STUDY OF A SPECIAL CONDITIONING PROGRAM AND ITS EFFECTS ON MAXIMAL OXYGEN CONSUMPTION IN FEMALE VOLLEYBALL PLAYERS

Yulian Karabiberov, Iveta Bonova, Valentin Panayotov
National Sports Academy "Vassil Levski", Sofia, Bulgaria

ABSTRACT

The aim of this study was to evaluate the changes in maximal oxygen consumption as a result of a special conditioning training program. We studied ten female players of Bulgarian National Volleyball Team during their preparation for the World Championships in Japan - 2018. For 8 weeks they performed 2 strength training sessions weekly using our methodology. We estimated the differences in between the beginning and the end of the preparation period and we found a small, but statistically significant increase in its values.

Key words: *female volleyball players, special conditioning program*

INTRODUCTION

Cardiorespiratory fitness, muscle strength and conditional training are important components of the physical working capacity of the body (Luke, 2015). Maximal oxygen consumption ($\dot{V}O_{2max}$) is an important indicator in volleyball. It helps in determining the capacity of competitors to bear heavy specific training loads, which require a swift fatigue elimination both during the initial and the final phases of recovery. $\dot{V}O_{2max}$ refers to the capacity of the body to use oxygen and is generally a parameter of the intensity of the aerobic processes. One of the most popular approaches for estimating the efficiency of a particular training program is through measuring the changes in $\dot{V}O_{2max}$ (Bassett, & Howley, 2000). Another two important factors, which are often used for assessment of the aerobic capacity of the body, are the maximal reached pulmonary ventilation (VE) and the maximal reached heart rate (HRmax). According to experts in elite sports training, increased aerobic capacity forms the base for further improvement of physical performance and overall motor abilities. V. Angelov, considers adaptations, which improve the functional capacity of the body an important part of the classification model of training methods aimed at bettering health status (Angelov, 2015). Based on the practical necessity of planning and controlling the effects of training for achieving top performance, we developed a special conditioning training program.

Aim and objectives of the study

The aim of the study was to evaluate the effects of

an 8-week-long special conditioning training program on maximal oxygen consumption in female players of Bulgarian National Volleyball Team.

The objectives of the study were as follows:

1. To design a training schedule for implementing a special experimental conditioning program for Bulgarian National Female Volleyball Team.
2. To apply the program for 8 weeks during the preparatory period of the Team.
3. To measure $\dot{V}O_{2max}$, VE and HRmax at the beginning and at the end of the experiment.
4. To evaluate statistically the changes in the studied variables.

METHODS

Design of the study

Our special conditioning training program uses the method of slow-dynamic muscle efforts. The accent was put on the development of muscle strength and the training sessions were held 2 times a week and included the following exercises:

1. Deadlift - 2 sets of 5/4 repetitions.
2. Half squat - 3 sets of 5/4/3 repetitions.
3. Standing calf raises - 2 sets of 5/5 repetitions.
4. Bulgarian squat with unilateral jump - 2 sets of 5/4 repetitions.
5. Incline dumbbell bench press - 2 sets of 5/4 repetitions.
6. Dumbbell military press - 2 sets of 5/4 repetitions.
7. Assisted chin-ups - 2-3 sets of 5/5 repetitions.
8. Moving from knee-hand position to plank

- position – 2 sets by 5/5 repetitions.
9. Unilateral expander pulls - 2 sets of 5/5 repetitions.
 10. Superset: biceps curls - triceps extensions – 2 sets of 6/5 repetitions.
 11. In the third week of the program we introduced two additional ballistic exercises:
 12. 3 kg medicine ball side throws – 2 sets of 7/6 repetitions.
 13. 3 kg medicine ball jump dunkings – 2 sets of 7/5 repetitions.

The program was split into two separate parts after the third week – the first engaged predominantly the muscles of the lower body and the second – those of the upper body. At the end of the strength training module, we added one additional contrast exercise after each slow-strength set.

The concept of the slow-dynamic method

The slow-dynamic methodology forms the foundation of the studied program. Each exercise is performed in the following manner: 4-seconds-long eccentric contractions followed by 4-seconds-long concentric contractions. A peak contraction completes each repetition. During a slow-motion mode of eccentric work, muscles generate their greatest strength. For that reason, 8-seconds-long concentrations effectively improve strength capacity at all points and at all angles through the range of motion. In our opinion, the stronger the muscle at a point of its range of motion, the bigger the velocity it is able to generate at that point. Additionally, if a new separate movement is to be started at this point it would be faster and more powerful (Karabiberov, 2016).

The resistance we used was 83%-88% of 1 repetition maximum (RM) for 5 repetitions for 5 sets at most (or until the participant fails to maintain the speed or the range of motion) and long rest intervals of 2-3 minutes between sets.

Participants

Ten female volleyball players participated in the study. They were aged 23.7 ± 2.8 years (mean $\pm$ standard deviation). Their height was 183 ± 8.6 cm and their weight – 69.7 ± 6.7 kg. (table. 1).

The incremental cardio-pulmonary test to exhaustion (CPET)

Estimating is a golden standard in estimating the aerobic working capacity (Fletcher, F., et al, 1995). We measured oxygen consumption per kilo of body mass (ml/kg/min) instead of absolute values of (l/min) because the latter correlate strongly with body weight. Pulmonary ventilation was measured in litres per minute and maximal heart rate – in beats per minute. We tested for those parameters twice – once at the beginning and once 8 weeks later, at the end of the experiment. The estimated the differences in their values at a level of statistical significance of $p < 0.05$. The first measurements were taken right after the end of the competition season and the players were at a top volleyball-specific sport form. More specifically, their jump endurance (the most important component of game efficiency) was at its highest level.

