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The Control of Explosive Force Training in Volleyball Using MGM 15 Jumping Mat

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Abstract

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Background. Explosive force testing provides information on the effectiveness of training methods and can provide enough evidence on the quality of adaptation and future orientation in training programming. Using equipment that provides objective and stable information on the physical status, provides coherent guidance to dosing means and adapting effort to each sport possibilities. Aims. The research aimed to study the effectiveness of a training method on a female volleyball team using the MGM15 jumping mat. Methods. The Miron Georgescu modified test with 15 jumps – MGM15 was used to evaluate the explosive force on a female volleyball team. The determined parameters were the unitary power (PU) on both legs, on the right leg (Pud) and left leg (Pus), the average height of jumps (Hzbor), the repetition speed (Vrep) the difference between the unitary power on both legs and the unitary power on the right and on the left leg. Data interpretation had as support a reference values kit of performance level. Results. The values of unitary power and average height of flight shows a middle level of training, insufficient for competitive sport. Repetition speed registered weak values. The difference between the power unit on two feet and the power unit on both feet expressed lack of force. The values of determined parameters are low for both parameters of force and speed. Conclusions. Research results show an average level of training, which is insufficient to competitive sport. Training program does not provide a suitable training as regards the explosive force.

Keywords: testing; physical effort dosing; control; intervention.

1. Background

Dynamic control and training programming aim to obtain sports performance and to protect the health of athletes. Explosive force training leads to adapting the organism to sports performance requirements. Examinations and physical testing standards ensure a control of the effectiveness of methods, but offer no clues on the quality of adaptation and orientation perspective.

Researches in this field have focused on analysing muscle strength of the athletes. Johnson and Bahamonde (1966) explored the power on the force platform in athletes of both genders. By multiple regression was performed predicting power: maximum jump height and maximum power. Raţă et al. (2010) studied the correlation between maximum power and possible maximum power by jumping on two feet and one leg, on the components of a volleyball team, division A, using the MGM15 jumping mat.

Our team researches were oriented towards the correlation between unitary power and body mass index, height, weight, maximum jump, repetition speed of junior volleyball players, students, division B and division A championship players (Mureşan, 2013; Mureşan & Bulduş, 2013).

The originality of this paper consist in using the performance testing with the jumping mat to evaluate the training level of the volleyball team and to make proper indication to adjust the physical preparation in accordance to individual characteristics of the athletes.

Aim

The research aimed to study the effectiveness of a training method that used as control mean the MGM jumping mat, on a female volleyball team.

Objectives

The objectives are:

- To evaluate the quality of the training program of a female volleyball team
- To test the level of performance by testing the explosive force of the volleyball players on the MGM15 jumping mat

Materials and Methods

Subjects

The subjects were players with different performance levels, components of a volleyball team in division B. The research was conducted in Cluj-Napoca between January 3 and February 17, 2014.

Testing explosive force on the MGM15 jumping mat took place at the Research Centre of the Faculty of Physical Education and Sport.

We mention that according to the Helsinki Declaration, Amsterdam Protocol and the Directive 86/609/EEC, there is the approval of Ethical Commission from the Department of Physical Education and Sport from the Babeş Bolyai University of Cluj Napoca.

Methods

1. Miron Georgescu evaluation test modified with 15 jumps - MGM-15

This test follows a scientific approach through a specific paradigm of physics involved in assessment of human performance. Hillerin (2009), one of the inventors, consider that premise of such

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a test was that optimum results are achieved by athletes who move with greater velocity and force than their opponents.

1.1. Jumping mat MGM-15

Jumping mat is an equipment that, through the installed program and sensors connected to PC, is recording ground contact times and duration of the stay in the air of the 15 valid jumps. Testing the athletes with the jumping mat MGM-15 provides information necessary to substantiate individualization of explosive strength training.

Testing performed consisted of record and electronic processing of the time spent on the ground and time spent in the air over 15 consecutive jumps on two legs and one leg.

The first series of jumps are executed on both feet, the second series on the right foot and the third series on the left foot with breaks imposed by data processing speed of the computer (30 "-1 ").

The test results are estimated by a rating system. Thus subjects, coaches etc., they can more easily assess the performance than through exposure of meaningless numbers in the practical system of values.

The computer interprets the data with speed, stability and accuracy.

