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Original Article

KNEE AND SHOULDER INJURY RISK ASSESSMENT IN SCHOOL LEVEL FEMALE BASKETBALL PLAYERS: A CROSS – SECTIONAL STUDY

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ABSTRACT

Objectives: One of the common reasons for talent not being converted in the big stage is career ending injuries. The best way out is preventing these injuries which is the easiest and most effective solution. Hence, this study was done to evaluate the injury risk among school level basketball players.

Materials and Methods: Total of 107 school level female basketball players were assessed for 1. Functional Movement Screen (FMS) – To assess risk of injury and functional ability. 2. VO2 max by questionnaire – to assess the maximum endurance level of the athlete. 3. Jump alignment on landing by HD slow motion video analysis - to assess risk of knee injury. 4. Glenohumeral Internal Rotation Deficit (GIRD) & Total Range Of Motion Deficit (TROMD) by Goniometer to assess risk of shoulder injury.

Results: In our study even though the FMS scores were good for majority of the players, the risk of shoulder injury was high TROMD (50.46%) compared to GIRD (11.21%). Jump alignment results showed that majority of players landed in internal rotation (62.61%). VO2 max assessment revealed superior results for all athletes. Majority of athletes had a good (79.43%) FMS score.

Conclusion: To prevent performance declining or career ending injury to talented athletes, early intervention at school level is the essential. So we recommend structured stretching exercise programme including sleepers stretches for shoulders and hip abductors and external rotators strengthening along with proper landing drills for athletes from school level itself.

KEYWORDS: Jump alignment, VO2 Max, FMS, GIRD, TROMD, Basketball, Shoulder injuries, Knee injuries

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INTRODUCTION

Sports talent is available abundantly, how ever not many of the young talents make it to the big stage. It is not being converted in the big stage. One of the common reasons is career ending injuries. The best way out is preventing these injuries which is the easiest and most effective solution. A variety of intrinsic and extrinsic factors predisposing athletes to injury have been documented in the literature including agonist/ antagonist muscle ratio for strength and endurance, structural abnormality, female gender, pretraining fitness level and history of prior musculoskeletal injury. More recently neuro-muscular control, core instability and contra lateral muscle balances have been suggested as other important risk factors for injury [1].

Athletes often utilize compensatory movement strategies to achieve high performance. However, these inefficient movement patterns may reinforce poor biomechanical movement patterns during typical activities resulting in injury. Compensatory movement patterns can increase the risk of injury in female collegiate athletes and can be identified using a functional movement screen (FMS) tool. In an effort to bridge the gap between the pre-participation medical screening and performance testing, Gray Cook et al developed the functional movement screen (FMS) [2]. It consists of seven movement tests that are intended to quickly and easily identify restrictions or alterations in normal movements. The tool was designed to challenge the interaction of kinetic chain mobility and stability necessary for performance of fundamental functional patterns. Such movements require controlled neuromuscular execution in a variety of occupational and athletic tasks. A score of 14 or less on the FMS resulted in an approximate 4 fold increase in risk of lower extremity injury over the course of competitive season in female athletes participating in sports including basketball, volleyball and soccer [3].

Aerobic fitness refers to endurance, or the ability to sustain work for prolonged periods. This is usually experienced in the abilities to walk, run, climb uphill, swim, etc. Most forms of sports, work, recreational and military activities include elements of aerobic fitness. In aerobic work, oxygen is obtained from the air and is transferred from the lungs to the blood and then to the muscles via the circulatory system. Maximal oxygen uptake or maximal aerobic power (VO2 max) is the indicator of aerobic fitness. Vo_2max is determined by the measurement of oxygen uptake during the performance of maximal work, typically while running on a treadmill or while cycling. Aerobic fitness is dependent upon age and sex and it can be improved by training. It is highest at ages 18, 19 years in males and 15 to 20 years in females, and it decreases with age in adulthood. In general, males have higher Vo_2max than females. The main reason for this is that aerobic fitness is directly related to fat-free body weight, which consists mainly of the weight of muscles in the body, and on the average, males have a higher muscle mass than females. As with other physiological functions, there are large individual differences in VO2 max of people of the same sex and age [4].

