Biomechanical analysis of male long jump techniques of selected Oromia regional state clubs

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ABSTRACT

Ethiopia is the potential area in order to produce world class jumpers. However, intensive work has been never done on the area of biomechanical analysis work. Thus, this research project is designed to assess the Biomechanics analysis long jumpers on Oromia region athletic clubs. The study was used explanatory research design and gathered data once from the subjects. Availability sampling technique was used in order to select jumpers (n = 20) and document analysis. For the purpose of data analysis, motion analysis software Kinovea was used to analyze video records. Then, quantitative data obtained from the motion analysis software were entered to further analysis into SPSS.Version 23. Pearson product moment correlation coefficient was used to found-out the relationship between long jumpers' seasonal best performance and long jump phases joint angles. Multiple regressions coefficient was used to analyze the effect of release parameters angles at release during take-off on jumping distance. The result of this study shows long jump Take off Preparation Knee have significant relationship with long jumpers jumping performance ($r = -0.67, p<0.05$) and long jump Take off knee have significant relationship with seasonal jumping performance of long jumpers ($r = -0.53, P< 0.05$. Knee angle during take-off preparation phase and take off phase explained by 67.6% of variance ($R2=.676$, $F(18, 2.72) =$, 15.1, $p < 0.05$). Effect size of long jump take off preparation knee angle was significant ($R2=.676$, $F (18, 2.72) =$, 15.1, Beta value (B) = -0.016, $p < 0.05$) and long jump take off knee angle ($R2=.676$, $F (18, 2.72) =$, 15.1, Beta value (B) = -0.014, $p < 0.05$). In conclusion, both phases (take off preparation and take off), knee have low effect size on long jumpers' seasonal performances.

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1. INTRODUCTION

1.1 Background of the study

The biomechanical approach to movement analysis can be qualitative and quantitative, with movement observed and described, meaning that some aspect of the movement measured. In such an approach, the motion characteristics of a human or an object are described using such parameter as speed and direction, how the motion is created through the application of forces both inside and outside the body, and the optimal body positions and action for efficient, effective motion (Akwinder & Nishan, 2016).

There are several problems in the application of biomechanics to sports, so the application of biomechanics in the qualitative analysis of sport skills by many coaches has been limited. More recent evidence (Knuodson, 2007) reveals that biomechanics scholars have long been interested in developing principles that facilitate the qualitative application of biomechanics to improve movement performance and reduce the risk of injury.

The long jump is horizontal jumping events of field. The primary goal of maximizing the horizontal distance jumped; a sprint-like approach on a runway (often the same one) to a take-off marker; an attempt to achieve a desired flight phase trajectory; and demands scientific training for the athletes (Melvin, 2016). Long jumping is a well-recognized discipline within the track and field sports and it has been a part of the Olympic Games since the restart of the modern games in Athens 1896 (Graham-smith & Lees, 2005). Ethiopian long jump achievements in national championship reveal that Gashaw Beza jumped 7.50m in 1989, Addis Ababa, Ethiopia. Hiwot Sisaye, during African Championships in 1993 registered 6.23 m in Durban, South Africa (Long jump results, 2012).

Thomas, Luis & Wolfgang (2001) suggests that the applied pattern biomechanics of long jumpers allows one to identify structural changes of movement patterns during a singular movement as well as individual movement styles within the same type of movement and they asserted that last stride was the most contributing factors for the long jumpers personal best. Other supporting literature (Mikael & Daniel, 2015) pointed out that long jumping technique has been widely studied both on elite athletes and with models made for determining optimal techniques. However, studies looking at women long jumping are scarce and there is still no consensus regarding which variables are the most important for determining long jumping performance then finally in their study they concluded that speed of long jumper determines long jumpers jumping distance by 40% additionally speed, accuracy and technique explained long jumpers jumping distance by 55%.

There is evidence to suggest that there are some differences between the techniques of elite male and female athletes, suggesting that coaches may need to emphasize different aspects of technique for each gender. More research examining these techniques is required. The question regarding whether these differences are due to strength and structure differences or due to differences in neural patterns remains unanswered (Marion and Alexander, 2005).

Graham-Smith et al (2005) and Bridgett et al (2006) reveal that there is a unanimous agreement among several of these key variables affecting the long jump in the current scientific literature, there are still lies a challenge in understanding the complete picture and possible interrelationships between factors related to a successful long jump. Thus, the researchers designed to assess the biomechanics analysis of long jumpers in Oromia regional state athletic clubs**.**

1.2 Research Questions

What is the relationship between joint angles and jumping distance performance of long jumpers in Oromia regional state athletic clubs?

