COMPARISON OF FUNCTIONAL MOVEMENT SCREEN AND FRONTAL PLANE KNEE PROJECTION ANGLE ON PREDICTION OF LOWER EXTREMITY INJURIES AMONG COLLEGIATE FOOTBALL PLAYERS

Rajadurai.R ¹, T.N.Suresh ²
¹STUDENT, SRM COLLEGE OF PHYSIOTHERAPY, SRM INSTITUTE OF SCIENCE AND TECHNOLOGY, SRM NAGAR, KATTANKULATHUR-603203, KANCHIPURAM, CHENNAI, TAMIL NADU, INDIA.
²VICE PRINCIPAL, SRM COLLEGE OF PHYSIOTHERAPY, FACULTY OF MEDICINE AND HEALTH SCIENCES, SRM INSTITUTE OF SCIENCE AND TECHNOLOGY, SRM NAGAR, KATTANKULATHUR-603203, KANCHIPURAM, CHENNAI, TAMIL NADU INDIA.
sureshn@srmist.edu.in

ABSTRACT

BACKGROUND: Football is the fast phased team sport resulting in more of lower extremity injuries. Lower extremity injuries are consisting 50% of all other injuries in collegiate athletes as reported by National Collegiate Athletic Association (NCAA). Predicting the injury will helps to reduce the injury incidences. Functional Movement Screen (FMS) and Frontal Plane Knee Projection Angle (FPKPA) are the tools used to predict the injuries. FMS consist of seven set of exercises pattern and be assessed with th FMS tool. FPKPA is the 2D analysis the Single Leg Squat (SLS) were performed and captured by the video camera the angle of deviation of knee valgus in degree will calculates with the captured footage by using Kinovea software in computer. In research aspect comparing these two tools will give an effective platform to predict the injury in sports players in cost and time effective manner.

OBJECTIVE: To findout the effective too predict the lowerlimb injuries in colligate football players.

METHODOLOGY: total of 23 football players are participated in this study. This is the observational and comparative study type with convenient sampling method. For all the participants the FMS and FPKPA test are done before the tournament. The players followed up for next three weeks. The injuries are regestred in the follow up.

RESULTS: out of 100% FMS predicted 39.1% of players are in high risk for injury and FPKPA 56.5% players are in high risk. After the follow up for three weeks the injury incidence are registered as 30.4%.

CONCLUSION: Based on the injury incidence rate both FMS and FPKPA both are correlating with the injury rate but FMS are highly correlating with the injury incidence than the FPKPA.

KEY WORDS: Injury Prediction, FMS, FPKPA, Lower Extremity injury prediction, 2D video analysis.

I. INTRODUCTION

Football is the fast phased team sport resulting in more of lower extremity injuries. Lower extremity injuries are consisting 50% of all other injuries in collegiate athletes as reported by National Collegiate Athletic Association (NCAA)².

To reduce the injury incidence address the modifiable risk factors is very essential. poor neuromuscular control over the lower limb results in excessive knee valgus which can be identified the Frontal Plane

www.turkjphysiotherrehabil.org
Knee Projection Angle on the other side during the sport performance the improper movement pattern such as stabilization, stabilization, constraint in motor control and functional asymmetry can be identified with the Functional Movement Screening Tool. Here FPKPA and FMS are the injury prediction tools and focusing on the lower limb.\textsuperscript{6,8,9} The uses of 3D motion analysis with the force plates is well known gold standard method to analyze the movement pattern. This type of methods requires the laboratory method to is not universally available, also this kind of setups are very expensive and requires extensive equipments and education.\textsuperscript{2}

This Frontal Plane Knee Projection Angle is the Two Dimensional (2D) Video analysis of the single leg squat (SLS). And this a reliable tool to measure the knee valgus while performing Single Leg Squat\textsuperscript{1,2}.

This one will be validated against the three dimensional motion video analysis which is gold standard tool to analyze the knee valgus while doing SLS. Whereas the three dimensional motion analysis is commonly costly and require laboratory setup to do the test. On the other side 2D video analysis is cost effective, ease to use in field environment and feasible to analyze with the software\textsuperscript{1}.

The Functional Movement Screening (FMS) is based on the ranking and grading system consist of seven fundamental movement patterns. FMS examination helps to evaluate the important motion patterns in the dynamic and practical way.

Aim of this FMS examination were to 1) recognize body asymmetry 2) assess mobility and stability within the kinetic chain of whole-body movements , 3) to discover poor quality of movement pattern. Each of the exercise consist of maximum score of three and the total score of FMS test is 21. Sum of the individual test score is considered as the final scoring of the FMS test. While some screening methods require advanced training, certification or a period of familiarization, the FMS is a reliable screening method even when administered by novice examiners.\textsuperscript{8} Kiesel et al concluded that strenuous injuries in football can be predictable by using FMS scoring method. The achieved total FMS score of 14 or less is having the higher chance of getting an injury. Studies are there to individually to find out the effectiveness of these tools individually but in this study we are going to compare these two injury prediction tools.