The rate of noncontact ACL injuries is 2–9 times greater in females than males, with an average increased incidence of 3.5–4. Females have a higher tendency to have risky landing patterns that are associated with ACL injury. The majority of ACL injuries occur during landing from a jump or sudden deceleration [5]. Females tend to land from a jump in a more erect position than males (insufficient knee and hip flexion), and also have greater hip internal rotation and hip adduction when decelerating or landing. Also, their movements involve more internal rotation of the hip along with external rotation at the tibia than males, leading to increased knee valgus. Taken together, these tendencies increase forces on the knee and are associated with greater risk for ACL injury [6].

The shoulder plays a vital role in many athletic activities. Throwing appears as one of the main gestures which involve this joint being present in many sports such as baseball, handball, tennis and basketball, with different techniques depending on each sport though. Athletes who practice throws above the head present higher probability in developing shoulder injuries. The overhead throwing motion generates tremendous demand on the glenohumeral joint at excessively high angular velocities [7].

The disparity between internal rotation of the dominant and non-dominant shoulder has recently increased attention from numerous clinicians. This disparity evidenced as less internal rotation on the throwing shoulder, has been referred to as GIRD (glenohumeral internal rotation deficit). GIRD as defined by Burkhart et al, is a loss of IR of the throwing shoulder of 20^0 or more compared with the non throwing shoulder. Some clinicians have suggested GIRD as a cause of specific shoulder injuries. Wilk et al proposed the total rotational motion concept, where the amount of external rotation and internal rotation at 90^0 of abduction are added and a total range of motion arc is determined. A total range of motion difference of more than 5^0 compared between the dominant and non-dominant shoulder were said to have total range of motion deficit (TROMD)[7].

MATERIALS AND METHODS

Participants: This study was conducted during a South Zone School level Basketball tournament held in July 2014 at Coimbatore. 107 basketball players across various teams trained by different coaches volunteered for the study. The age distribution was between 10 to 20 years with the average age being 14.5. Among the volunteers all the players were right hand dominant individuals. All players were given a questionnaire which included their demographic data, level of sporting activity, any previous injuries and treatment for the same. Exclusion criteria were players who had any previous shoulder and knee injuries. Table 1 presents a descriptive data of the participants.

Age in years	14.5 ± 4.5
No. of players	107
Years of experience	4±1.5
Height in metres	1.6±0.2
Weight in Kg	45.5±20.2
BMI	20.36±5.5

Table1: Demographic data.

Testing procedure: All players were planned to undergo a series of tests to assess their injury risk assessment. These tests are as follows:

- FMS.
- VO2 MAX – Questionnaire
- Jump analysis – slow motion HD video analysis.
- TROMD & GIRD - Goniometer.

FMS was assessed by asking the players to perform the seven basic movement patterns which include deep squats, hurdle step, in line lunge, shoulder mobility, straight leg raise, rotator stability and push ups. Every player scored from zero to three for each movement was based on their movement pattern with the maximum of 21 and graded into good to high risk. VO2 Max was computed by questionnaire which had the basic demographic data, BMI, perceived functional ability and physical activity rate using the George Non-Exercise test [8]:

VO2max (ml/kg/min) = 45.513 + (6.564 * Gender) – (0.749 * BMI) + (0.724 * PFA)+ (0.788 * PA-R)

Gender = 1 for male and 0 for female; PFA = sum of both PFA scales; PA-R = number form PA-R scale.

Jump alignment and jump height were assessed using slow motion video analysis with the player six meters from the camera to avoid parallax error.

Players had markers placed on their shoulder, elbow, hip, knee and ankle to assess the alignment at impact on landing. Players were asked to mimic the jumping action as in the basketball match and anteroposterior videos were captured.

Glenohumeral passive range of movement was assessed for all participants with the help of standard goniometer. Participants were made to lie down in order to arrest the movement of scapula and range of movement was checked in the plane of scapula. All participants were examined by the same examiner. The examiner moved the glenohumeral joint in internal and external rotation and the PROM was checked where the examiner felt the end point. To avoid altering the normal glenohumeral arthrokinematics the humeral head was not stabilized. For all shoulder measurements the axis of the goniometer was placed along the olecranon process, with the stationary arm perpendicular to the ground and the moving arm along the ulna facing the ulnar styloid process [7]. All measurements were taken prior to any exercise, warm-up or matches.

Reliability: A pilot study was conducted with ten volunteers for whom the glenohumeral passive range of movement, Jump alignment and grading for FMS was assessed over five consecutive days. Intra-observer reliability was established using this pilot study.

