A Prediction model for the prevention of soccer injuries amongst youth players

SUMMARY

Background: Football (Soccer) is arguably the most popular sport in the international sporting arena. A survey conducted by FIFA (Fédération Internationale de Football Association) (FIFA, 2000) indicated that there are 240 million people who regularly play soccer around the world. Internationally, there are 300 000 clubs with approximately 1.5 million teams. In South Africa, there were 1.8 million registered soccer players in 2002/2003 (Alegi, 2004). Although youth players are predominantly amateurs and have no financial value for their clubs or schools, their continued health and safety are still of vital importance. There are some clubs which contract development players at 19 years of age in preparation for playing in their senior sides and these young players should be well looked after, to ensure a long career playing soccer. Being able to predict injuries and prevent them would be of great value to the soccer playing community.

Aims: The main aim of this research was to create a statistical predictive equation combining biomechanics, balance and proprioception, plyometric strength ratios of ND/Bil (Non dominant leg plyometrics/ Bilateral plyometrics), D/Bil (Dominant leg plyometrics/ Bilateral plyometrics) and ND+D/Bil (Non dominant leg + dominant leg plyometrics/ Bilateral plyometrics) and previous injuries to determine a youth soccer player's risk of the occurrence of lower extremity injuries. In the process of reaching this aim it was necessary to record an epidemiological profile of youth soccer injuries over a two season period. It was also necessary to record a physical profile of, and draw comparisons between, school and club youth soccer players. Following the creation of the prediction model a preventative training programme was created for youth soccer players, addressing physical shortcomings identified with the model.

Design: A prospective cohort study

Subjects: Schoolboy players from two schools in the North West Province, as well as club players from three age groups were used for this study. Players from the U/16 and U/18 teams in the two schools were tested prior to the 2007 season. Players from the U/17, U/18 and U/19 club development teams were tested prior to the 2008 season. The combined total number of players in the teams amounted to 110 players.

Method: The test battery consisted of a biomechanical evaluation, proprioceptive and plyometric testing and an injury history questionnaire. The Biomechanical evaluation was done according to the protocol compiled by Hattingh (2003). This evaluation was divided into five regions with a dysfunction score being given for each region. A single limb stance test was used to test proprioception. A Sergeant jump test was utilised using the wall mark method to test plyometric jumping height. A previous injury questionnaire was also completed on all players prior to testing. Test subjects from the schools were tested with the test battery prior to commencement of the 2007 season. The testing on the club teams was undertaken prior to the 2008 season. Injuries were recorded on the prescribed injury recording form by qualified Physiotherapists at weekly sports injury clinics at each of the involved schools and clubs. The coaching staff monitored exposure to training activities and match play on the prescribed recording forms. These training and match exposure hours were used, along with the recorded injuries for creating an epidemiological profile. Injuries were expressed as the amount of injuries per 1000 play hours. Logistical regression was done by using the test battery variables as dependent variables for grouping players into two groups

(Statsoft, 2003). This analysis created prediction functions, determining which variables predict group membership of injured and non injured players.

Results: There were 110 youth players involved in the research study from seven teams and four different age groups. There were two groups of U/16 players, an U/17 group, three U/18 groups and an U/19 group. The players were involved in 7974 hours of exposure to training and match play during the seasons they were monitored. The average age of the players was 16.6 years. The majority of players were right limb dominant (83.6%) and 65.7% of players failed a single limb stance test. The mean jump height for both legs combined was 33.77cm, with mean heights of 22.60cm for dominant leg jump and 22.66cm for the non dominant leg.

In the biomechanical evaluation of the lower leg and foot area, the average youth player presented with adaptation of toes, normal or flat medial foot arches, a normal or pronated rear foot in standing and lying and a normal or hypomobile mid-foot joint. Between 42.7% and 51.8% of players also presenting with decreased Achilles tendon suppleness and callusing of the transverse foot arch.

The youth profile for the knee area indicated that the players presented with excessive tightness of the quadriceps muscles, normal patella tilt and squint, normal knee height, a normal Q-angle, a normal VMO:VL ratio and no previous injuries. This profile indicated very little dysfunction amongst youth players for the knee area.

