KINANTHROPOLOGY ANALYSIS OF POLE VAULT

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Abstract

Pole vault is one of the most complex, and probably the most complex athletic discipline in addition to long jump, high jump and triple jump. It is one of the jumping discipline, and it is used for probing rod. The aim of this study was to perform biomechanical analysis and determine the necessary morphological characteristics, motor skills, personality traits for achieving good results. It can be used by coaches, both in selection and in programming training.

Key Words: pole vault, motor abilities and morphological characteristics, personality traits

Introduction

By analysis of specific sports, athletic activities or positions on the team, we can get the necessary data that are relevant for the technician who conducts the training. This primarily refers to the knowledge of motor skills that are relevant for a given discipline, morphological characteristics, personality traits ... This way it can be carried out a selection and grouping of those who are tentatively destined for a given sport, a sport or position the team. The next thing to be done by an expert is by use of information obtained from the analysis to make proper planning and programming of training which is the only way to achieve top results.

It can be noticed that modern technology is a key to achieving good results and world records. Also, the technology can be used in the training process, in order to improve. Exactly in the discipline pole vault, it can be seen the impact of technology in the training process and the competition. In the training process it can be used cameras with different frequencies in order to analyze the movements, and the competitors can use different poles of the overshoot at the competitions. It is fact that the best result of the first modern Olympic Games was 3.3 m, and the current record is 6.15 m. Sometimes it was used to be stick of ash, spruce, bamboo, cedar, and today is used fiberglass poles.

Pole vault is one of the most complex athletic discipline in addition to long jump, high jump and triple jump, and it is one of the jumping discipline, with specific that it is used for probing rod. Components that are essential for achieving good results in the pole vault as running speed, reflection, swing leg, elastic force poles and reflect the hands on the pole. This discipline requires good physical and technical preparedness, and psychological stability of an athlete. It is known that the pole vault is an individual sport disciplines and psychological preparation is even more important for beating a rival, a personal record or some planned level. Just moving the runway is very complex, and the jumper is required performing accurate and movement arranged in proper order.

The aim of this study was to perform biomechanical analysis and determine the necessary morphological skills, motor skills, personality traits for achieving good results. It can be used by coaches, both in selection and in programming training.

Material and Method

The work is based on the collection and analysis of data from the literature.

Structural Analysis

If we observe the movement and moves in pole vault discipline from beginning to end, then the pole vault is acyclic discipline, which consists of a cyclic motion, or running, and acyclic movements bounce,
flight and landing. Tentatively movement in athletic discipline pole vault can be divided into four phases. These are: 1. run-up, 2. rebound, 3. flight, 4. landing

**Structural analysis of the run-up**

The phase run-up is very important for achieving good jump. At this stage, the jumper needs to realize that a higher speed will increase the pressure component. In phase running it can be noticed several elements to grip the pole, running and poking sticks in the box.

**Grip.** Before the start of the run-up, jumper must be good to grab the pole. The pole is captured depending on the dominant hand of the jumper, dominant hand should be at the top of the pole. Width captures approximately shoulder-width apart, but it is something that mostly depends on the jumper. Narrow grip provides a better jumper momentum and direction of the leg up as dragged by participating in both hands. The wider grip is generally used when the wind blows in the chest, and then the rod and catch is a little bit lower.

**Run.** Running in this discipline is very important, because it has to be soft, rhythmic with progressive with optimal speed. This phase begins with the free standing start. The length of this phase is on average, between 38m to 42m, which is usually run off with a 18 to 20 steps (Petrov, 2004). Running is also specific because the jumper carries the pole. At the beginning of the running angle between the pole and the ground is about 60°, and so rebounder reaching speeds approaching the box stabbing poles so the angle between the pole and the ground decreases. In addition, during the running speed of the coupling oscillates with respect to the exercise of divers hand movements to small amplitudes. The step length and frequency of running are the most important things to achieve good speed in the running. Stride length at initial start is not the same, and it depends on the length of the leg, running technique, flexibility and strength. Most of the jumpers take momentum around 40m for just about 35 - 40m a top speed. In Table 1, it can be seen how important is the running speed rebound in athletic events on the basis of their results achieved in the last 5m.