1.2. Energetic parameters

Energetic parameters obtained by jumping mat give information about the body's energetic resources of the subjects.

a) Average unitary power (PU)

PU during jumping (on both legs, right foot and left foot) provide data on:

- conditional preparation orientation in sports training;
- information on the qualities of force-velocity (F-V).

Power is measured in watts reported to kg, where Tai = time in air; Tsi = time on the ground; where i is the serial number of the jump after removing data outliers.

PU - this type of indicator is calculated many times for engines, when performance is significant. In sports with jumping, weight can affect performance by loading additional body to be off the ground. Determining the optimal weight of the athlete aims to harmonize the variables involved in the training.

Hillerin (1999) provides data on average unitary powers in jumping on both feet, right leg and left leg.

Table 1. Reference values for average unitary powers are:

Values	Women	Men
Weak development	<3.5 W/kg	< 4.5 W/kg
Average	3.5 – 4 W/kg	4.5 – 5 W/kg
Good	4W/kg < PU < 4.5 W/kg	5W/kg < PU< 5.5 W/kg
Exceptional	>4.5W/kg	>5.5 W/kg

b) The difference in unitary power

In general negative values:

– 1 W/kg, (balance between V and F);

> - 1 W/kg to 0 W/kg, or positive, force deficit;

– 1.40 W/kg -1.80 W/kg, light force excess, compare with the values of speed. If these are weak, reduce power load emphasizing fast executions in strength training. If V.R. values are average or good, continue with the used loads, but with an emphasis on faster executions V;

-1.8, -2 W/kg. Shall be understood as excessive force, probably reducing speed, but depends on the sport (for throws or weightlifting is normal). It is recommended to reduce the load and it is desirable that executions are faster.

c) The average height of flight (Hzbor)

Provides information mainly oriented towards power, characterizing the effort expended in testing mainly on the qualitative aspect of force (FVF).

This value is different from the landmark expansion measured at the head or arm extended above: raising on the toes (which depends on the mobility of the ankle joint and foot length) and scapular-humeral joint mobility may influence different values of the jump.

Both types of parameters (PU and Hzbor) are interpreted as proportional to the numerical value obtained: the higher the value, the better the measured quality value.

Table 2. Reference values for average height of flight (FVF) are:

Values	Women	Men
Weak	>200 ms	> 200 ms
Average	180ms – 200 ms	180ms – 200 ms
Good	170 ms – 180 ms	170 ms –180 ms
Exceptional	< 170 ms	< 170 ms

d) Repetition speed (Vrep)

The parameter called repetition speed is the mean of remaining time on the ground and provide information oriented to FVV; measured quality is even better as the numerical value of the parameter is lower in jumping on two feet.

Guidance values:

- Between 160-165 ms, very good values of speed;
- Between 170-180 ms average to normal values;
- Over 200 ms very weak values of speed.

Repetition speed is one of the main forms of the motor quality - speed. Highlights the rapidity of the successive processes of excitation and inhibition in the nerve cells and processes of contraction with relaxation in the muscle.

When operators offered the test automation and test were performed on one leg, it was noted that: Pud + Pus is different from Pua.

If the curve (force - velocity) should be constant power (Fv = ct) should be as Pua = Pud + Pus, but in reality it is not.

If jumping on one leg, the load is greater and effort is placed on the Hill curve at lower speeds. In jumping on two feet, we have high speed; the remaining on the ground times are smaller and we have lower forces values.

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At a certain muscle structure each individual is performing at a certain ratio force- velocity. This shows that there is a special area for higher yield, which may occur by balancing speed - power ratio.

To improve performance through training intervention is important to determine the area where the individual specificity manifests and move to the area of interest.

The difference in power unit gives information on the imbalance occurred in the force- velocity relationship training:

• noted that when training is geared towards large forces, to reach large differences, up to (-1.8) and even (-2) W / kg

• When training is geared towards speed (or low force) differences are in (-1) W / kg tending to zero or even become positive;

Unitary power on both legs is different from the sum of the unit on each leg separately: PU both legs ≠ (PU right +PU left).

Indicative values:

- normal athlete (-1 W / kg); balance between V and F
- weak force (high speed) to values between -1 and 0, or positive; force deficit
- high force (low speed) occurs at values between - 1.8 and - 2W/kg; slightly excessive force

Example: if the power difference values are between -1.40 and -1.50 W/kg can keep the same force, but that training must be geared towards speed training.

Under these values in meaning trend towards (-2), we have low load (force) and worked mainly for speed.