II. METHODOLOGY

- **STUDY DESIGN** Observational
- **STUDY TYPE** Comparative study
- **STUDY DURATION** 3 weeks
- **SAMPLE SIZE** 23 football players
- **SAMPLING METHO** convenient sampling
• SAMPLE SETTING  Directorate of  Sports, SRM Sports complex

INCLUSION CRITERIA
• Age between 17 – 27 years
• Male football player
• No history of lower extremity injury within 3 months
• Those who are willing to participate in the study

EXCLUSION CRITERIA
• Recent injuries to lower extremity such as back,
• hip, knee, ankle and foot
• Players having hyper mobile joints

MATERIALS USED
• FMS TOOL KIT
• Digital Camera
• Kinovea video analysis software
• Inch tape
• Markers for bony land marks

PROCEDURE
Based on the inclusion and exclusion criteria the subjects were selected. For each player the FMS and FPKPA tests are applied on the same day.

Functional Movement Screen is consist of seven set of physical examination includes

1  Deep squat
2  Hurdle step
3  In-line lunge
4  Active straight leg raise
5  Trunk stability pushup
6  Rotator stability
7  Shoulder mobility

Each and every test are consisting the score range between 0-4 and the maximum score of the FMS is 21. The movement pattern will be graded based on the quality and ability to produce the optimal movement pattern. If the individual performing exercise without compensatory movements and able to do the exercise within the standard expectations of movement patterns the individual get 3 points. If the player performing the exercise with compensatory movement pattern the player will get 2 points. If the player not able to complete the exercise he will get 1 point. If the player feeling pain at any part of body while performing the exercise the players score will be 0. The score results are documented in the FMS scoring sheet.
Frontal Plane Knee Projection Angle is the 2D video analysis from the frontal plane. Before the video analysis the players are allowed to perform the trial squats and familiar with the single leg squat. The body markers are stucked in the anterior superior iliac spine (ASIS), center of the knee joint and center of the ankle. Player need to perform the SLS in the marker over the floor which is 3 meter distance from the camera and the camera fixed 1 meter height from the floor. The participants need to perform the SLS in the marked location. Canon 1300D Digital Single Lens Reflex (DSLR) camera was used to capture the SLS movement patterns and Kinovea software is used to analyze the captured video.

In video analysis the oblique line which if from the ASIS to the center of the knee and another perpendicular line passing through the center of the ankle to center of the knee. intersection points of these lines are are giving the degree of knee valgus. That will be calculated and noted. Lower limb questionnaire are given to the participants which is excludes the injuries from the out of intrinsic factor. The acute lower limb injury resulted in an athlete being unable perform in the practice as well as during the tournament. The injuries were registered by the team coach/ team captain and the injured player are aske to fill the questionnaire. For the injury registration I contacted the team on daily basis. On the day or next day I collecte the history like injury time, place, casuse, type and time loss due to the injury in a standardized manner with the assessment of the injury

STATISTICAL ANALYSIS

The baseline demographic data such as Age, Height, Weight, BMI, baseline FMS and FPKPA results and Final results were collected and plotted in MS Excel sheet. Pearson correlation co-efficient was calculated to findout the correlation with the final results. That is the collected data from the FMS results are Correlated with the final results and the FPKPA results were correlated with the Final results to find out the highly correlating one.

III. RESULTS

Data were obtained from the 23 player with the age, height, weight and BMI. The frequency and correlation were calculated with the final injury incidences

Table 1 shows the result of FMS injury prediction scores that is 39.1% of players are in high risk of injury and the table 2 shows that 30.4% of players are had the injury. Table 3 was showing the correlation between the FMS value and injury incidence.

Table 4 shows the Results of FPKPA injury scores that is 56.5% of players were in high risk category and the table 5 shows the actual injury incidence of 30.4%. the table 6 shows the correlation of injury prediction between the FPKPA and injury incidences.

IV. DISCUSSION

In many of the sports the involvement of the lower exterimity is more high to deliver the effective performance. So the injury incidence in the lower limb also more high in frequencies. Especially the game like football requires more of lower limb involvement to deliver the performance. Neuromuscular deficiencies such as poor frontal plane knee control is the potential factor for the intrinsic factor for the risk of injury and more associated with the lower limb. These intrinsic factor for the risk of injuries are identifiable an modifiable. On the other side the asymmetry of the movement patter on either side will derive the injuries while performing the game.