To what extent joint angles influence the jumping distance performance of long jumpers in Oromia regional state athletic clubs?

2 Methods and Materials

2.1 Research Design

A mixed methods research design is a procedure for collecting, analyzing, and "mixing" both quantitative and qualitative research and methods in a single study to understand a research problem. In this study, a mixed method research design was used mixing both qualitative analyses with quantitative analysis. The way data were collected from the participants through the cross- sectional survey.

2.3 Subjects of the Study

The total population of athletics clubs in Oromia Regional state athletics clubs was (N =18). The target population of Oromia regional state athletics clubs was selected five (n =5). The sampled club athletes were selected using a multistage sampling technique. First, the population of jumpers (n=3) from five (n = 5) athletics clubs was for boys and girls (n = 20) in total. Secondly, the total samples from both athletics disciplines were (n = 20) for both boys (Shalabh, 2016).

Table.2.2. Sampling techniques and sample size determinations

No	Clubs	Long jumpers
		M
1.	Burayu Athletics club	3
2.	Laga Tafo Laga Dadhi Athletics club	4
3.	Sululta athletics project club	4
4.	Sebeta Athletics clubs	3
5.	Gelan Athletics club	3
6.	Bishoftu Automotive club	3
Total		**20**

2.3 Procedure of data collections

For the purpose of this study two video recording cameras named Nikon: Coolpixp900: 90004607 were used. The instrument of data collection for the purpose of this study includes three (3) digital Camera, measuring tapes, different geometric instruments, motion analysis software, athletes (n = 20) and seasonal jumpers' distance were taken. The qualitative interviews were made with five (N=5) club managers from 30minutes to 2hours in the silent convenient place.