For the hip area, the youth profile was described as follows: There was shortening of hip external rotators, decreased Gluteal muscles length, normal hip internal rotation and no previous history of injury. Between 38.2% and 62.7% of players also exhibit shortened muscle length of the adductor and Iliopsoas muscles and decreased length of the ITB (Iliotibial Band).

In the Lumbo-pelvic area there was an excessive anterior tilt of the pelvis with normal lumbar extension, side flexion, rotation and lumbar saggital view without presence of scoliosis. Between 58.18% and 65.45% of players presented with an abnormal coronal view and decreased lumbar flexion. Between 41.81% and 44.54% of players also presented with leg length, ASIS, PSIS, Cleft, Rami and sacral rhythm asymmetry. The similarity of the results for these tests in all players contributed to a new variable called ‘SIJ dysfunction’. This was compiled from the average of the scores for Leg length, ASIS, PSIS, Cleft, Rami and Sacral rhythm, which was also considered for inclusion in the prediction model.

The neurodynamic results of youth players indicated that approximately between 44.54% and 50.91% of players presented with decreased Straight leg raise and Prone knee bend tests. The total combined dysfunction scores for the left and right sides were 17.091 and 17.909 respectively, indicating that there were higher levels of dysfunction on the right side than the left. This increased unilateral dysfunction could probably be attributed to limb dominance and increased use of the one leg for kicking and passing during the game.

In the epidemiological study on youth players, there was a total of 49 training injuries and 52 match injuries. The total injury rate for youth players was 12.27 injuries/1000 hours, with a total match injury rate of 37.12 injuries/1000 match hours. The combined training injury rate was 7.17 injuries/1000 training hours. 87.13% of injuries were of the lower limb area and the individual areas with the highest percentage of injuries were the Ankle (25.74%), Knee (19.80%), Thigh (15.84%) and Lower leg (14.85%).The totals for youth players indicated that sprains (30.69% of total), strains (27.72% of total) and contusions (27.72% of total) were the most common causative mechanism of injuries. The severity of injuries show 'zero day' (no time off play) injuries to be the most common type (35.64%), followed by 'slight' (1 to 3 days off play) (33.66%) and 'minor' (4 to 7 days off play) (14.85%). School players had higher injury rates than club players but the severity of injuries to club players was higher, with longer absences from play. Non-contact injuries accounted for 52.47% of the total with 46.53% being contact injuries. School players had lower levels of non-contact injuries than club players, which correlated well with lower dysfunction scores recorded for school players during the biomechanical evaluations. This demonstrated that there was a definite relationship between levels of biomechanical dysfunction and the percentage of non-contact injuries in youth players, which formed the premise of the creation of a prediction model for non-contact youth soccer injuries.

The next step in the creation of a prediction model was to identify the variables that discriminated maximally between injured and non-injured players. This was done using stepwise logistic regression analysis. After the analysis, ten variables with the largest odds ratios were selected for inclusion in the prediction model to predict non-contact injuries in youth soccer players. The prediction model created from the stepwise analysis presented as follows:

$$P(\text{injury}) = \frac{\exp(-8.2483 - 1.2993a + 1.8418b + 0.2485c + 4.2850d + 1.3845e + 1.3004f - 1.1566g + 1.8273h - 0.9460i - 0.5193j)}{1 + \exp(-8.2483 - 1.2993a + 1.8418b + 0.2485c + 4.2850d + 1.3845e + 1.3004f - 1.1566g + 1.8273h - 0.9460i - 0.5193j)}$$

a = Toe dysfunction
b = Previous ankle injury
c = Ankle dysfunction
d = SIJ dysfunction
e = Lumbar Extension
f = Straight Leg Raise
g = Psoas length
h = Patella squint
i = Gluteal muscle length
j = Lumbar dysfunction

In the ankle area, the toe positional test, previous ankle injury history and combined ankle dysfunction score were included in the prediction model. In the knee area, the patella squint test was included in the model. In the hip area, the Psoas component of the Thomas test was included, along with the Gluteal muscle length test. In the Lumbo-pelvic area, the SIJ dysfunction (average of Leg length, ASIS, PSIS, Rami, Cleft and Sacral rhythm tests), lumbar extension test and lumbar dysfunction scores were included in the prediction model. In the neurodynamic area, the Straight leg raise test was included in the prediction model. The prediction model therefore contained tests from all five the biomechanical areas of the body. Overall, this model correctly predicted 86.91% of players as either injured or not-injured. The I value (effect size index for improvement over chance) of the prediction model (I=0.67), along with the sensitivity (65.52%), specificity (94.87%), overall correct percentage of prediction (86.91%) and Hosmer and Lemeshow interferential goodness-to-fit value ($X^2(8) = 0.7204$), all demonstrated this prediction model to be a valid and accurate prediction tool for non-contact youth soccer injuries.