This study is focusing on comparing the two different injury prediction tools. Because predicting the injury as the the baseline assessment can give the idea about the individual players weakness and lag in the particular muscle group. So that we can predict the injuries due the intrinsic factors.

The FMS is the Predicting tool for injury consisting seven set of exercise each exercise having the individual maximum score of three and the total FMS score is 21. The players scored less than 14 are predicted as high risk of injury. The Functional movement Screening tool been used to analyze the movement pattern. The FMS scoring sheet which is the standardized method to collect the score and documented. Here its not compulsion to having deficit in bi lateteral side. The scoring method of FMS will takes the least score obtained by the both side of the limb.

In FPKPA is based on the video analysis, the captured video was processed in Kinovea software to findout the knee valgus angle while performing the SLS. Kinovea is the free version softwar which is available for the
Microsoft windows operative system. The lines are draw between the markers which is placed on the players body landmarks. The angular measurement option in the kinovea software will give the exact angulation in degrees between the lines.

To our knowledge previous studius are there as individual for FMS and FPKPA. But there is no study have done to compare these two injury prediction tools in the same group.

The FMS and FPKPA were applied for the individual player on the same day with adequate rest period. We assessed the player before two days of tournament time. We were followed the participants in daily manner for three weeks to identify and register the injury. The lowerlimb outcome questionnaire are given to the coach and team captain and asked to fill that while getting any injury. That quationnaire helped to exclude the injuries which not a intrinsic cause such as bruise, impact injuries or and skin lesion. On the other time, the day or next day I visited to meet the team and injured player collect the history, cause, time loss of injury and for physical assessment to register the injury.

The utility of implementation of injury prevention strategies and interventions in rehabilitation and sports performances is explained by Hewett et al⁴. He followed 1,263 high school athletes who are instructed to follow the injury prevention programme included the strength training, proprioception and flexibility exercise programme. To compare with the untrained athletes in the same group are likely 4.8 to 5.8 times having more risk for injury.

The intensity of the game play is depends on the player position and time duration during the game. However all the players were participated in the game during the tournament season. At the end of three week the we were accumulated the data.

It resulted in FMS injury prediction shows that 39.1% of partipants are predicted as in high risk of injury. In Table 2 we were compared the FMS results with the injury incidence that is 30.4% players were injuries during that game play. In pearson correlation coefficient analysis it was highly correlating. In FPKPA table 4, 56.5 of players were predicted as high risk for injuy and 30.4% of participants only got injured. In pearson correlation coefficient analysis the FPKPA is correlating with the injuriy incidence but its less the significant value of FMS.

In lower extremity the injuries are documented in various parts such as ankle, knee, hip. Here we were not include the injuriy incidence from the trunk and upper extremity. But from the 23 participants one injury happened in the upper limb which is excluded here.

V. CONCLUSION

From these two injury predicting tools, both were correlating with the injury incidence but the FMS is highly correlating with the injury incidence than the FPKPA

<table>
<thead>
<tr>
<th>TABLE 1:</th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Std. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGE IN YEARS</td>
<td>23</td>
<td>19.00</td>
<td>24.00</td>
<td>21.1739</td>
<td>.32457</td>
<td>1.55657</td>
</tr>
<tr>
<td>HEIGHT IN CMS</td>
<td>23</td>
<td>159.00</td>
<td>178.00</td>
<td>169.4565</td>
<td>.85507</td>
<td>4.10076</td>
</tr>
<tr>
<td>WEIGHT IN KGS</td>
<td>23</td>
<td>58.50</td>
<td>70.00</td>
<td>65.2826</td>
<td>.80624</td>
<td>3.86660</td>
</tr>
<tr>
<td>BMI</td>
<td>23</td>
<td>19.90</td>
<td>24.80</td>
<td>22.7217</td>
<td>.22031</td>
<td>1.05656</td>
</tr>
</tbody>
</table>

Descriptive Statistics – Mean, SD, Std Error between age, height, BMI.