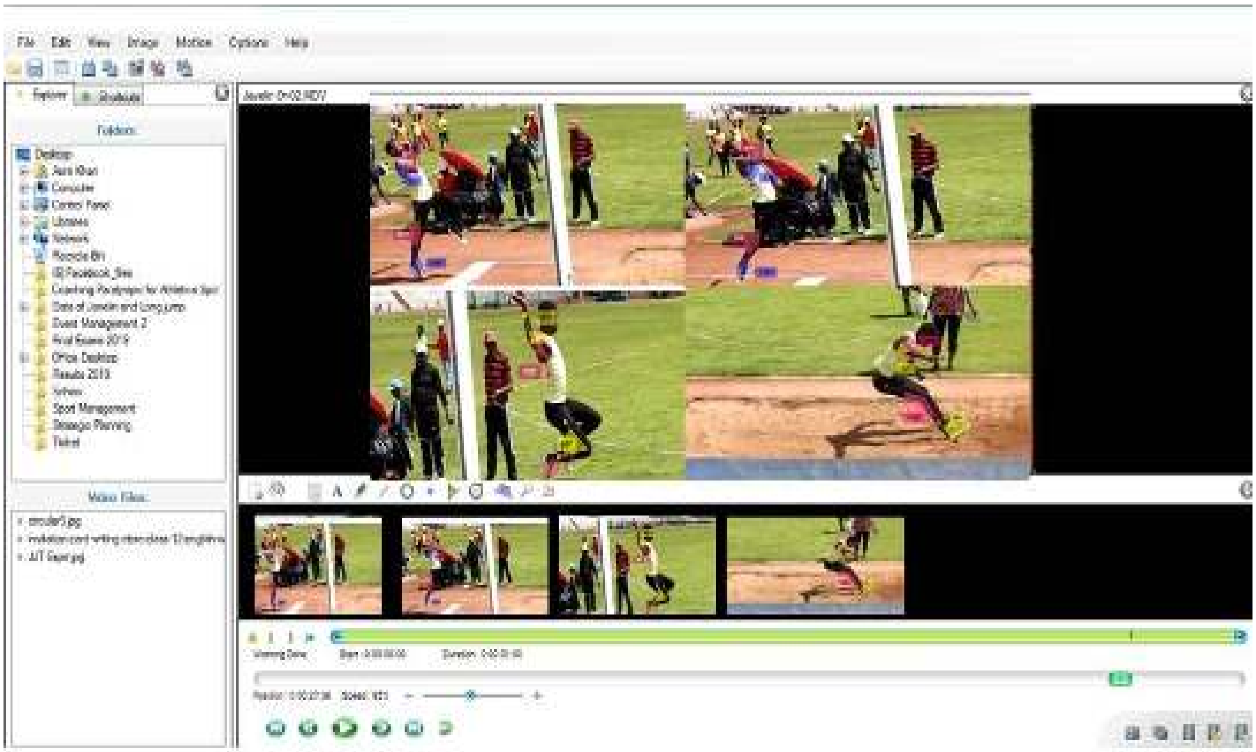

Figure 2. 1 Kinovea biomechanical analysis of long jumpers' joint angles

2.4 Identification of variables

2.4.1 Independent variable

Long jump phases joint angle include take-off preparation (ankle, knee, shoulder and elbow), take-off (ankle, knee, shoulder and elbow), flight (ankle, knee, shoulder and elbow) and landing (ankle, knee, shoulder and elbow).

2.4.2 Dependent variable

This includes jumping distance. This is both the result during the field test and from document analysis in their clubs' archive.

2.5 Methods of data analysis

The quantitative data were entered into motion analysis software Kinovea athletics analysis software. Then entered into Moreover, entered into SPSS (Version ≠ 23), Pearson product moment correlation coefficient was used to found-out the relationship between long jumpers seasonal best performance and long jump phases joint angles. Multiple regressions coefficient was used to analyze the effect of release parameters angles at release during take-off on jumping distance. In addition to this, the qualitative data obtained from field notes, recorded semi-structure interview were entered into Nvivo, version # 12 for better data management and coding the themes and subtheme. Accordingly, the data were transcribed immediately right after data collection in order to give clear picture and meaning to the data collected without missing its' original flavor.

2.4 Ethical Issues

Letter of permission was obtained from Jimma University, Research and postgraduate coordinating office. Then, Oromia Regional State selected clubs were communicated and respondents were preserved with confidentiality. Accordingly, data were collected from jumpers and club managers after participants signed informed consent.

3 RESULTS AND DISCUSSION

Table 3.1. Correlation coefficient matrix results of long jumpers

Phases	Joints Angles	R Value	Sig.
Take-off Preparation	Ankle	-0.16	0.49
	Knee	*-0.67*	*0.001*
	Shoulder	0.18	0.43
	Elbow	-0.67	0.001
Take-off	Ankle	-0.09	0.71
	Knee	*-0.53*	*0.02*
	Shoulder	-0.38	0.1
	Elbow	0.22	0.34
Flight	Ankle	-0.02	0.94
	Knee	0.3	0.19
	Shoulder	0.35	0.13
	Elbow	0.1	0.67
Landing	Ankle	0.11	0.63
	Knee	-0.12	0.61
	Shoulder	-0.12	0.61
	Elbow	-0.14	0.54

The above table indicates that biomechanical analysis of Oromia regional athletics clubs long jump Take off Preparation Knee have significant relationship with long jumpers jumping performance ($r = -0.67$, $p<0.05$) and Long jump Take off knee have significant relationship with seasonal jumping performance of long jumpers ($r = -0.53$, $P< 0.05$. Thus, both long jumps take off preparation knee and long jump take off knee significant relationship with athletes' long jumpers' seasonal performance.

Table 3.2. Regression coefficient results

Independent variables	B	*Std. Error*	Sig.
(Constant)	7.57	0.597	0.01
Knee Angle during Take-off Preparation Phase	-0.016	0.004	0.01
Knee Angle during Take-off Phase	-0.014	0.005	0.02
Note: R^2=.676, F = 15.1, *p < .05,			

The multiple regression result output reported that knee angle during take-off preparation phase and take off phase explained by 67.6% of variance (R2=.676, F(18, 2.72) =, 15.1, p < 0.05). Hence, from the analysis one could understood that in both phase knee joint angle significantly impacting the performance of Oromia regional state clubs long jumpers. Effect size of long jump take off preparation knee angle was significant (R2=.676, F(18, 2.72) =, 15.1, Beta value (B) = -0.016, p < 0.05) and long jump take off knee angle (R2=.676, F(18, 2.72) =, 15.1, Beta value (B) = -0.014, p < 0.05). Moreover, both long jump take off preparation knee and long jump take off knee have low effect size on athletes' long jumpers' seasonal performance.

