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Dissertation thesis presented by

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Title

THE RELATIONSHIP BETWEEN SOME KINEMATIC PARAMETERS WITH THE PERFORMANCE LEVEL OF EGYPTIAN HIGH JUMPERS

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Prague 2013

1. Introduction

There was no high jumping event in the ancient Greek Olympic Games. This sport event seems to have its origin at the Celts (Tailteann Games). But modern high jumping began in Germany in the late 18th Century. It started as a physical education activity for children, and then it developed into a competitive sport in England in the 19th Century and soon, afterward, spread to Canada and to United States (Dapena, 2002). The next technique in the evolution of high jumping was the “scissors”, in which the legs are lifted over the bar in alternation one after the other. The advantage of the scissors technique is that parts of both legs are below the level of the bar at the peak of the jump. (Dapena, 2002). The scissors has been followed by the “Eastern cut-off’” technique (in Europe sometimes called the “Lewden scissors”). In the Eastern cut-off the athlete rotates the trunk into a horizontal position at the peak of the jump. The Eastern cut-off was succeeded by the “Western roll” technique. In the Western roll the athlete cleared the bar on his/her side, with the take-off leg tucked under the rest of the body. The Western roll was followed by the “straddle” technique. In the straddle the athlete cleared the bar face-down. The Eastern cut-off technique with the body stretched along the bar (Dapena, 2002).

At the 1968 Olympic Games in Mexico City, Dick Fosbury won the gold medal in the high jump using a revolutionary new technique, which became known as the “Fosbury Flop”. At present, in high jumping the Fosbury Flop is the sole technique used by world-class high jumpers. In general, the high jump can be divided into three parts or phases: run-up (or approach), take-off and flight (or clearance bar) (Dapena, 1996; Isolehto, 2007). The most of all modern high jumpers use the Fosbury Flop technique and the current world records (men: 2.45 m, women: 2.09 m) were set with this technique (Ae, at el, 2008).

However, the jumping events can be divided into two general categories – the vertical jumps (high jump and pole vault) and the horizontal jumps (long jump and triple jump) (Ecker, 1997).

One fact we know is that if a jumper introduced to high jump event, initially learns poor or compromised technique, it will be very difficult for that athlete to eliminate later that

technique when attempting personal best heights, even if they later switched to work with a more knowledgeable coach, who corrected their technique.

Initial understanding of the correct mechanics of the high jump and understanding of the event and action - reaction consequence of different movement patterns is extremely important for the athlete to master (Holling & Ritzdorf, 2003).

In addition, the high jump competition is where one´s performance and improved record level depends on many kinematic parameters needed to be studied.

As well as sports biomechanics are used to improve performance by developing techniques and to improve the latest techniques to minimize injuries, to maximize performance, develop exercise mode and, lastly, to modify sport techniques. So, for the long jump, triple jump and high jump, the biomechanical principle will be able to minimize injuries and improve performance (Ismail, 2002).

Most of progressive nations have developed methods in physical education to improve the performance of athletics for better record level by applying scientific research methods and studies in this field. Biomechanics is concerned with the study, analysis of physical movement, and looking for suitable dynamic motions improving the performance of competitors in a particular competition. Biomechanics, as a scientific discipline of kinesiology, studies specific sport movements on the basis of adjective physical, anatomical, and physiological laws. Without doubt, biomechanics is one the fundamental methods for the objective study of special sport motions constantly increasing competition in modern sports – which particularly applies to track and field – calls for increasingly in depth work in the introduction of a new biomechanical technologies and procedures for objective assessments of the technique of movement (Čoh, 2002).

Biomechanics is very important for physical educators, coaches, and other in the business of teaching or analyzing human motion (Simonian,1981)

2. Literature review

2.1. Biomechanics of high jump

The high jump competition´s performance and improved record level depend on many kinematic variables needed to be studied.

