International Journal of New Technology and Research (IJNTR)
ISSN:2454-4116, Volume-2, Issue-5, May 2015 Pages 30-33

Case Study: Proposal for Training in Combined Plyometrics and Muscular Strength in Improved Vertical Jump in Beach Volley

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Abstract: **This study examined the effects of combined training in improving the vertical jump Counter Movement Jump (CMJ) on a beach volleyball athlete. The athlete's age (19 years), weight (62kg) and height (1,78cm) participated in a combined program overseen by six weeks consecutives, which consisted of strength training (weight training) and plyometrics (jumps). Descriptive analysis (mean and standard deviation) and even the t-test with $p \leq 0.05$ significance level. After 6 weeks program was significantly change the pretest: height of the jumps (0.29 ± 0.03) and time of flight (0.42 ± 0.00) compared to the post-test (0.43 ± 0.01) ($p \leq 0.05$) and (0.57 ± 0.00) ($p \leq 0.05$) respectively. It was been possible to acquire 14 cm vertical jump. This study suggests that the combined program of six weeks can positively change the vertical jump height and jump flight time Counter Movement Jump (CMJ) which may contribute to the improvement of athletic performance.**

***Index Terms*—beach volley. plyometric, power rating, vertical jump height, volleyball**

I. INTRODUCTION

In each sport is necessary the development of different specific physical qualities that are employed during their practice [1]-[2]. In beach volleyball over the years with its changes to the rules the athlete should fundamentally provide a good physical strength, such as speed (reaction and displacement) , agility, explosive power and maximum force [3]-[4]-[5].

The vertical jump is indispensable for volleyball, as well as, among other sports, since its implementation has a direct influence on the outcome of the match.

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A successful athlete must not only be able to jump high, but also able to reach this point quickly, which requires an ability to generate energy in a very short time [6]. Nevertheless, as in[7] in basketball, [8] in football and basketball and [9] in tennis, [10] in handball corroborate their studies ensuring that the jump is a basic action to sports that can take advantage in offensive and defensive actions.

Previous studies show that the combination of strength resistance training associated with the explosive power (plyometrics), are more efficient than applied alone in improving vertical jumps [11]-[12].

In their investigations, [13] reported that individuals who participated in resistance strength training combined with plyometric, show significant improvements in speed, agility and muscle power in relation to others who participated in the survey in strength resistance training and plyometric separately.

Reference [14] show in their search with young people from 14 to 16 years engaged for 12 weeks of combined training (plyometric with muscle strength) and evaluated in various tests, it has already shown up in the 1st and 2nd most efficient week than the isolated training and during the entire period of training.

Guided by these arguments, the purpose of this investigation was to evaluate the effects of a training period of six weeks of power training (plyometric) combined with the dynamic force (muscle strength) in order in the vertical jump improvement in beach volleyball athlete.

II. MATERIAL AND METHODS

Instruments Procedures

Two evaluations were performed, a pre-test to check the performance in the vertical jump and a post-test after 6 weeks of completion of muscle power training (plyometric) and weight training. For the vertical jump test was used an Italian device known as Sensorize (Free Power jump NEXT®[15]), in order to verify the athlete's jumping height. In turn, to evaluate the maximum force (muscle strength), was held the maximum load test 1RM in the exercises (horizontal leg press, squat with free bar and leg curl). The training was implemented in the period in which the assessed athlete was in the specific periodization phase for power training.

The vertical jump used as power evaluator was the Counter Movement Jump (CMJ) from the [16] study. For its implementation, the athlete started from a static standing position with hands on hips, feet shoulder width apart and the body fully extended. After the bending of the lower limbs (90º) (opposite movement to jump), the athlete performs a

vertical jump, the athlete being instructed to jump the greatest possible speed, as high as you can (without removing hands from the initial position). The athlete performed three times of the CMJ, using the average height of jumps as a performance indicator.

The collection of anthropometric data was adopted the standard established by the International Society for Advances of Kinathropometry (ISAK, apud [17] in order to record the height, body mass, skinfold thickness and body circumferences. In anthropometric measurements we used the mathematical model for the body density of women developed by [18], the equation of [19], the percentage of body fat and body mass index (BMI) developed by Quetelet (1841). Consequently on checking of body mass and height was used a portable digital scale anthropometric (Plenna®, Brazil) and a portable stadiometer (Sanny®, Brazil) with precision 0.01kg and 0.001M, respectively. In measuring the skinfolds the same measure was used in all measures (Lange®, USA) with precision 0,01cm. Finally as the perimeters was used a metal tape measure anthropometric (Sanny®, Brazil) with precision 0.01cm.