According to the interview response, most of long jumpers joint angle have poor biomechanics performance, because in Oromia regional state coaches-athletes ratio have been very low; athletes' developmental pathway was not properly implemented; coaches were either having psychomotor domain or cognitive domain; poor preparation training plan (session plan, micro-cycle plan, meso-cycle plan, annual and Olympic cycle plan); there were mass nutrition system and mass feeding system and training principle (specificity) not followed

4. DISCUSSION

The results of this study show that the relationship between both phases take off preparation and take-off, knee joint angle has significant relationship with athletes' long jumpers' seasonal performance. Similar study conducted by Nicholas et al., (2011) suggested that relationships between run-up velocity, take-off technique, and jump distance. Correspondingly, Oleg et al., (2018) found that significantly higher take-off velocity and its horizontal component, and significantly shorter ground contact time exhibited by the athletes of the higher performance level, as well as a strong correlation between effective distance and knee angle at touchdown in the group of jumpers of lower performance level. Those that badly agree with the simulation results include significantly higher vertical velocity at take-off and lager take-off angle in the more qualified group of jumpers, as well as the lack of strong correlations between effective distance and take-off velocity, horizontal take-off velocity, take-off angle, leg angle, and CG height at touchdown. Obviously, this is due to differences in power ability of the athletes between and into two qualification groups, which does not correspond to the initial positions defined for the simulation.

In consistency with this study Nicholas et al., (2011) reveals that in all jumps the horizontal take-off force was predominantly a backwards braking force and so the athlete's horizontal velocity was substantially reduced during the take-off. The athlete's breaking impulse increased with increasing run-up velocity, but not so much as to negate the increase in run-up velocity. The optimum long jump take-off technique is a compromise between the conflicting desires of generating vertical impulse and minimizing the horizontal braking impulse. In agreement with this study Nicholas, Maurice and Lisa (2005) reported that for all athletes, to produce low take-off angles were produced using progressively shorter and slower run-up. The take-off speed decreased and the take-off height increased as the athlete jumped with a higher take-off angle. The calculated optimum take-off angles were in good agreement with athletes' competition take-off angles. Study conducted in Japan by Yutaka, Michiyo and Hiroyuki (2011) reveals that the World group indicated the greater horizontal center of gravity velocity and smaller decrease in the horizontal center of gravity velocity during the take-off preparation and take-off than those of the Japan group and The Japan group tended to flex and extend the knee joint of the support leg, and to raise the trunk in earlier timing during the preparation phase.

In this study multiple regression result suggested that both phases (take off preparation and take off) knee have low effect size on athletes' seasonal performances. In agreement to this study, other similar study Oleg (2018) suggested that optimum leg plant angle is likely to depend on the athlete's anthropometric factors (e.g. limb segment lengths) and the athlete's physical conditioning (maximum running velocity; eccentric leg strength). Other factors such as the 'vigor' of the arms and free leg during the take-off may also interact in a complex way with the optimum leg plant angle. When using her competition run-up length, the athlete in the present study used a leg plant angle of about 63°.

Other finding Lee, Fowler and Derby (2007) reveals that the touch off down take-off angle was responsible for generating vertical velocity. The study was concluded that there was evidence for mechanical, biomechanical and muscular mechanisms. Morinaga et al., (2003) investigated the takeoff preparatory and takeoff motion in good- and poor-jumps for six male long jumpers and found out that the trunk in the good jumps leaned forward at the takeoff and the decrease in the horizontal Center of gravity velocity was smaller than in the poor jumps.

5. Conclusion

The present study has increased our knowledge on biomechanical analysis of Oromia regional state long jumpers. The finding of this study reveals that both long jumps take off preparation knee and long jump take off knee significant relationship with athletes' long jumpers' seasonal performance. Thus, both phases (take off preparation and take off), knee have low effect size on long jumpers' seasonal performances.

6. Recommendations

Based on the finding of the study the following recommendation was drawn. These were:

- It is better if selected Oromia Athletics clubs provide significant technical training that will be given to athletes during multi-event stage of athletes' development
- It is recommendable if long jumpers will have specific additional diet pertinent to their discipline
- It is good if long jumpers get appropriate technical training by themselves
- It is better schools and clubs have strengthened their integrity.
- It is good if incoming researcher use d/t types of statistical techniques

7. Limitation of the study

- The study was cross-sectional design, longitudinal will be preferred
- The study used small sample size, generalization was impossible
- There were confounding variables, which were not included in the study
- There was co-variance, which was analyzed in the study
- Availability sampling was used, not randomized, generalization was difficult

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