A second prediction model, for the prediction of hip and groin injuries amongst youth players, was also created. The prediction model created from the stepwise analysis for groin injuries presents as follows:

$$P\text{ (Groin injury)} = \frac{\exp(-116.2 + 33.5383d + 14.5108k + 4.1972m + 1.9330e + 10.7006f - 14.4028n + 48.8751p)}{1 + \exp(-116.2 + 33.5383d + 14.5108k + 4.1972m + 1.9330e + 10.7006f - 14.4028n + 48.8751p)}$$

d = SIJ dysfunction
k = Previous knee injury
m = Previous hip injury
e = Lumbar extension
f = Straight leg raise
n = Limb dominance
p = ND/Bil plyometric ratio

The prediction model for hip and groin injuries included the variables of SIJ dysfunction, previous knee injury, previous hip injury, lumbar extension, straight leg raise, limb dominance and the ratio of non-dominant leg to bilateral legs plyometric height. When all the validifying tests were examined, the I-value (0.64868), sensitivity (66.67%), specificity (98.01%), false negatives (1.98%), false positives (33.33%), Hosmer and Lemeshow goodness-to-fit value ($X^2(8) = 0.77$) and the overall percentage of correct prediction (96.26%) all reflected that this model was an accurate prediction tool for hip and groin injuries amongst youth soccer players.

Conclusion: This study showed that it was possible to create a prediction model for non-contact youth soccer injuries based on a pre-season biomechanical, plyometric and proprioceptive evaluation along with a previous injury history questionnaire. This model appears as follows:

P (injury)=

$$\frac{\exp(-8.2483 - 1.2993a + 1.8418b + 0.2485c + 4.2850d + 1.3845e + 1.3004f - 1.1566g + 1.8273h - 0.9460i - 0.5193j)}{1 + \exp(-8.2483 - 1.2993a + 1.8418b + 0.2485c + 4.2850d + 1.3845e + 1.3004f - 1.1566g + 1.8273h - 0.9460i - 0.5193j)}$$

a = Toe dysfunction
b = Previous ankle injury
c = Ankle dysfunction
d = SIJ dysfunction
e = Lumbar Extension
f = Straight Leg Raise
g = Psoas length
h = Patella squint
i = Gluteal muscle length
j = Lumbar dysfunction

It was also possible to create a prediction model for non contact hip and groin injuries, which appears as follows:

P (Groin injury)=

$$\frac{\exp(-116.2 + 33.5383d + 14.5108k + 4.1972m + 1.9330e + 10.7006f - 14.4028n + 48.8751p)}{1 + \exp(-116.2 + 33.5383d + 14.5108k + 4.1972m + 1.9330e + 10.7006f - 14.4028n + 48.8751p)}$$

d = SIJ dysfunction
k = Previous knee injury
m = Previous hip injury
e = Lumbar extension
f = Straight leg raise
n = Limb dominance
p = ND/Bil plyometric ratio

Using the hip and groin prediction model, combined with the injury prediction model, injuries in youth soccer players can be predicted. The data for each player should first be substituted into the injury prediction model, to determine the chance of getting injured during the season. The data should then be substituted into the hip and groin injury prediction model, determining the chance of hip and groin injuries during the season. The results from the groin injury prediction model could then be used to exclude groin injuries amongst players. A negative result for the hip and groin injury, which showed a false negative percentage of 1.98%, could be used to determine that an injury that was predicted using the overall injury prediction model, would not be a hip and groin injury. A positive result in the groin injury test could, however, not exclude injuries to other body areas that were predicted by the overall injury prediction model, so the groin injury prediction model could only be used to exclude hip and groin injuries.

Keywords: Youth soccer, soccer injuries, soccer injury prevention, soccer injury prediction, youth biomechanical profile, soccer injury epidemiology, proprioception, plyometrics