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The kinematical analysis of static and dynamic balance variables and their relationships with the accuracy shooting in soccer players U16

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Abstract

Aim: The goal was to describe the kinematical analysis of static and dynamic balance variables and their relationships with the accuracy shooting in soccer players U16.
Methods: Participants were 12 male soccer players (age=15.6±0.51years). Balance ability was evaluated with two types: Stork test (static balance), and Fleishman test (dynamic balance), also accuracy kicking in soccer was evaluated with two tests: Nested rectangles test, and Nelson Worner test. during the performance of accuracy kicking tests we analysed the variables (angles of knee, thighs, trunk and height $_{BCG}$-body centre Gravity) by used camera (AEE Magic Cam) for capturing, and Dartfish.9 software for kinematical analyse. The data were analysed in SPSS 22.0 program.
Results: As a result of the statistical analysis, there was significant correlations between static balance with distance of Height $_{BCG}$ "^{D} Height $_{BCG}$" ($p \leq .001$) in all phases of kicking the ball, also with dynamic balance ($p \leq .001$) and with Nested rectangles test ($p \leq .01$) in phases of the backswing and ball contact, and ($p \leq .05$) in the follow-through phase.
Conclusion: the kinematical variables ^{D} Height $_{BCG}$ and knee angle were observed to effective in dynamic and static balance, which in turn is closely related to the accuracy of soccer kicking.

Keywords
Kinematical analysis, Balance static, Balance dynamic, Accuracy shoot, Soccer (U16),

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INTRODUCTION

Human postural demands and balance control during mobility and rotational motion are of primary interest for athletic performance and daily life. The game of soccer is one of the most popular team sports worldwide. It is a ball sport with many demands on the technical and tactical skills of the individual player (Inklaar, 1994). The soccer kick is considered the most powerful of the playing techniques, it's also the main offensive action during the game and the team with more kicks on target has better chances to score and win a game (Kellis & Katis, 2007). In a most studies (Coloma, 2007; Rahnama et al., 2002; Reilly, 2003), soccer kicks accounted for approximately 64% of important actions in the game, but a powerful kick is not always a successful one because accuracy has a bearing on a kick's success for goal scoring. There are many factors that influence the success of a ball kick, but the three dominant factors to consider are accuracy, strength, and swing (Davids et al., 2007).

Balance plays a pivotal role in the soccer playing conditions, such as pushing opponents, kicking the ball, changes to the ball's orbit, moving, etc. Facing soccer players during a soccer game (Evangelos et al., 2012). Balance is generally defined as the ability to maintain the body's center of gravity within its base of support (Hrysomallis, 2011), postural control, on the other hand, involves controlling the body's position in space dually and is divided into two as static and dynamic control (Samuel et al., 2015). Good balance will also help to minimize energy waste during a performance, increasing movement efficiency and enabling the athlete to improve their performance (Fatah et al., 2018). Balance, pelvic stability and posture are all heavily influenced by sensory information from the foot. The sole of your foot is sensitive for a good reason: it is constantly sending information into your central nervous system so that you can instantly and unconsciously adjust your body's alignment (Roll et al., 2002). Biomechanics is the main field of objective research into the technical rules and methods of various

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kinetic skills (Guebli Abdelkader et al., 2018). thus, there are many biomechanical principles factors that can be manipulated to improve these factors for the player to achieve the accuracy in kicking ball.

For this reason, improvement of soccer instep kick technique is one of the most important aims of training programs in young players (Weineck, 1999). Especially the balance element that has a prominent impact on the accuracy of the kicking technique in football game, and the relationship between the factors of biomechanical performance, balance and accuracy kicking, which are the basis in preparing learning and training programs for youth beginners players. Thus, the current study aims to the kinematical analysis of static and dynamic balance variables and their relationships with the accuracy shooting in soccer players U16. by determining the statistical relationships between variables analyse in our study.

METHOD

Participants

A total of twelfth healthy male football Players (age=15.6±0.51 years, length=169.1±2.55 cm, weight=66.3±2.40 kg) from the Ghilizan academy of football club category U16 years provided their informed consent to participate in the study as volunteers. Where all parents of player's participants provided written informed consent before commencing the study to the investigator, with the condition of keeping personal data secret. We collected a brief medical history from each athlete to ensure the athlete's eligibility for the study, none reported a history surgery. The research protocol was approved by the Laboratory of physical and sports activity, society, education, and health in Hassiba Benbouali University of Chlef.