We have analysed data on the unitary power (PU), repetition speed (Vrep) the difference between PU and the unitary power on the right foot (PUd) and unitary power on the left leg (PUs).

Data interpretation had as support a table of performance level offered by one of the inventors of the jumping mat "Miron Georgescu" (Hillerin, 2009).

Recording and analysis of performance is provided on a transversal research that shows the effectiveness of the method of preparation.

From discussion with the coach is revealed that he does not wish the intervention training methodology during the championship, as long as they meet performance targets. Tests and analyses will become milestones for the next year competitive training.

Means used during the time period 03.01.2014 - 15.02.2014.

Methods used to develop explosive strength are:

1. Semi squats with the weight of the weightlifting bar;

2. Lift on the toes with weights chosen by the athlete;

3. Jumping from lunge with weights of 5 kg;

4. Weight press with convenient weights for athletes;

The total power load for the weekly cycle, on mezocycle or macrocycle or workload expressed in kg is calculated by multiplying the number of series with the number of repetitions and with the number of kg.

Example of a workout:

Squats - 4 series x 50kg x 8 repetitions (4 x 50kg/8) = 4 x 50x 8 = 1600kg = 1.6 tones.

Jumping like the ball with weight of 40 kg - 4 series x 40kg x 10 repetitions (4 x 40kg/10) = 1600 kg =1.6 tones.

Total on the two exercises or means: 1.6+1.6 =3.2 tones.

2. Results

Values of height, weight and body mass index (BMI) are shown in table no.1 and graph no.1.

Table 3. Body mass index (BMI)

Name	Height	Kg	BMI	
BA	176	70	22.6	normal
BRada	175	66	21.5	normal
BR	176	73	23.6	normal
BS	174	56	18.5	lower limit
CA	179	62	19.3	normal
CN	180	65	20	normal
DR	170	64	22.1	normal
GC	180	63	19.4	normal
MA	180	61	18.8	normal
ND	178	70	22.1	normal
PM	180	67	20.6	normal

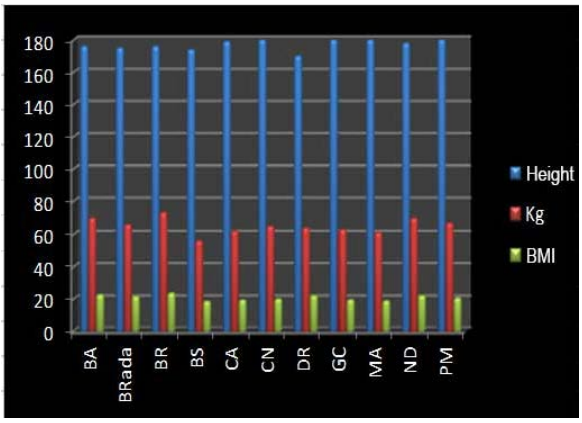

Fig.1. Body mass index (BMI)

Values determined from somatometry show that squad is heterogeneous with height not fall into the somatic pattern of international volleyball players proposed by Romanian Volleyball Federation: centers female players must be over 185 cm, setters over 174-176 and extremes higher than the latter.

Weight is quite high, considering that the optimum weight for performance volleyball players results from taking of 10 units from the number of centimetres that pass over a meter in the height of the athlete, even if BMI is normal for the population being considered unsportsmanlike (Cordun M., 2009, pp. 138-139; pp. 90-91).

The values shown in table no.2 and chart no.2 express the unitary power on both feet (PU), on the right foot (Pud) and left foot (Pus).

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Table 4. Unitary powers expressed in ratings

Name	PU	Pud	Pus	
CN	4.24	2.39	2.61	Good
MA	4.14	2.61	2.56	Good
CA	4.18	2.16	2.51	Good
BS	4.58	2.3	2.32	Excellent
GC	3.93	2.07	2.29	Medium
BA	4.33	2.08	2.05	Good
DR	3.74	1.98	1.98	Medium
BR	4.19	2.46	1.69	Good
PM	3.59	1.46	1.54	Medium
ND	4.19	1.79	1.53	Good
BRada	4.36	1.98	1.34	good

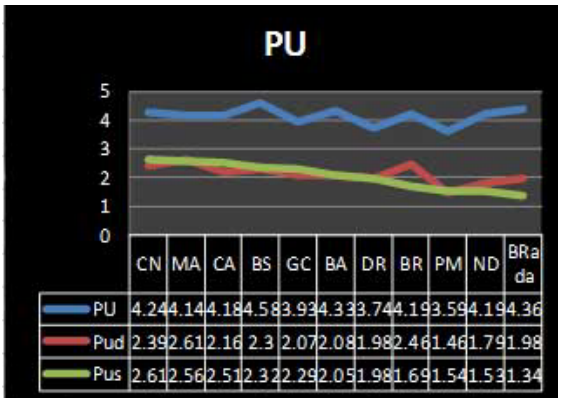

Fig. 2. Unitary powers

At some players we can notice quite large differences in values between the unitary power developed on one leg and the other.