As well as sports biomechanics is used to improve performance by developing techniques and to improvise the latest techniques to minimize injuries, maximize performance, develop exercise mode and lastly modify sports techniques. So, for the long jump, triple jump and high jump, the biomechanical principle will be able to minimize injuries and improvise performance (Ismail, 2002). However, most of progressive nations have developed methods in physical education to improve the performance of athletics for better record level by applying scientific research methods and studies in this field. (Hong, et al, 1996) indicated that correct execution of body movement leads to successful sports performance. Only sport biomechanics that can provide valuable kinematic information of sport movements, in countries, such as United State, Australia and Germany where sports and sport science are well developed, the study of biomechanics has already been proved as a major scientific tool for innovation of techniques and thus achievement in performance. Biomechanics is concerned with the study, analysis of physical movement, and looking for suitable dynamic motions improving the performance of competitors in a particular competition. Also, biomechanics, as a scientific discipline of kinesiology, studies specific sport movements on the basis of adjective physical, anatomical, and physiological laws. Without doubt, biomechanics is one the fundamental methods for the objective study of special sport motions constantly increasing competition in modern sports – which particularly applies to track and field – calls for increasingly in depth work in the introduction of a new biomechanical technologies and procedures for objective assessments of the technique of movement (Čoh, 2002).

Also, (Simonian, 1981) added that biomechanics is essential for physical educators, coaches, and other in the business of teaching or analyzing the human motion. The high jump, as we know it today, became popular in 19th Century and was included into

the program of the first modern Olympic Games in 1896. The most primitive technique for clearing the bar is the “Scissors Style”, in which a straight run-up is used. From there, the technical evolution of event has included techniques known as the “Western Roll”, the “Straddle” and the “Fosbury Flop”, which is the most fashionable at present. Dick Fosbury (USA), winner of the high jump at Olympic Games in Mexico City, is credited with being the first athlete who successfully uses the back lay-out clearance from a curved approach. Almost all modern high jumpers use the flop and the current world records (men: 2.45 m, women: 2.09 m) were set with this technique (Ae, et al, 2008).

On the other hand, a high jump can be divided into three parts: the run-up (approach) phase which server as preparation for the take-off phase, the take-off phase, the most important part of the high jump, and the flight (clearance bar) phase (Dapena, 1992; Bradamante, et al, 2004; Vindušková & Jelínek, 2004; Ae, et al, 2008; Čoh & Supej, 2008).

2.2. Conclusion of literature review

As a result of the literature review and relative studies that have been done on the high jump event, the researcher has found most of them place an emphasis on the take-off phase which is most important phase to get the best performance in the high jump event. This literature has helped the researcher to choose and identify the most kinematic parameters and what should be measured.

According to some studies conducted by various authors, the take-off phase is important phase in high jump event (Čoh & Supej, 2008; Ae, et al, 2008). This is because the vertical velocity and the height CM at the end of the take-off phase, both of them determine the height CM at the moment of the bar clearance (Dapena, 1990,2; Isolehto, et al, 2007) affirmed that the peak height CM is totally determined at the end of take-off phase. It is determined by the height CM at the end of the take-off phase and by its vertical velocity at the end of the take-off phase. Also, the literature review confirm on the importance of some kinematic parameters which will study in this research, including: the velocity at the end of the run up phase, the vertical velocity at the end of

the take-off phase, the height CM at the start of the take-off phase, the height CM at the end of the take-off phase, the peak height CM at the flight phase, take-off time, and some angles on the some parts of the body (Dapena 1990, 1; Isolehto, et al, 2007; Čoh & Supej, 2008; Ae, et al, 2008; Vindušková, et al, 2008).

Finally, the literature reviews have also helped the researcher to select the kinematic parameters which should be analyzed in his research as well as which will be considered and discussed as well as the selection of equipment.

3. Methodology

3.1. The problem of study

The problem of research has risen because of the declining of the jump record level in Egypt is (2.24 m). This country is part from North Africa, this record level is very low compared with the Arabic record level which is (2.34 m) and even much lower than the World record which is (2.45 m). This decline of the Egyptian performance levels is due to lack of researches and training in the field of high jump athletics. Thus there is a need for research to study the kinematic parameters affecting the performance of competitors to improve the record levels that are required to become comparable with the world record. However, despite the relatively large number of studies that deal with the high jump event, the researcher was unable to find even one study of the high jump in his faculty in Prague, which has studied the jumpers in North Africa. Also, he could not find even one three dimensional analysis movement of the high jump event in his country.

3.2. The aim

The aim of this study is to determine how the performance of the Egyptian high jumpers is dependent on the kinematic parameters of take-off phase.

3.3. Scientific question of study

According to the aim of study, the following question can be put as a study question about high jump event in Egypt:

How the performance of high jumpers is dependent on the kinematic parameters of take-off phase?

