint on 5 meters, **15M** – sprint on 15 meters, **20Y** -20-yard shuttle*

Results of the t-test for dependent samples are shown in the table 2. Significant differences between initial and final measurements were found for CMJ (t=-3.11, p=0.01), 5M (t=-11.06, p=0.01) and 15M (t=-10.86, p=0.01).

**Table 3.** T-test

| Variable | t-value | p |
|---|---|---|
| MBT (m) | 1.45 | 0.17 |
| SJ (cm) | 0.35 | 0.73 |
| CMJ (cm) | -3.11 | 0.01* |
| DJ (cm) | -2.02 | 0.07 |
| RSI (index) | -1.40 | 0.19 |
| 5M (s) | -11.06 | 0.01* |
| 15M (s) | -10.86 | 0.01* |
| 20Y (s) | -1.97 | 0.07 |

***Legend: MBT** – medicine ball throw, **SJ** – squat jump, **CMJ** – countermovement jump, **DJ** – drop jump, **RSI** – reactive strength index, **5M** – sprint on 5 meters, **15M** – sprint on 15 meters, **20Y** -20-yard shuttle*

## DISCUSSION

This study aimed to evaluate effects of 4-week intervention of Olympic weightlifting training on speed, agility and power performance in young recreational athletes. Results in general showed improvement in jumping capacities, with statistically significant difference noted for CMJ ($p>0.01$). Upper body power and agility performance did not show any significant changes, while surprisingly, a decline in sprinting performance was found for both S5 ($p>0.01$) and S15 ($p>0.01$).

### *Improvement in power capacities*

Progress in the power of the lower extremities was recorded in all types of jumps, regardless of the type of muscle contraction. However, significant differences compared to the initial measurement were observed only in the eccentric-concentric jumping, i.e. in the CMJ. This finding is in line with the results of other studies that repeatedly confirmed the positive impact of OW training on power (Arabatzi et al., 2010; Hackett et al., 2016a; Pichardo et al., 2019; Tricoli et al., 2005). In particular, a review by Hackett et al. (2016) included six studies in order to evaluate the effects of Olympic weightlifting (OW) on vertical jump height and recorded improvement of 7.7% compared to control group (Hackett et al., 2016b). In the study on the sample of male students, authors found that OW training improved power and muscle activation during the concentric phase of the CMJ (Arabatzi et al., 2010). Authors explained this improvement with kinetics and kinematics similarity between jumps and OW exercises (Arabatzi et al., 2010). In line with this study, Tricoli et al. conducted the experiment on similar participants (young male physical education students) and found the positive effect in both concentric (Squat jump) and eccentric-concentric (Countermovement jump) type of jumps (Tricoli et al., 2005). Besides mentioned biomechanical similarities, authors that examined this topic in general concluded that the load imposed in the OW exercises result in the development of a wider spectrum of mechanical parameters and greater motor-unit synchronization which can be transferred to execution of other sport tasks (Arabatzi et al., 2010; Hackett et al., 2016a; Tricoli et al., 2005).

Although the interventions in these studies lasted somewhat longer (specifically from 6 to 15 weeks), it is obvious that even interventions of only 4 weeks like conducted herein, are enough for certain advances in power performance.

### *Decline in speed performance*

And while the jump results are expected, the speed test results are quite surprising. In particular, not only was there no improvement in speed, but there was a significant decline in performance. These results are clearly not in accordance with previous studies which regularly reported positive effect of OW training on speed capacities. For example, study on 20 member of collegiate football team found significant improvement in 40-yard running after 5-week OW training program (Hoffman et al., 2004). However, it is important to note that the sprint and agility training program was incorporated into the intervention and most likely had a significant impact on speed performance (Hoffman et al., 2004). Similar to this, Chaouachi et al. (2014.) noted advancement on 5- and 20-m sprint times in 10 to 12 years old kids after 12-week OW program (Chaouachi et al., 2014). This gains in speed output are primarily consequence of the high rates of force development and improved contractile properties of muscular-skeletal system (Duchateau & Hainaut, 1984; Häkkukinen, Komi, & Alen, 1985; Hoffman et al., 2004).

Considering the unexpected, and in fact counterintuitive results, we can only hypothetically discuss possible explanations of the findings obtained here. By authors opinion, most probable explanation for this can be found in the fact that the participants worked for four weeks on tasks that biomechanically are not similar to the structure of sprinting movement. In detail, during a period of 4 weeks, the subjects did only OW exercises and did not conducted any speed or running session. This potentially resulted in acute effects in terms of kinetic and kinematic parameters that led to sprint performance decline.

However, we need to emphasize few study limitations that possibly influenced the results. First of all, anthropometric measurements were taken only on the initial testing so there is possibility there was an increase in body mass, which had a somewhat negative effect on sprinting. Also, the sample of participants was relatively small so these results could occur as specificity of the observed participants. Finally, the duration of the experiment was only four weeks which is less than usual experimental studies on this or similar topic so these results should be taken with some caution.

## CONCLUSION

The results of this research showed that in young recreational athletes there is an improvement in the power of the lower extremities already after 4 weeks of systematic OW training. Once again was confirmed the positive effect of OW training on athlete's power capacities.

On the other hand, the decline in speed performance is hypothetically explained by different biomechanical demands during the intervention period. This may suggest that in speed-explosive sports, athletes should not only rely on OW method, but should include other training modalities for developing these capacities, specifically athletic speed training.

The major limitations of the study are; small sample, recreational athletes, lack of strain factors control (body mass measurement, other physical activity records, etc), and short intervention period.

Study confirmed positive effect of OW training on power performance in recreational male athletes. Hence, date gathered could be helpful in expanding safe and efficient training modalities with recreational athletes' population.

In the future studies, it is necessary to further expand the sample of the observed variables and especially perform a longer intervention with inclusion of the control or some other experimental group.

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