Unitary power values express the quality of training and provide athletes the opportunity to intervene in the optimal dosing of effort by increasing or decreasing series, the number of kg high or the number of repetitions in the series. It is recommended to test the quality of about 10 workouts. One single athlete recorded exceptional values. All other fit in average and good qualification, which expresses a certain lack of control over dosage training.

The value of Hzbor, Hzbord, Hzbors are shown in table and graph nr.3.

Table 5. The average height of flight

Name	Hzbr	Hzbrd	Hzbrs
CN	0.28	0.14	0.17
MA	0.28	0.19	0.17
BS	0.33	0.15	0.16
CA	0.29	0.14	0.16
GC	0.26	0.14	0.15
BA	0.32	0.13	0.13
DR	0.25	0.13	0.13
BR	0.28	0.15	0.1
ND	0.29	0.11	0.1
BRada	0.32	0.13	0.08
Average	0.28	0.14	0.13

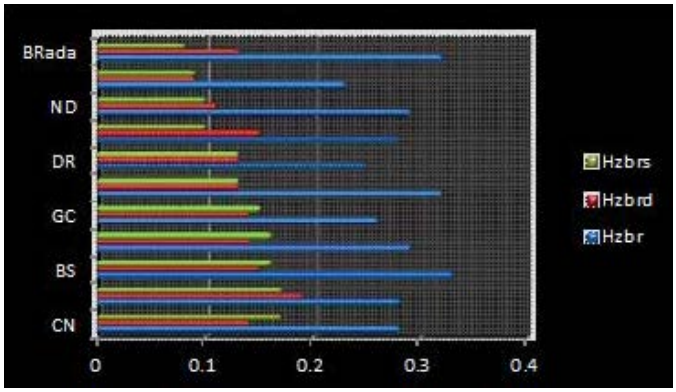

Fig. 3. The average height of flight

The average height of flight gives information about the repetition speed of the players. Particularly interesting is the jumping height on both legs, as none of the players use jumping action game based on one leg.

Hzbor values obtained by each player are significantly related to PU as shown in Table no.4.

Table.6. Comparison between Hzbor and PU

Name	PU	Hzbor
BS	4.58	0.33
BRada	4.36	0.32
BA	4.33	0.32
CN	4.24	0.28
BR	4.19	0.28
ND	4.19	0.29
CA	4.18	0.29
MA	4.14	0.28
GC	3.93	0.26
DR	3.74	0.25
PM	3.59	0.23

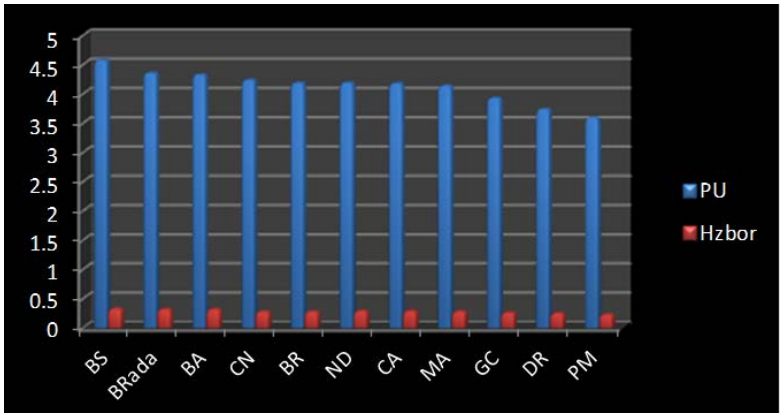

Fig. 4. Comparison between Hzbor and PU

The corresponding values of PU and Hzbor are displayed in descending order. The comparison between PU and Hzbor demonstrates that high levels of PU corresponds to high values of Hzbor. We consider that appropriate values of 0.29 to Hzbor are random or express other variables and fit into the same group 0.28 - 0.29.

Vrep, Vrepd and Vreps values are shown in table no.5 and chart no. 5.