3.4. Hypothesis

1. The researcher supposes that the Egyptian athletes will have different kinematic parameters in comparison with the World elite.
2. The researcher assumes that the values of kinematic parameters for athlete (A_1) will be different with athlete (A_3).

3.5. Conclusion of methodology

The style of methodology in this study, allows a lot of detail to be collected that would not normally be easily obtained by other research designs. The data collected form the sample and motion analysis are normally a lot richer and of greater depth than can be found through other experimental designs. One advantage of this method is that it provides a great amount of description and detail on our athletes. Researcher, coaches and athletes could learn a lot from this sample. He has taken this sample because we should know how the elite of high jumpers were in this stage before reaching high level of performance. This volume of details suggests many future research questions to follow up in other studies and help us to improve our athletes to get the best performance level in future. On other hand, the chief disadvantage of the motion analysis and case study is that the results might not generalize to others. In other words, the experiences of our sample (Egyptian high jumpers) might not apply to other high jumpers especially elite jumpers. The Researcher, he was doing this case study with the three jumpers (who were from Egypt). He has a great amount of information on these jumpers, but what he found might not be true of all jumpers. With this study, we

learn and get a lot of results about one case Egyptian High jumpers, but what we learn might not apply to the larger other high jumpers. Overall, I think that this study is an important and useful method of data collection, especially in high level of high jumpers who are like our athletes. It would be extremely very expensive and difficult just to make a larger sample size to use a different experimental design method. However, as data is collected on new cases I think it is important to always refer back to previous data in order to build on existing knowledge and ensure findings are as applicable to Egyptian high jumpers as possible. In this study, the researcher has tried to use a scientific method that is not widely used in his country because he thinks that the motion analysis movement and study of physical characteristics, they will help Egyptian Athletics Unions to develop their Methods about training and selection our athletes in our countries and begin our countries with developed countries. (Hong, et al, 1996) indicated that correct execution of body movement leads to successful sports performance. Only sport biomechanics and motion analysis movement that can provide valuable kinematic information of sport movements, in countries, such as United State, Australia and Germany where sports and sport science are well developed, the study of biomechanics and motion analysis have already been proved as a major scientific tool for innovation of techniques and thus achievement in performance.

The researcher believes that the effects of physical characteristics and motion analysis of movement on the Egyptian high jumpers, they will help him to find the reasons of their weaknesses in high jump event. (Galloway, 2006) confirmed sports science and athletes can greatly benefit from advances in 3D human movement analysis technology. Aspiring amateurs and professionals alike can learn the proper mechanics faster cognitively and through muscle memory. Also, ensuring that physical activity is performed with proper mechanics can help prevent future injuries like tendonitis.

4. Results and discussion

As can be seen from many studies results, there are considerable variations in execution of the final stages of the run-up and the take-off at different heights under competitive situations. This strongly accentuates the importance of developing the structure of the final stages of the run-up and the take-off by employing more near-maximal and maximal height jumps in training.

The official results (2.05, 2.02, 2.00 m) in this study are one of poorest in the high jump events. The measurements of the kinematic parameters related to the approach show the poorest parameters. When, comparing the values obtained to earlier studies (Dapena, 2000; Čoh.M & Supej. M, 2008; Isolehto, et al, 2007).

4.1. The physical characteristics of the high jumpers

Name of Athlete	Team	Height m	Weight kg	Age	Training Age	The Results m
Athlete (A_1)	Smouha	1.96	94	28	8	2.05
Athlete (A_2)	Al maadi	1.85	70	17	4	2.02
Athlete (A_3)	Police Union	1.83	78	22	7	2.00

Table (1): The physical characteristics of the Egyptian high jumpers

4.2. The CM velocities of take-off action of high jumpers

Velocity is defined as displacement per until of time, and having both magnitude and direction, it is a vector quantity. In high jumping the athlete's run-up is not nearly as fast as that of the long jumper, for the obvious reason that a radical change in direction must be made at take-off, which would not be possible at high speeds. The long jumper

seeks maximum horizontal distance where the high jumper needs only enough horizontal velocity to carry the body past the bar after it has been cleared. Maximum efficiency is demonstrated when the jumper's CM is raised no higher than necessary to clear the bar.