Table 1- Anthropometric characteristics of athlete

Variables	Data
Age (years)	19
Body heigth (cm)	1.785
Body mass (kg)	62
BMI (kg/m²)	19.46
% fat (%)	11.9
Lean body mass (Kg)	54.730
Muscle mass (kg)	50.331
Fat mass (Kg)	7.270
Residual mass (kg)	3.992

BMI (body mass index), Kilogram per square meter (kg/m²)

Fat percentage (%), Centimeters (cm), Kilogram (kg)

Participants

All experimental procedures only started after verbal and written consent to participate in the study, prepared in accordance with the Declaration of HELSINKI (2008), as described in the Consent and Informed (IC). This study met the Standards for Research Achievement in Human Beings, Resolution 196/96 of the National Health Council of 10/10/1996.

The selection of the subject for the intervention group was conducted through random sampling intentional. Thus she attended a beach volleyball female athlete of a professional team, aged 19 years (youth category), which had at least two years of practice in the sport.

III. Procedures

The combined training (plyometric and weight training) were performed with the frequency of twice a week for a period of six consecutive weeks. The weight training was composed of exercises, Leg horizontal press (LHP) on a machine (Technogym®), Squat exercise (SE) with free bar and leg curl (LC) machine (Technogym®). Initially, the athlete performed a test of one repetition maximum (1RM) to determine the load for the training that was set between 85-90% of 1RM. The 1RM test followed the procedures proposed by [20]. Lined in [21] study was established for plyometric training, deep jumps and jumps on the box. The materials used for training were box and one (1) of 30 cm mat used to cushion the impact of the drop jump. After the end of six weeks of power training (plyometric) and weight training, the athlete again held evaluation of CMJ.

Once the load of 1RM strength training (weight training) comprised of two weekly sessions performed in (Monday and Thursday) respectively, totaling 12 sessions (six weeks), and the 1st to 4th weeks were worked with loads of 85% 1RM and the 5th and 6th weeks with loads of 90% of 1RM. The following order of exercises was established; horizontal leg press, squat with free bar and leg curl, being held 4 series (sets) of the 5 repetition with 2 minute intervals between sets and five minutes between exercises, according to [22] studies. Pursuant to, the plyometric training also comprised of 2 weekly sessions (Tuesday and Friday) following the same pattern of sessions in six weeks. The sequence of jumps was performed this way: first exercise - jump on the box with both feet resting on the same and the second exercise - depth jumps. The first exercise consisted of 4 sets of 8 jumps and the second exercise for 3 sets of 6 repetitions, totaling (100 weekly jumps). As found in studies of [23] and [24] weekly was adjusted to box height, starting from 35 centimeter to 60 centimeter, as well as between the series be observed 2 minute intervals and between 5 minutes of exercise. A heating protocol is designed for both training (plyometric and weight training), in order to standardize the study consisted of: quadriceps stretching, hamstrings and gluteus (2 series of 20 seconds in static position) and after 5 minutes bike without loads.

IV. Statistical Analysis

For the statistical analysis, descriptive statistics, mean and standard deviation and inferential analysis comparing the pre and post-test was carried out, we used the t -test. The level of significance was set at ($p<0.05$) and used the version 22 of SPSS

V. Results

In Table 2 are shown the values of the variables of the 3 vertical jumps of the pre and pos-test.

Table 2 - Average values and standard deviation (SD) of vertical counter movement jump, with percentual (%) and respective gains as well as *p* values at pre and pos test

Parameter	Pre test	Pos test	Gains	Values
	Mean / SD	Mean / SD	%	P
Height (cm)	0.29±0.03	0.43±0.01	27.49	0.043*
Flight time (s)	0.42±0.00	0.57±0.00	20,24	0.050*
Muscle Power (w/kg)	25.95±0.99	26.55±3.07	1.61	0.784
Concentric work (j/kg)	6.90±0.74	8.66±0.45	15.99	0.032*
Eccentric work (j/kg)	-4.02±0.82	-4.30±0.36	-4.75	0.547

***Significative differences to p≤0,05, Centimeters (cm), Second (s), Watts per Kilogram (w/kg), Joule per Kilogram (j/kg)**

For the variable values of the vertical jump in centimeters (cm) of pre and post-training, they were found 0.29 value in the pre and post workout 0.43, showing a difference of 14 cm between tests, as well as we observe significant values statistically variable height ($p \leq 0.40$), flight time ($p < 0.05$) and concentric work ($p \leq 0.03$) of 3 vertical jumps of the pre and post-test noted in table 2.