Research design

In our study, we have analyzed some kinematic variables in one-dimensional during the performance of football Shooting skill tests. The analysis of the present study was with the software dartfish 9 (Guebli et al., 2018). The video capture with one camera (AEE magic cam, 170° view, MOV Format Video, 720p Video Resolution, 120 ips NTFS, Screen Resolution 1280*720 16:9). we placed the camera that depicting in site (X1 m, Y6 m, Z1.1 m) first test as Fig. 1a, and (X2 m, Y19 m, Z1.1 m) second test as Fig. 1b. Each athlete was required to wear tight-fitting clothing (ie, spandex shorts and a sleeveless shirt). The tape reflective markers were bilaterally attached on the surface of the skin over the following joints: the neck, hip, knee. Where reflective markers on all volunteers were attached by one investigator. Also, all athlete was encouraged to warm up according to the normal routine to ensure optimal performance. Once warmed up, the athletes performed the tests, data collection occurred in Ghilizan Stadum, Ghilizan by the researchers (APAAS Laboratory, Chlef, Algeria).

Test protocol

The tests were conducted on the above variables for sample, each one from sample give three attempts in all tests, we used the mean of this attempts for statistical analysis. Also, we were used the following tests for accuracy kicking and balance performance (static/dynamic), two tests for each:

Nested rectangles test (accuracy shooting): To administer Nested rectangles test (figure .1[a]) the subject was prepared to try kicking balls in wall from 6 m away. Which was used and divide into three sections along and height the wall, the dimensions of first section (dark gray) X 1.20 m, Y 1 m, second section (gray) X 1 m, Y 0.80 m, third section (white) X 0.80 m, Y 0.60 m. The subject was then asked to kicking the ball on one section, we give her four point if the ball shooting on section one, two point on section two, and one point on section three. A calculates sum of point in shooting of five ball (B. H. Islem & Bouabdellah, 2018).

Nelson Worner test (accuracy shooting): To administer Nelson Worner test (Figure. 1[b]) the subject was prepared to try kicking balls in goal. A goal was used and divide into six sections along and height the goal, the dimensions of sections A, B, F and G; X 2 m, Y 1.22 m, sections C and D; X 3 m, Y 1.22 m. The subject was then asked to kicking the ball on one section, for sections A, B, F and G we give him four point, and for other two sections we give him two point only. A calculates sum of point in shooting of five ball (Coloma, 2007).

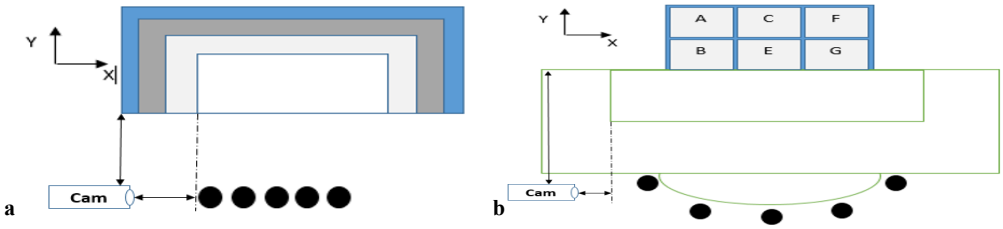

Figure .1: Accuracy shooting tests, a) Nested rectangles test, b) Nelson worner test

Stork test (static balance): To administer the Stork test (Figure .2[a]), the player was made to stand comfortably on both feet with hands on the hip, lift one leg and place the toes of that foot against the knee of the other leg. The stopwatch was started as the heel was raised from the floor and stand on their toes, if the hand(s) came off the hips or the supporting foot swiveled or moved in any direction, or the non-supporting foot lost contact with the knee, or the heel of the supporting foot touched the floor, the stopwatch stops (Kollarics et al., 2018).

Fleishman test (dynamic balance): To administer the Fleishman test (Figure .2[b]) the player was made to stands comfortably on both feet with hands on the hip. A hexagonal wooden balance base was used, which is consisting of six wooden boards, each one length 60 cm, width 2 cm, and the height 7.5 cm. The subject was then asked to move back to the starting point by walking (walk back) on a hexagonal balance board. The stopwatch was started as the subject start walk back. The stopwatch was stopped after one minute, a calculates the number of falls in one minute (Fleishman, 1963).