RESULTS

107 school level basketball players volunteered and participated in our study who were among the age distribution of 10 to 20 years with the average age being 14.5. 72.9% of players were in the 10 to 15years age group and27.1% in the 16 to 20 age group. 55.2% were having normal weight for the age whereas 39% were underweight and 5.7% overweight. All the players were right hand dominant.

FMS was assessed and among the 107 players 79.4% had a good core stability, movement patterns and hence low risk of injury whereas 3.7% of the players had a score of less than 14 out of 21 and were high risk individual for injuries as they had poor stability and mobility. 16.8% were in the risk group as they had either poor

Chart 1: Showing the Functional Movement Screen (FMS).

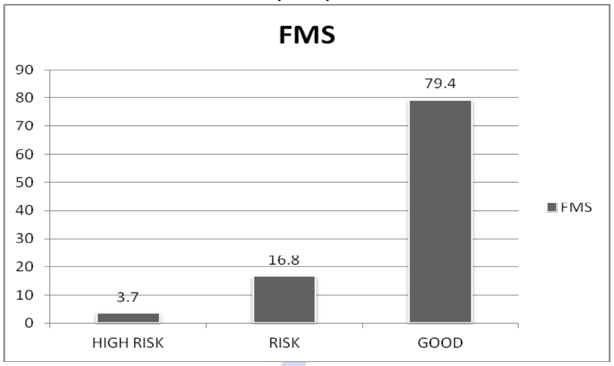


Chart 2: Showing the VO2max.

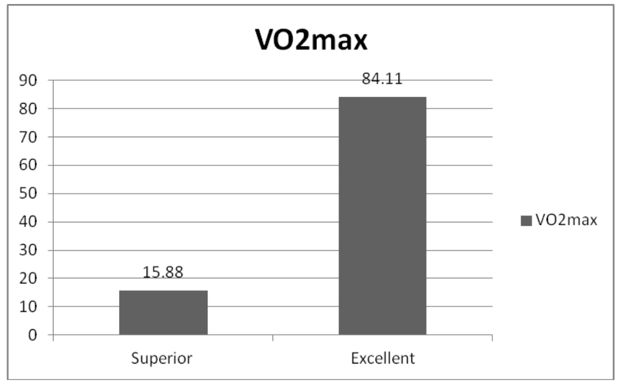


Chart 3: Showing the Allignment.

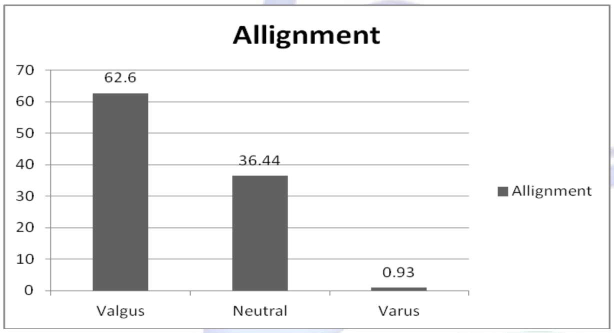
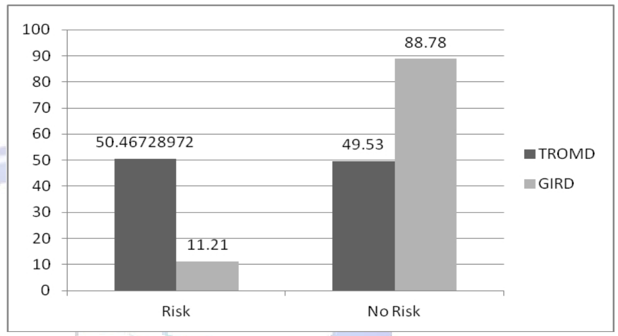


Chart 4: Showing the variations in TROMD Vs GIRD.



stability or mobility which is depicted in chart - 1. Vo2 max assessed by formula method revealed 84.11% of the players in the excellent group according to the ideal Vo2max norms for their age and 15.88% had superior results (chart – 2).

Jump alignment results (chart – 3) assessed by slow motion video analysis showed 62.6% of the players had valgus alignment impact on landing which was supposed to be significantly high compared to 36.44% with neutral alignment and 0.93% with varus alignment. Jump height was also assessed as the player jumped and it ranged from 210 to 280 centimetres with the average jump height of 250.5 centimetres.