<table>
<thead>
<tr>
<th>Discipline</th>
<th>Result in last 5m (m/s)</th>
<th>Man</th>
<th>Result in last 5m (m/s)</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long jump</td>
<td>11,2</td>
<td>Lewis (USA)</td>
<td>10,25</td>
<td>Drechsler (GER)</td>
</tr>
<tr>
<td>Triple jump</td>
<td>10,9</td>
<td>Edwards (GBR)</td>
<td>9,5</td>
<td>Kravets (UKR)</td>
</tr>
<tr>
<td>Pole vault</td>
<td>9,9</td>
<td>Bubka (UKR)</td>
<td>8,6</td>
<td>Feofanova (RUS)</td>
</tr>
</tbody>
</table>

Petrov, V. (2004). Pole vault - the state of the art

**Stabbing sticks.** It can be seen that run phase ends when competitors are poking sticks in the box. Last 2m rising pole should be over the jumper’s head. At the time of sticking poles front arm should be slightly bent, and the other arm should be stretched at an angle of 180°. In the phase of reflection, front arm should be slightly bent, and the other should be stretched at an angle of 180°.

**Structural analysis of rebound**

The phase of running is very important for the achievement of good results in the pole vault, but even the reflection, as the initiator of vertical movement is very important. Bounce is very much connected with poking sticks and hard to separate. Reflex foot is still on the ground hips and upper body to push forward, and other leg is bent at the knee and quickly and forcefully pushed upward and forward, in order to acquire good "conditions" for reflection. Immediately after this, the next phase of the flight is begining, which is largely dependent on the running and reflection.

**Structural analysis of flight**

Reflex foot, which was stretched at an angle of about 180° relative to the hull, there is tilting of the hip joint and, thus reflex foot overtaking the other leg. The hands are in the same position as at the beginning of reflection. At the time of stretching the body, the front arm starts its movement flexion and extension expressed by the body and the rear arm begins to bend at the elbow joint. Also, the flight phase comes to rotation about the longitudinal axis, which is achieved for reasons that jumper was facing the ladder when
moving through it. Upon completion of the rotation jumper facing the strip and comes to stretching the front hand first, and then the other hand.

**Structural analysis of landing**

The goal of each jumper after crossing the bar is a safe landing through the bar first crossing legs, due to a slightly curled torso, head and hands. After crossing over the bar jumper continues rotation started and the apprehension of arms and legs on the body safely landing on the back.

**Biomechanical Analysis**

Biomechanical analysis of the pole vault is starting since the rebound. At the time of the rebound comes to pushing the poles, with the two major components, a component of the pressure that is focused on a point of poles and ground, and a component of the vertical motion of the body perpendicular to it. Biomechanical analysis phase of flight can be divided into two sub-phases, and two phases of flight. The first phase of the flight at the very beginning, and this is the most important component of the pressure because it provides bending poles, which is essential for the second phase. The second phase of the flight starts stretching the body and correcting the poles.

**Analysis of trends in the discipline of pole vault**

By simply observing the movement of the pole vault discipline, it is obvious that the horizontal and vertical movement are different.

**Horizontal movement.** In the pole vault discipline, this type of movement is achieved during running. As already mentioned running is realized on a section of about 40m. The aim is to realize a higher speed and thereby increase the component of the maximum pressure.

**Vertical movement.** For the horizontal movement the most important thing is run, but for the vertical movement it is reflection. It is achieved contrary to the force of gravity.

**The effect of force on the jumper**

Simple division of powers in the internal and external can be analyzed, which are the forces that act on a jumper in the pole vault discipline.

Internal forces. Movements in the pole vault discipline is very complicated, and all movement is accomplished by force of muscle, which is accomplished by muscle contractions.

External forces. In the pole vault discipline we can identify the gravity and drag force protection. Gravity, or the force of gravity occurs after reflection where vertical movement is achieved, then the muscle power overcomes the force of gravity.

**Morphological characteristics**

The longitudinal dimension of the skeleton, transversal dimension, volume and body mass and subcutaneous adipose tissue is something that defines the morphological characteristics of a person. In Table 2, it can be seen the height and weight of the best jumpers in the history of the discipline, which of course is not sufficient to conclude that the characteristics are essential for achieving good results.