VI. Discussion

In this experiment it was found that when performing a combined training protocol (plyometric and weight training) with volume and intensity in different numbers of sets and repetitions for 6 weeks, showed a difference in height in the Counter Movement Jump.

Reference [11] show in his study used plyometric training (PT), strength training (ST) and the combined training (CT) to assess the improvement of explosive strength in lower limbs in 34 male athletes divided into (TP), (TF) and (TC). The tests evaluated were the Squat Jump and the Counter Movement Jump. The results of the weighted test did not show statistically significant difference in the income of three groups for the two evaluated heels. The above study had the training time last for six weeks with a weekly frequency of 2 times, as well as this proposed study who also had the same duration and provide meaningful data regarding the vertical jump for jump Counter Movement Jump as shown in table 2.

However, the study [7] found significant results in vertical jump test. The study aimed to clarify the effects of a training program combined for eight weeks with a frequency of three times a week with 35 players of a basketball team. The test used was Sargent Jump Test (vertical jump test). The result was statistically higher ($p < 0.05$) compared to the initial test, which confirms the research proposal, even though the type of jump used by the researchers have been different, but the proposal of combined training has assorted superior effect the control group.

Reference [14] show pointed out in their study that a ten week program that included training combined, significantly improved strength and vertical jumping ability ($p < 0.01$) in 72 adolescent boys , compared to the group who trained alone training strength and plyometric.

Similarly, [13] investigated 60 students male, eight weeks conducting training 3 times a week and only one training session per day, divided in four training groups consisted of a group of plyometric, strength training, combined training and control groups with the aim of identifying which of the proposed training would improve explosive power and muscle strength in the lower limbs. The study results showed that all three training produced significant improvement in explosive strength and muscle strength compared to the control group, but it was evident that the combined training protocol produced the greatest impact ($p < 0.05$) than resistance training and plyometric alone.

As for the study of [12] that during seven weeks found that the plyometric training, strength training, maximum strength and combined training was able to improve the vertical jump performance and muscle strength in 65 physical education students. But the findings of the authors, it was evident that the combination of strength training associated with plyometric becomes more efficient than each program performed alone.

The results of [8] with 40 athletes from basketball and football explained that the group who participated in the combined training had improvements in vertical jump and anaerobic power in race ($p < 0.001$) compared to the group that made the isolated strength training, it shows that it is in accordance with the research proposal that the combined program of strength and plyometric training can significantly increase the ability in the vertical jump.

Although this research has shown significant results, it may present some limitations, as only one athlete (despite being Olympic athlete). Moreover, it was not possible to assess during the eight weeks, due to the proximity of the competition (World beach volley U21) and finally, no recourse to a control group.

VII. Conclusions

According to the obtained results, the weight training combined with plyometric revealed a significant effect on vertical jumps compared to other training methods.

After six weeks of work increased, it was possible to obtain 14 cm of gains in vertical jump.

It seems important to the realization of the use of combined training work, in view of the results obtained in this study.

It is recommended that further similar studies are conducted with the highest number of participants and control group, considering the influence of other methodological variables during the experimental process so that they can produce results that indicate the superiority of one or more methods, which may lead the athlete to have a great performance.

VIII. Practical Implications

The present findings suggest that Beach Volleyball coaches should use combined strength and plyometrics training programs with regularity throughout the competitive season in order to achieve gains in maximal strength.

By other hand, we suggested that in practice the coaches to use whenever possible a combined training, because as shown in this study, an increase of 14 cm in vertical jump after 6 weeks of combined work. If we increase to 8 or 12 weeks, the results can still be better. However, it is recommended that before starting the combined work there is a monitoring of the implementation of technical and without great expense using plyometrics boxes.

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