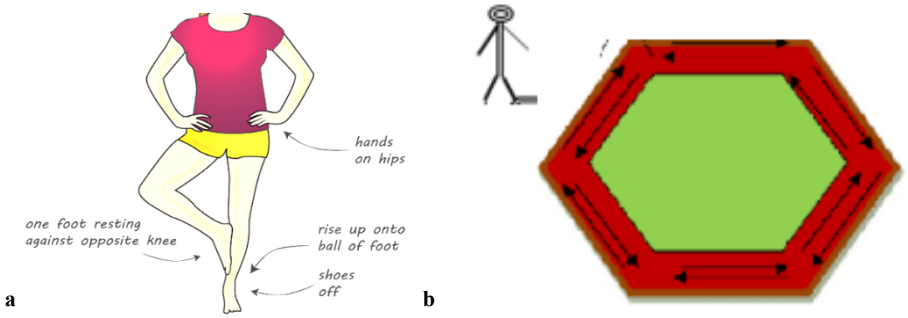

Figure .2: Balance tests, a) Stork test "static balance", b) Fleishman test "dynamic balance"

Kinematic Variables analysis

Based on some previous studies, we choose the kinematic variables for analyzing the performance kinetic of players; [a)] Knee Angle, [b)] Thighs Angle, [c)] Trunk Angle, and [e)] Height Body Centre Gravity (figure. 3). The analysis of the kinematic variables was performed during the performance of the accuracy kicking tests. We used dartfish 9. software for the kinematical analysis, it's a video player for sports analysis. It provides a set of tools to capture, slow down, study, compare, measure technical performances, and annotate.

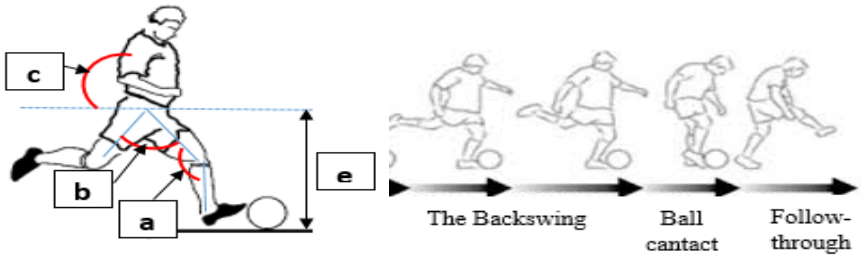

Figure .3: Kinematic variables analysis, [a)] Knee Angle, [b)] Thighs Angle, [c)] Trunk Angle and [e)] Height $_{BCG}$.

Statistical analyses

The obtained data were analyzed by using a software IBM SPSS Statistics (SPSS for Windows, version 22.0, SPSS Inc. Chicago, Illinois, USA)(Zerf Mohammed et al., 2015), we used Person "R" test to analyze the correlations between variables analyzed for our sample. Significance was accepted at $P < 0.05$. All data are presented as mean ± standard deviation.

RESULTS

The performance of our sample were analyzable regarding the distance of height body center gravity (^{D} Height $_{BCG}$), trunk angle, thighs angle, knee angle, nested rectangles test, and nelson test. In addition, the sport training logs were checked for the sample. None of the participants performed strenuous an additional physical training besides the training program of their team, and these not playing other sports (just football). All the participants included in this study completed all tests, and the requested data was analyzed.

Table .1; shows the description results of performance kinematic analysis for our sample during performed the performance of accuracy kicking tests in three phases (The Backswing, Ball Contact, and Follow-through), in addition the results of accuracy shooting and balance tests.

Table .2; shows the results of tests (balance and accuracy) and their correlations with the values of kinematical analysis during the performance of accuracy kicking tests. The significant correlation was observed in (1-tailed) and degrees of freedom (n-1) between the variables in three phases of kicking the ball;

The first phase (the backswing), the correlations are positive significant between the variables; the static balance with knee angle at ($p \leq 0.05$), the dynamic balance with trunk angle at ($p \leq 0.005$), with knee angle at ($p \leq 0.05$), and with static balance at ($p \leq 0.001$), the nested rectangles test with trunk angle, static balance, and dynamic balance at ($p \leq 0.005$), and with thighs angle at ($p \leq 0.05$), the nelson test with thighs angle at ($p \leq 0.05$).