The longitudinal and transversal dimensionality of the skeleton are the characteristics that can not be changed and they are the most dependent on genetic factors. The volume, body mass and subcutaneous adipose tissue can be changed by training. It is not difficult to conclude that the jumpers are extremely muscular guys, especially the upper body, both when they are moving the runway, and when they are in the air, subcutaneous adipose tissue is an aggravating factor.

**Constitution of the body**

The most commonly applied method for determining the constitution of the body is Heath - Carter method which is based on the classification of types Sheldons constitution. Sheldon involves the use of three components:

1. Endomorphic (relative development of body weight)
2. Mezomorphic (relative musculoskeletal)
3. Ectomorphic (relative linearity of body)

In contrast to the classification of Sheldon, Heat - Carter method comprises a mixture of all three types of constitution, which has a dominant one. It can be concluded that the jumpers in the discipline pole vault belong to the ecto - mezomorph. In this case, the muscle mass is dominant, and ectomorphic component is greater than endomorphic.
**Motor skills**

Based on numerous studies of motor space man, it is widely accepted division between basic and specific motor skills. Basic motor skills include (according Zaciorski): strength, speed, endurance, coordination, balance, agility, accuracy. Specific motor skills are developed in the course of life and sports career and they are the result of a specific operation in a given activity. For the pole vault discipline all essential basic motor skills will be accordingly analyzed below.

**Strength**

The most complex motor ability for analyzing is strength. Strength occurs in all types of motor actions and means overcoming external resistance. To analyze the forces in the jumper it must be acknowledged divisions according to the topological parameters (strength of arms and shoulders, power trunk and leg strength), the action parameters (static, repetitive and explosive power) and divisions in relation to body mass (absolute power and relative power). Power analysis will be carried out in relation to the structure of the movement, which was mentioned above, based on the distribution of power according to the topological and action criteria.

*Phase of run-up.* This phase can be improved by increasing the strength. The muscle flexor and extensor muscles of the lower leg and foot extensors are the most responsible for run.

*Phase of reflection.* The explosive power of foot extensor muscles is the most important for the achievement of a good reflection, which indicates the fact that the reflection is done in the range of 0.11 s to 0.14 s (Katsikas et al, to Kastikas, 1992). It can be added and generated the force to the ground when a reflection of an athlete is between 200 and 300 kp (Milanović, 1994).

*Phases of flight.* The trunk flexors are the most responsible for the other leg. Different positions of arms contribute to the involvement of different muscles while stretching and during the rotation. The flexor muscle strength of elbow last hand, extensor muscles of the elbow joint front hand and shoulder muscles retroflexio are responsible for stretching and rotation. During the rotation, the last hand engages flexors, and resists engaging the extensor muscles of the elbow joint. Firmly grip the pole is very important both for technique and for safety, and that are engaged in the muscles of the forearm, which all the time are in contraction.

**Speed**

For the discipline pole vault the most important is the individual movement and speed of movement. Latency motor response is not significant for the discipline as a jumper on the runway moving freely.

Velocity of individual movements. This type of speed is largely associated with explosive force. Most of the exhibits are reaching feet reflex by tilting the trunk and correcting troops.

Speed frequency movements. Running as an integral part of this discipline involves movements that are repeated for this reason that this type of speed is very important. Top speed achieved in the last 5m, and it is the speed of the factor that gives a good base for a good result. In Table 2, we can see running speed in the last 5m in divers who jumped a height of 6m.