N= total numbers of samples 23.
TABLE 2: statistics for the demographic data

<table>
<thead>
<tr>
<th></th>
<th>AGE IN YEARS</th>
<th>HEIGHT IN CMS</th>
<th>WEIGHT IN KGS</th>
<th>BMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>N Valid</td>
<td>23</td>
<td>23</td>
<td>23</td>
<td>23</td>
</tr>
<tr>
<td>Missing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mean</td>
<td>21.1739</td>
<td>169.4565</td>
<td>65.2826</td>
<td>22.7217</td>
</tr>
<tr>
<td>Std. Error of Mean</td>
<td>.32457</td>
<td>.85507</td>
<td>.80624</td>
<td>.22031</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>1.55657</td>
<td>4.10076</td>
<td>3.86660</td>
<td>1.05656</td>
</tr>
<tr>
<td>Range</td>
<td>5.00</td>
<td>19.00</td>
<td>11.50</td>
<td>4.90</td>
</tr>
<tr>
<td>Minimum</td>
<td>19.00</td>
<td>159.00</td>
<td>58.50</td>
<td>19.90</td>
</tr>
<tr>
<td>Maximum</td>
<td>24.00</td>
<td>178.00</td>
<td>70.00</td>
<td>24.80</td>
</tr>
</tbody>
</table>

Mean, standard error in the mean, standard deviation, Range of the collective data

TABLE 3: FMS Injury prediction and injury incidence

<table>
<thead>
<tr>
<th>FMS</th>
<th>Predicted high for injury</th>
<th>Predicted low risk for injury</th>
<th>Injured players</th>
<th>Non injured players</th>
</tr>
</thead>
<tbody>
<tr>
<td>No of players</td>
<td>9</td>
<td>14</td>
<td>7</td>
<td>16</td>
</tr>
<tr>
<td>Percentage of injury</td>
<td>39.1</td>
<td>60.9</td>
<td>30.4</td>
<td>69.6</td>
</tr>
</tbody>
</table>

The above table explaining predicted high risk and low risk for injury in players and injury incidences.

TABLE 4: Correlation between predicted FMS values and injury incidences

<table>
<thead>
<tr>
<th>FMS Value</th>
<th>Injury Incidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Correlation</td>
<td>1</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.037</td>
</tr>
</tbody>
</table>

* Correlation is significant at the 0.05 level (2-tailed).

Pearson correlation coefficient between the FMS score results and the injury incidences.

TABLE 5: FPKPA Injury prediction and injury incidence

<table>
<thead>
<tr>
<th>FPKPA</th>
<th>Predicted high for injury</th>
<th>Predicted low risk for injury</th>
<th>Injured players</th>
<th>Non injured players</th>
</tr>
</thead>
<tbody>
<tr>
<td>No of players</td>
<td>13</td>
<td>10</td>
<td>7</td>
<td>16</td>
</tr>
<tr>
<td>Percentage of injury</td>
<td>56.5</td>
<td>43.5</td>
<td>30.4</td>
<td>69.6</td>
</tr>
</tbody>
</table>

The above table explaining predicted high risk and low risk for injury in players and injury incidences.
TABLE 6: Correlation between predicted FPKPA values and Injury incidences

<table>
<thead>
<tr>
<th>FPKPA</th>
<th>Frontal Plane Knee Projection Angle Score</th>
<th>Final Result Incidence of Injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frontal Plane Knee Projection Angle Score</td>
<td>Pearson Correlation Sig. (2-tailed)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>.008</td>
</tr>
<tr>
<td></td>
<td></td>
<td>.970</td>
</tr>
<tr>
<td>Final Result Incidence of Injury</td>
<td>Pearson Correlation Sig. (2-tailed)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>.008</td>
</tr>
<tr>
<td></td>
<td></td>
<td>.970</td>
</tr>
</tbody>
</table>

Pearson correlation coefficient between the FPKPA results and Injury Incidences

SCATTER DIAGRAM 1: FMS and FKPKA values

CONFLICT OF INTEREST- NIL

SOURCE OF FUNDING- SELF FUNDING

ETHICAL CLEARANCE- INSTITUTIONAL ETHICAL COMMITTEE

REFERENCES
5. Injuries in adolescent female players in European football: a prospective study over one outdoor soccer season, Söderman Ket al (2001)
12 Real-time assessment and neuromuscular training feedback techniques to prevent ACL injury in female athletes, Myer GD et al (2011)
15 Is there a correlation in frontal plane knee kinematics between running and performing a single leg squat in runners with patellofemoral pain syndrome and asymptomatic runners?, Rees D et al (2018)
16 Are tibial angles measured with inertial sensors useful surrogates for frontal plane projection angles measured using 2-dimensional video analysis during single leg squat tasks? A reliability and agreement study in elite football (soccer) players, Hughes T et al (2019)
17 A dynamic valgus index that combines hip and knee angles: assessment of utility in females with patellofemoral pain, Scholtes SA et al (2017)
19 Single leg squat ratings by clinicians are reliable and predict excessive hip internal rotation moment Barker-Davies et al (2018)
22 Knee valgus angle during single leg squat and landing in patellofemoral pain patients and controls Munro A et al (2014)
23 Two-dimensional frontal plane projection angle can identify subgroups of patellofemoral pain patients who demonstrate dynamic knee valgus, Gwynne CR et al 2014