The second phase (ball contact), the correlations are positive significant between the variables; the dynamic balance with ^{D} Height $_{BCG}$ and static balance at ($p \leq 0.001$), and with °knee angle at ($p \leq 0.0005$), the nested rectangles test with ^{D} Height $_{BCG}$ and thighs angle at ($p \leq 0.05$)*, and with trunk angle, knee angle, and static balance at ($p \leq 0.01$), the nelson test with trunk angle and dynamic balance at ($p \leq 0.005$), and with thighs angle at ($p \leq 0.001$).

The third phase (follow-through), the correlations are positive significant between the variables; the dynamic balance with static balance at ($p \leq 0.001$), the nested rectangles test with trunk angle, static balance, dynamic balance at ($p \leq 0.05$), the nelson test with highs angle at ($p \leq 0.05$), with knee angle at ($p \leq 0.005$), and with dynamic balance at ($p \leq 0.001$).

The correlations are negative significant between the static balance with ^{D} Height $_{BCG}$ at ($p \leq 0.001$) in all phases of kicking the ball.

Table .1: Descriptive Samples Statistics.

Variables	The Backswing		Ball Contact		Follow-through		Measuring Unit
	Mean	Std. D	Mean	Std. D	Mean	Std. D	
Kinematical							
^{D} Height $_{BCG}$	97.18	3.01	95.26	2.26	98.79	3.05	Centimeter
° Trunk	94.36	2.42	95.61	2.73	99.27	3.56	Degree
° Thighs	116.16	4.24			78.36	4.28	
° Knee	143.33	8.27	130.63	8.67	131.38	13.13	
Balance test							
	Mean				**Std. D**		
Static balance	43.9				8.76		Second
Dynamic balance	5.5				2.71		Number
Shooting accuracy tests							
Nested rectangles test	14.5				2.32		Point
Nelson test	14.8				2.52		

Table .2: The Correlations between results of tests

The Backswing							
	^{D} Height $_{BCG}$	° Trunk	° Thighs	° Knee	Static balance	Dynamic balance	Nested rectangles test
Static balance	-.000**			.047*			
Dynamic balance		.004**		.034*	.000**		
Nested rectangles test		.007**	.034*		.005**	.001**	
Nelson test			.037*				
Ball Contact							
	^{D} Height $_{BCG}$	° Trunk	° Thighs	° Knee	Static balance	Dynamic balance	Nested rectangles test

Static balance	-.000**						
Dynamic balance	.000**			.003**	.000**		
Nested rectangles test	.035*	.007**	.013*	.037*	.006**		
Nelson test		.001**	.000**			.001**	
Follow-through							
	[D] Height BCG	° Trunk	° highs	° Knee	Static balance	Dynamic balance	Nested rectangles test
Static balance	-.000**						
Dynamic balance					.000**		
Nested rectangles test		.034*			.032*	.023*	
Nelson test			.047*	.003**		.000**	

($p \leq .05$) * Correlation is significant at the 0.05 level.
($p \leq .01$) ** Correlation is significant at the 0.01 level.

DISCUSSION

Based on the results obtained, we referred to the characteristics in the motor performance during kicking ball, and their relationships with the balance and accuracy. The soccer kick is a complex movement being the result of multiple movements coordination performing for kicking the ball with accuracy (Clarys et al., 2003). And this coordination of the movement needs stability and balance (Guebli et al., 2018).

Different kicking conditions are expected to create different kicking foot's positioning demands relative to the ball, and, as a result, the aim of the player when kicking a ball to a top target is to lift the ball from the ground and giving the ball an upward trajectory with direct the ball to the desired target area (Weineck, 1999). The player should position the swinging foot behind the ball, while the ankle joint should be in a dorsiflexed position to allow a foot-ball impact that would permit to the ball to rise from the ground (Asai et al., 2002; Prassas et al., 1990). Bessenouci .I 2019 indicated that the Gravity and aerodynamics are among the factors affecting the accuracy of ball shooting in soccer, as they are responsible for the diversity of the trajectories of the soccer ball (B. H. Islem & Bouabdellah, 2019).