**Table 2. Jumpers with result over 6m**

<table>
<thead>
<tr>
<th>Jumper</th>
<th>Record (m)</th>
<th>High (m)</th>
<th>Height (kg)</th>
<th>Speed in last 5m (m/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bubka (UKR)</td>
<td>6,15</td>
<td>1,83</td>
<td>80</td>
<td>9,94</td>
</tr>
<tr>
<td>Tarasov (RUS)</td>
<td>6,05</td>
<td>1,94</td>
<td>81</td>
<td>9,75</td>
</tr>
<tr>
<td>Markov (AUS)</td>
<td>6,05</td>
<td>1,81</td>
<td>80</td>
<td>9,84</td>
</tr>
<tr>
<td>Hartwig (USA)</td>
<td>6,03</td>
<td>1,94</td>
<td>92</td>
<td>9,73</td>
</tr>
<tr>
<td>Gataulin (RUS)</td>
<td>6,02</td>
<td>1,90</td>
<td>81</td>
<td>9,75</td>
</tr>
<tr>
<td>Trandenkov (RUS)</td>
<td>6,01</td>
<td>1,90</td>
<td>78</td>
<td>9,47</td>
</tr>
<tr>
<td>Brits (RSA)</td>
<td>6,01</td>
<td>1,96</td>
<td>88</td>
<td>9,74</td>
</tr>
<tr>
<td>Lobinger (GER)</td>
<td>6,01</td>
<td>1,90</td>
<td>82</td>
<td>9,62</td>
</tr>
<tr>
<td>Ecker (GER)</td>
<td>6,00</td>
<td>1,93</td>
<td>78</td>
<td>9,71</td>
</tr>
<tr>
<td>Galfione (FRA)</td>
<td>6,00</td>
<td>1,84</td>
<td>82</td>
<td>9,68</td>
</tr>
</tbody>
</table>

Petrov, V. (2004). Pole vault – the state of the art
Coordination

Coordination is a factor which includes the performance of organized movement in space and time, and it is present in all phases of the pole vault, ranging from running, glare, crossing the bar at the end of the collection for a safe fall. It is particularly important to connect all the parts into a whole. Only when you learn the basic movements and trends you can then go to other elements that are essential for the pole vault. If we analyze the model Zaciorskog, where three different events coordination, coordination ability as accurate (exact) performing fast movements, coordination as well as the ability to learn movement and motor coordination as well as the ability to transfer the related and unrelated movements, then we can only confirm how the movement of discipline pole vault is complex.

Flexibility

The analysis of trends in the pole vault discipline is concluded that it is present at all stages. One way to increase speed is by increasing the flexibility of the lower leg flexors, which increases the range of motion and steps. In the phase of reflection and phase of flight flexibility is very important when a jumper sticking pole with bring arms up when jumper resists hands on the pole, where the essential is flexibility of the shoulder belt.

Balance

Balance is a motor skill that involves keeping the movement in a balanced position. Analysis of the balance in the pole vault, it is the best to make the division of the stable, unstable and indifferent. For this discipline are essential equilibrium labile and stable, that are mutually interchanged.

Stable equilibrium. This type of equilibrium implies that the center of gravity is below the surface of the support. This occurs when the jumper is in the initial phase of the flight with the hips under the arms and he is in a stable equilibrium.

Unstable equilibrium. It occurs when the center of gravity of the body above the surface of the palm, or in the starting phase and when the jumper stretched himself in the flight phase.

Accuracy

This motor ability occurs only at one point, during the movement of the pole vault discipline, and that is when the jumper has to hit the box to the pole. Since the movement is done with a stick in his hands, it can be concluded that it is a precision targeting, and managing the coupling to the target.

Functional abilities

The functional potential of athletes is consisted of aerobic and anaerobic energy processes. As per analysis of functional ability in any sport, or sports discipline, it is very important to obtain information on the representation energetic mechanisms and, consequently, to planning and programming training. In the preparatory period, pole-vaulter 25 % applies to strength training, 25 % of the running section, 20 % of the practicing gymnastic elements to gymnasium, 30 % of the training pole vault, and the competition between the 70 % refers to the training pole vault, 30 % on strength training, running and gymnastics (Jerković, I., S. Jerković, Tkalčić, Živčić, Jerkovic M., 2003.)

Anaerobic capacity

It is not difficult to conclude that athletics pole vault is one of the sports discipline anaerobic type. Since the anaerobic capacity divided depending on the source of the anaerobic alactate energy (adenosine triphosphate, phosphate and creatinine) and anaerobic lactate (glycogen), the anaerobic capacity analysis is a very important finding of the duration of the activity. Duration of activity is important in order to know whether it is in terms of phosphate energy system that can supply energy for about 8-9 seconds or glycolytic energy system that is responsible for the activities of 8 seconds to 2-3 minutes. The overall activity pole vault is an average of about 7.5 seconds, and all the movements and trends are submaximal (start running) and the maximum intensity on the grounds that it can be concluded that the discipline pole vault using phosphate energy sources, or adenosine triphosphate and creatine phosphate.