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Table 7. Repetition speed

Name	Vrep	Vrepd	Vreps	
BRada	0.22	0.33	0.36	weak
DR	0.22	0.33	0.34	weak
ND	0.2	0.31	0.34	weak
BA	0.23	0.29	0.32	weak
BR	0.19	0.27	0.32	medium-normal
BS	0.2	0.32	0.32	weak
PM	0.21	0.34	0.32	weak
GC	0.21	0.33	0.3	weak
MA	0.21	0.33	0.29	weak
CA	0.2	0.32	0.28	weak
CN	0.18	0.26	0.28	medium-normal
Average	0.21	0.31	0.32	

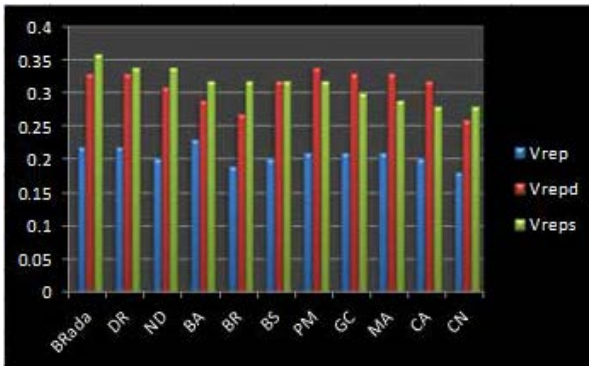

Fig. 5. Repetition speed

Qualitative analysis from the right side of the table no.5 reveals that the values are very low for the repetition rate. Two sports have average values but that cannot provide notable performance.

Chart no.5 represent differences between repetition speed on two feet and on one foot. Sports group is homogeneous, but at a lower level.

Differences in unitary power and power percentage differences are shown in the table no.6 and chart no.6.

Table 8. Differences in unitary power and power percentage differences

Name	Vu	Vp	
BRada	1.04	23.84	force shortage
ND	0.86	20.56	force shortage
PM	0.6	16.6	force shortage
BA	0.2	4.61	force shortage
BR	0.04	1.01	force shortage
BS	-0.04	-0.9	force shortage
DR	-0.22	-5.99	force shortage
GC	-0.43	-11.04	force shortage
CA	-0.49	-11.72	force shortage
CN	-0.76	-17.92	force shortage
MA	-1.03	-24.86	force shortage
Average	-0.02	-0.53	

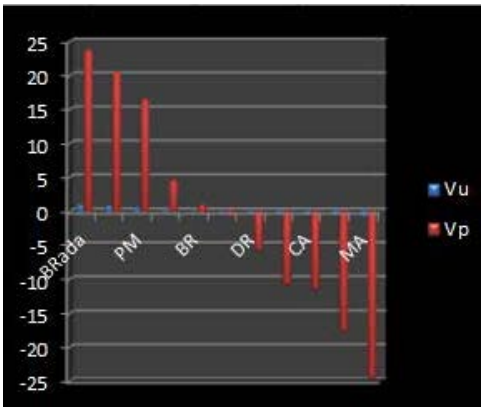

Fig. 6. Differences in unitary power and power percentage differences

Differences in unitary power expressed both the table and chart show that the preparation of force is weak for the volleyball players from Division B.

3. Discussion

Preparing lower limb explosive strength ensures high impact point for the spike, block and speed for short runs and jumping service.

Data analysis shows that athletes are not prepared intensively for explosive power but are not overused in other respects. From health perspective the medical principle "Primum non nocere" is respected.

We believe that although the coach has used a recipe adapted to specialists (Bompa, 2003; Cardinale, 2000), the lack of a benchmark such as lifting maximal value (RM) does not ensure control and consistency to explosive strength training. Yet the coach is prepared in the future to use the MGM15 jumping mat as a means of controlling the quality of the training and start a new selection and accurate recording of individual potential of the players.

4. Conclusions

Unitary power values and the average height of flight show a medium level of training, insufficient for competitive sports.

Repetition speed recorded low values. To correct this, requires a selection of volleyball player average equipped in terms of the quality of motor skill - speed. It requires a corroboration of the repetition speed to personal optimal weight of athletes.

The differences between the unitary power on two feet and the power on the right and left feet expressed, with one exception, force deficit.

The research proves that the use of the jumping platform MGM15 provides the coach with control over the effort for the individualization of the explosive force training.

5. Conflicts of interest

There are no conflicts of interest.

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