The Previous studies underlined the importance of an appropriate technique during soccer kicking trials (Kellis & Katis, 2007; Adrian Lees & Nolan, 2011). At low speed, gravity dominates and only the Galilean parable is observed. At high speed, aerodynamics become preponderant and the trajectory begins to depend on the rotation of the ball (B. I. B. Islem et al., 2018). Without rotation, it goes straight or zigzags, depending on the laminar or turbulent nature of its boundary layer. This almost straight trajectory continues, until the ball is slowed down enough for gravity to drop it. The last regime is that of rotating balloons which leads to circles, even to pieces of spiral when the distance covered is sufficiently great (Bray & Kerwin, 2003; B. I. B. Islem & Bouabdallah, 2018). shooting skills are characterized by being linked to the motor characteristics (compatibility, balance) and cannot separated. In theory, accuracy and level of skill may differ in professional players as opposed to amateurs (Dellal, 2008).

Therefore, accuracy demands should remain at high levels during the entire duration of the game. Anderon Study confirmed that the velocity of the foot and the ball have a positive linear relationship (A. Lees et al., 2010). The velocity of the ball during a direct free kick is between 25.8 m / s and 28.3 m/s (Hong et al., 2012). The decrease in the center of gravity of the body and its height during the stages of kicking the ball effectively affects the trajectory of the ball. The ball gains a rotational movement due to the deviation of the trunk angle, also to the flexion value of the knee angle, which expresses the explosive value of acquired force of the foot during the kicking the ball. The best starting velocity of the sphere is 20.4 m/s, so that the ball travels along its flight path during a free kick as soon as possible so that it is difficult for the goalkeeper to tackle it (Bray & Kerwin, 2003).

Therefore, our results indicate, that the knee angle of support foot affects kicking accuracy, this is probably reflected in the level of balance exerted by the foot on the ground upon impact neither on the contact duration. Also, the decrease in the center of gravity of the body and its height during the stages of kicking the ball effectively affects the trajectory of the ball. The ball gains a rotational movement due to the deviation of the trunk angle, also to the flexion value of the knee angle, which expresses the explosive value of acquired force of the foot during the kicking the ball. This finding underlines the significant are taking place so that the ball is directed to the desirable target by slowing down the knee extension and the movement of the kick, permitting a more accurate kick (Katis et al., 2013), In addition

to knee angle, accurate top target kicks were accompanied by a higher $_{BCG}$ at ball impact compared with inaccurate kicks.

Moreover, the player who plays with one foot makes his task difficult and reduces the effectiveness of his aim, as he is accustomed to kicking the ball with one foot. Thus, it is possible that when a soccer kick does not lead to the desirable result, that mean when the kick does not hit the target, an error of the movement sequence has occurred (Savelsbergh & Kamp, 2000).

The results of the present study underline the importance of the balance in accurate kicking of ball, the shooting skill in soccer contains many different kinetic responses to unexpected changes in the external environment. this by coordinating full-body movements, where balance effected by the ideal values of kinematical variables analysed in this study, therefore, programs for learning and training should aim to achieve good motor coordination, and this is to support balance during the performance of kicking the ball in order to achieve the goal.

CONCLUSION

The use of kinematical analysis technology was effective in clarifications the relationships between balance and accuracy kicking the ball. This is because of the importance of balance in the kinetic performance of kicking the ball.

We recommend our coaches to focus on the kinematical performance details during kicking the ball, in order to achieve accuracy in kicking and goal. The ball kicking strength may be affected by the positions of the body joints during the performance, which may cause an imbalance for the player, which causes him to lose accuracy in kicking. also, the software of motor performance analysis becomes part of their regular teaching and training regimens when learning, training, and evaluating student's technical skills in different physical activities because the analysis of kinetics performance of students in different phases of skill performance allows us not only to measure the effort distribution but also define the techniques and errors of practice.

PRACTICAL APPLICATION

Balance ability has been associated with the accuracy in performance during shoot skill in soccer. This may indicate that athletes' movement strategies may be different depending on the kinematic performance and that normative values that may need to be established for each variable. therefore, we need to focus on using the ideal values of kinematical variables to achieve balance during the kinetic performance of shooting skill, where this contributes to successful shooting accuracy in soccer.

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