50.5% of the players had total range of motion deficit (chart – 4) and were more prone for shoulder injuries compared to 49.5% who had normal arc of motion. Whereas glenohumeral internal rotation deficit showed less significant results with 11.2% in the risk group (chart – 4) and 88.78% in normal group with no predisposing risk for shoulder injury.

DISCUSSION

Even though immense talent is available only tip of the iceberg is converted and proven. The reasons of which being plenty, we have taken up this study to emphasize the importanance of sports injury risk assessment in school level female basketball players.

FMS was used in this study to determine if compensatory movement patterns predispose female basketball players to injury and if FMS could predict injury in the study population. A trend was noted regarding the performance of shoulder mobility and trunk stability pushup in female subjects. Majority of the players in our study obtained good scores (79.43%).

There are various methods available to determine an individual's aerobic fitness (Vo2max) which is broadly divided into exercise and non-exercise tests, we have chosen a simple method of non-exercise test by George method. Aerobic fitness is supposedly to be the maximum during the age group of 15 to 20 years in female subjects which correlates with our study yielding excellent results in majority of players (84.11%).

The other side of our study reveals alarming results with higher incidence of riskier landing patterns and total range of motion deficit. This requires early intervention to prevent talented players from getting injured and stay away from sports for a longer period. There are a few suggestions on how these riskier landing patterns can be avoided. Adequate musculature strength, along with appropriate muscle recruitment and timing, are important aspects of knee stability. In 2011, LaBella et al studied the effects of a neuromuscular warm-up program on ACL injury rates in high school female athletes in Chicago public schools and came to a conclusion that 56% reduction in total non-contact lower extremity injuries in the intervention group compared with the control group. The intervention group also had lower rates of ankle sprains, knee sprains, and gradual onset of lower extremity injuries. This program is known as KIPP, Knee Injury Prevention Program Strength training should especially include hamstring strengthening and recruitment [1,10].

Strengthening hip abductors may help reduce knee valgus, so gluteus strengthening should be included as well. Also, any asymmetry in strength and movement patterns should be addressed. Some have also recommended incorporating core strengthening to help stabilize trunk motion. Plyometrics should incorporate high intensity agility drills that work on footwork and quick explosive movements emphasizing power and speed, along with proper muscle recruitment and mechanics, with increasing difficulty. This can incorporate cutting, jumping, lateral movements, followed by addition of “perturbation”, or disturbances, to see if proper form is maintained as the athlete is challenged and the situation begins to more closely resemble a real sports situation [9].

Adrian and Cooper, 1995, described basketball as a sport which involves three types of throw: overhead (throw), lateral (pass) and low (low pass). The overhead throw in basketball emphasizes the technique and accuracy, contrary to baseball and other sports which aim at strength and velocity to obtain better performance. Based on this, the basketball throw is performed with low velocities and less strength; therefore, it is believed that the osteomyoarticular adaptation may be different in comparison to the baseball throw [16].

Most throwers exhibit an obvious motion disparity hereby external rotation is excessive and internal rotation is limited at 90^0 of abduction. The loss of internal rotation has been reported in literature by numerous authors. There have been numerous proposed reasons for the motion adaptations, which include osseous adaptation (retroversion) and soft tissue adaptations capsular and muscular) [14]. Reinold et al reported that following a pitching performance, there is a loss of Glenohumeral joint internal rotation of 9.5^0 that lasts for 24 hours. Burkhart et al suggested that GIRD is due to posterior capsular tightness. They concluded that stretching is the most appropriate treatment to address the internal rotation deficit, and they recommended a posterior capsular release, should an aggressive stretching programme not improve internal rotation passive range of motion.

Implementation of a posterior capsule stretching program may be helpful to facilitate increased passive internal rotation range of motion at the glenohumeral joint. Further research should be performed using a control group not receiving the stretching program in order to more completely establish the impact of stretching on measures of passive glenohumeral range of motion [7,11].

CONCLUSION

Although VO2max and FMS assessment results in our study have showed excellent and good results respectively, the high prevalence of TROMD and Valgus alignment on landing is quite alarming. Previous studies showed overhead athletes with TROMD and knee valgus alignment landing had a higher incidence of shoulder and knee injury. Hence to prevent performance declining or career ending injury to talented athletes, early intervention at school level is the essential solution. So we recommend structured stretching exercise programme including sleeper stretches for shoulders and hip abductors and external rotators strengthening along with proper landing drills for athletes from school level itself.

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Conflicts of interest: None

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