Aerobic capacity

In anaerobic processes, energy is released in the presence of oxygen and it is responsible for the actions of low and medium intensity. It was already noted that the movements and trends of maximum and submaximal intensity, and it can be concluded that aerobic capacity is not so important for pole-vaulter. However, the shares being run at low and moderate intensity in the training process with pole-vaulter used at least once a week, mostly to eject the accumulated products in the body, which were acquired at maximal and submaximal training intensity.
Psychological analysis

To achieve top results is certainly not possible if a person is not healthy and has no certain psychological skills and features. If you have the necessary skills and characteristics, and have a great motor, functional ability, morphological characteristics, its progress has been limited and these athletes generally achieve satisfactory average results. For the pole vault discipline very important are cognitive abilities and conative characteristics.

Cognitive abilities

Cognitive abilities are commonly identified with the term intelligence. In this case, intelligence is a very broad term and is difficult to be defined. Frequently used theory of analysis of the structure is that of Thurston. Some problems he considered to depend on the seven primary factors and one general intelligence second order factors.

1. Spatial (S) - the ability to imagine and represent spatial relationships. Before running, jumpers usually imagine themselves in moments of crossing, in this case, it is essential to have committed a successful probing.

2. Perceptive (P) - the ability to solve tasks that are perceptual present.

3. Verbal (V) - the ability to understand words, their relationships and verbal reasoning. This factor means the ratio of coaches and athletes, and in that respect they need to understand, that athletes understand what the coach wants to say.

4. Factor verbal fluency (W) - the ability eloquence. Easily find a word, a wealth of vocabulary and fluency. The most refers to describe the subjective feelings of the athletes, which are very important for the coach.

5. Factor reasoning (R) - the ability to find general principles and execution of rules and laws of the given data. Based on personal experience, the athlete has to come to other conclusions how best to perform a movement.

6. Factor memory (M) - the ability to direct memory numbers, letters or words. This factor is relatively important for pole-vaulter, refers to memory as to the steps to make the runway, or to remember the words of his coach who said what to pay attention. It also involves theoretical knowledge of their discipline.

7. The numerical factor (N) - the ability of numerical operations basic computer operations. This factor is not so important for pole-vaulter.

Conative characteristics

At the conference, Yelena Isinbayeva's coach, explained what kind of personality she was. "She has a very positive attitude and influence to the group, happy and confident, psychological complex destined for great sports scores. Her mother is Cossacks and father Caucasian, she was not afraid of anything, fighting until the end and as primers in major competitions. She did not have a complex of "star" nobody ever too would respect, simple and stable. Jelena never hesitates " (translated: Spajić, 2004 by: Trofimov, 2004).This quote explains what should be a pole-vaulter. Pole vault is a discipline of an athlete requires certain personality traits, and that in some disciplines are certainly not necessary. Basic personality traits are certainly motivation and temperament, which are essential for athletes. Desirable characteristics of a jumper. Self-consciousness (means that the athlete knows what it wants to achieve), self-control (to direct their feelings for achieving good results, so that its use does not harm), self-motivation (motivation man to reach the goal, including the fantasy of achieving the goal), courage, calmness.

The undesirable characteristics. Anxiety (inner restlessness, fright), phobia (pronounced permanent fear of something), depression (mood disorder), hypersensitivity (hypersensitivity), impulsivity (attention deficit disorder).

Conclusions

Subject to the analysis of the discipline pole vault, it can be concluded that athletes must have well-developed motor skills, especially power, speed, coordination, precision and flexibility, usually belonging to the ecto-mesomorph types, and it is desirable to have the following psychological characteristics: self-control, courage, humility, self-motivation. Discipline pole vault is one of the sports discipline anaerobic type using phosphate energy sources, or adenosine triphosphate and creatine phosphate.
References

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