Jumpers / Kinematic parameters	Unit	Athlete (A_1)	Athlete (A_2)	Athlete (A_3)
Horizontal velocity of CM at start take-off (V_{x1})	$m.s^{-1}$	4.16	4.27	4.36
Vertical velocity of CM at start take-off (V_{y1})	$m.s^{-1}$	-0.08	-0.20	-0.35
Horizontal velocity of CM at end take-off (V_{x2})	$m.s^{-1}$	2.08	2.10	2.49
Vertical velocity of CM at end take-off (V_{y2})	$m.s^{-1}$	4.85	3.96	3.71

Table (2): CM velocities of take-off action of the Egyptian high jumpers

4.3. The height of CM and take-off time of high jumpers

A tall high jumper has an advantage, as do tall athletes in most events, providing the physique is equal to the other demands of the event. All movements which raise limbs at take-off raise the CM also. So a fully extended and raised lead leg, a high upward thrust of the free thigh and arms well raised up are assisting in this direction.

5. Recommendations

According to the results obtained, the researchers recommend the following: continuous training of the specimen competitors particularly competitor (A_2), in course of training of competitors for high jump event attention should be concentrated to vertical velocity component (V_y) for CM of body athlete with minimum take-off time, choosing tall competitors for high jump event as they will have large height of CM which will lead to

better record levels, using methods of videotaping in three dimensions in biomechanical analysis of data, results and conclusions should be compared with other studies for better applications. Also, it is critical that the jumper stay relaxed and maintain run-up speed through the last two strides. When using a double arms action, it is important that jumper move through the arms and not stop them. Stopping the arms over the last two strides will result in decrease in run-up speed to the bar. Thus, it is important that arms move to fit the run-up. It is important that the athlete time up the momentum of the free leg and arms at the take-off phase. As the jumper leaves the ground, the eyes should no longer be focused on the crossbar. At this point, the eyes and head should follow in natural alignment with the transverse rotation of shoulders. The more inexperienced the jumper is, the closer the take-off point should be. The more experienced the jumper, the father away the take-off point should be. Factors influencing this take-off point will depend on the athlete's experience, speed and strength.

6. Conclusion

Within the limit of research sample, in view of data collections, the results interpretations, analysis motion by computer and videography the following conclusions were achieved: there is relation between record level and vertical velocity component (V_y). Also, there is relation between each of following: take-off time and height projection, take off time and the vertical velocity component (V_y). It is also, the hypotheses of research and expectations of researcher have been achieved, that means that the aim of the research was achieved and accessible. Looking at the value of horizontal and vertical velocity at start and end of take-off phase, height of CM at start and end of take-off phase and take-off time, we can see the different of the values of kinematic parameters between the Egyptian high jumpers and elite high jumpers; this is what the researcher expected to occur. On the other side, when we look at the results of the Egyptian high jumpers A_1, A_3 we can see the different of the values of some kinematic parameters for each one; this what the researcher expected before.

Based on this study it is possible to confirm that effectiveness in high jumping largely depends on the take-off action. The take-off action is primarily defined by the horizontal

velocity of CM at the start of take-off phase and the vertical velocity of the CM at the end of the take-off phase as well as by duration of the take-off phase. Also, it can be concluded that different variations of the flop technique enable the utilization of the best physical capacity of each individual jumper. Therefore, it seems that there is not a single, ideal technique for achieving good results and jumpers with different body type, physical characteristics and performance techniques have good possibilities to compete successfully at the highest level. Looking at both the horizontal and vertical velocities, it is seen that as the height of the bar increases both the horizontal velocity and the vertical velocity of the jumper increase. This is what we expected to occur since it would seem unusual for a jumper to have the same horizontal and vertical velocities for different heights. With improvement in technique and better fitness levels, our jumpers can achieve further progress in their results. This raises optimism because Omar Samir (A_2) is very young, and his current record is 2.02 m gives hope for future World – class. Systematic follow-up of studied kinematic parameters enabled our jumpers to have a fast and rational technique learning process. Kinematic analysis contributed to easier identification the positive and negative characteristics of their technique. In this way, detected errors were systematically corrected during the training process. For certain technique elements, the coaches modified the existing exercises or developed completely new ones in the training process. At the end, the performance of high level in the high jump is not necessary to depend on technique and training only, but there are several other factors such as social, psychological and health factors.

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