We used the Cardio-pulmonary Exercise Test (CPET) to determine their physical fitness. The measurements were done with a “breath-by-breath” gas analyzer DYNOSTICS, Germany, model 2018 and a treadmill H/P/Cosmos. The system was calibrated prior to every personal testing. CPET starts at an initial speed of running of 7 km/h. The duration of each step is fixed at 3 minutes and the speed is increased by 2 km/h at each step. The inclination of the treadmill was 2.5%. The procedure was terminated when a failure was reached. A standard inquiry protocol was used for evaluating the personal health status of each participant. All subjects signed informed consent declarations.

RESULTS

In table 1 we presented the average initial and final values of the studied variables.

Table 1. Descriptive statistics of studied variables

Parameter	Age (years)	Height (cm)	Weight (kg)	VO _{2max} (ml/kg/min)	VE (l/min)	HR max (bpm)
Mean initial	23.7	183.00	69.7	48.70	99.90	186.00
SD initial	2.80	8.60	6.70	10.00	15.79	7.80
Mean final	23.70	183.00	69.67	51.13	104.66	185.33
SD final	2.80	8.60	6.35	10.28	17.62	7.98

We used SPSS 17 statistical software in our analysis. The differences between the initial and the final values of studied variables are shown in table 2. We tested the data for normality and the Shapiro test

procedure (results not shown here) did not confirm the hypothesis. Accordingly, Wilcoxon sign ranked test was used for estimating the statistical significance of the differences.

Table 2. Differences between the initial and the final values of studied variables (Wilcoxon sign ranked test)

Parameter	VO _{2max} (ml/kg/min)	VE (l/min)	HR max (bpm)
Z	-2.6	-2.8	-1.6
Sig.(2tailed)	0.005	0.005	0.1

All 3 studied parameters decreased in value but only the differences in and VE were statistically significant ($p < 0.05$).

DISCUSSION

We expected the continuous tension our program imposed on muscles to cause a local discomfort within an increasingly anaerobic cell environment. These processes activate oxygen delivery pathways and vegetative functions of the body. After completion of a strength training set, they also stimulate the deployment of . The energy for muscle work during a volleyball game comes predominantly by anaerobic-aerobic pathways and accordingly, mostly type II muscle fibers are involved in the process. Those muscle fibers are most prone to development via high intense strength training methods like the slow-dynamic method. Our methodology increases not only maximal strength but the ability of the body to generate it constantly for long periods of time – the strength endurance (Frontera, W., William, E., 1990).

The average value of of the participants in our study was 48,70 ml/kg/min at the beginning. Our data corroborate the results of other researchers – for example, Wilmore and Costill reported values of 40-56 ml/kg/min for female club volleyball players at Great Britain aged 18-22 years (Wilmore and Costill, 2005). Eight weeks later, at the end of the experiment, the average value of of our subjects was 51.13 ml/kg/min – a statistically significant difference of 2.43 ml/kg/min. reaches its maximum between 17 and 22 years of age (Melo, RS, 1997). Studies report that its rate of increase is at its maximum between 15 and 18 years of age (for middle- and long-distance runners) (Божова, И., 2018). Our experimental conditioning methodology successfully increased the despite the fact that the participants were older – 23.7 years of age on average. The other parameter of aerobic fitness we

tested for, the pulmonary ventilation, also increased in value (a statistically significant difference). It was aimed at increasing mostly strength, but in our opinion, the main reason for the increase in the aerobic capacity was an undergoing process of transferring of physical abilities. We consider the slow-dynamic conditioning training a powerful tool for inducing peripheral transformations, which to stimulate favourable changes in aerobic capacity. Kraemer, W., et al have reached similar conclusions in their studies (Kraemer, et al 2003).

The literature is reported that resistance training together with specific volleyball training significantly increased aerobic endurance as evidenced by the improvement in 20m Multistage Run Test and VO_{2max}. The volleyball players increased their 20m Multistage Run Test from 1960 to 2300 (m) and VO_{2max} from 57.6 to 62.2 ml/kg/min (Armagan Kafkas et al, 2018).

We expected our methodology to stimulate a reduction in maximal heart rate. Instead, measured slightly higher values (statistically insignificant difference) at the end of the experiment. In our opinion, this was due to increased volatility of the processes of adaptive readjustment of the function of the cardiovascular system because of the relatively short duration of the experiment.

The experimental special conditioning methodology we studied increases oxygen consumption after a heavy resistance training set. It raises lactate concentration, oxygen insufficiency and metabolic stress. The body adapts to those changes via improving its metabolic resistance and its abilities to work in an impaired homeostasis

environment. Additionally, it develops mechanisms for counteracting the metabolic discomfort and of increasing its efficiency of oxygen delivery and utilization. Those adaptations, both directly and indirectly, improve the capacity of oxygen consumption. At the same time, the special program did not impair the aerobic capacity of the participants. In our opinion, the main practical advantage of our special conditioning methodology is its potential to maintain or even increase using such an unconventional approach as the slow-dynamic training methodology.

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