Intrinsic modifiable risk factors for lower extremity injuries in female soccer players: a prospective study during one season.

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Wauters Evi

Supervisors: Prof. Dr. Roosen Philip, Dr. De Ridder Roel, Dr. Verrelst Ruth

A dissertation submitted to Ghent University in partial fulfilment of the requirements for the degree of Master of Rehabilitation Sciences and Physiotherapy

Academic year: 2016 – 2017
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Gratitude

We would like to say thank you to those who helped us in the process of writing this study. First of all, thanks to the University of Ghent to give us the opportunity to make this study. Secondly, a big thank you to our (co)promotors for their support during this work; De Ridder Roel, Verrelst Ruth and Philip Roosen.
Also thanks to the Spartanova team and the Royal Belgian Football Academy (RBFA) for the good cooperation. And surely many thanks to all the participants, and their parents, for their effort during the screening and follow up, without them the study was not even possible. Also the use of accommodation in Tubize (Belgium) was an asset to our study, so thanks again to the RBFA.
Further, we cannot forget our fellow students. Everybody did his share in this great work and provided an ease for each other. We are also grateful to the biostatics unit of the University of Ghent for their support with our statistical analyses.
Last but not least, we would like to thank our friends and family for their support during the process.
# INDEX

ABSTRACT (English version) .................................................................................................................. 8  
ABSTRACT (Dutch version) .................................................................................................................. 9  
Introduction ........................................................................................................................................... 10  
Method .................................................................................................................................................. 14  
Study and participants ......................................................................................................................... 14  
Experimental procedure .................................................................................................................... 15  
Injury registration ............................................................................................................................... 20  
Statistics ................................................................................................................................................. 21  
Results .................................................................................................................................................... 21  
Player and injury characteristics ......................................................................................................... 21  
Risk factors lower extremity .................................................................................................................. 24  
Discussion .............................................................................................................................................. 28  
Demographic variables and injury risk: .............................................................................................. 28  
Functional factors and injury risk ......................................................................................................... 29  
Methodological considerations ............................................................................................................ 30  
Conclusion .............................................................................................................................................. 32  
References .............................................................................................................................................. 33  
Addendum ............................................................................................................................................... 42
LIST OF TABLES AND FIGURES

Figure 1: Flowchart participants
Figure 2: Lateral step down
Figure 3: Y-Balance Test Lower Quarter
Figure 4: Y-Balance Test Upper Quarter
Figure 5: Tuck Jump Test
Figure 6: Illinois Agility Test
Figure 7: Age distribution of the injured and non-injured group
Figure 8: BMI distribution of the injured and non-injured group
Figure 9: Total sport distribution of the injured and non-injured group
Table 1: Demographic data for non-injured and injured group
Table 2: Descriptives of the tests
Table 3: Single logistic regression
Table 4: Multiple logistic regression
LIST OF ABBREVIATIONS

ACL= Anterior Cruciate Ligament
App= Application
ASIS= Anterior Superior Iliac Spine
BMI= Body Mass Index
CI= Confidence Interval
D= Dominant
I= injured
IAT= Illinois Agility Test
LSD= Lateral Step Down
LQ= Lower Quarter
ND= Non-Dominant
NI= Non-Injured
RBFA = Royal Belgian Football Academy
ROM= Range Of Motion
THD= Triple Hop for Distance
TJ= Tuck Jump
UEFA= Union of European Football Associations
UQ= Upper Quarter
YBT= Y-Balance Test
ABSTRACT (English version)

Background: High injury incidences are seen in female soccer players. However little is known about the risk factors and the use of functional tests as a screening tool.

Objectives: To investigate intrinsic modifiable risk factors for lower extremity injuries in female soccer players.

Study design: Prospective cohort study; level of evidence 3.

Methods: Players of the RBFA (Royal Belgian Football Academy) (n=7 teams) were invited for a preseason screening before the 2016-2017 competitive season. This screening started with a baseline questionnaire for demographic information followed by some functional test like the YBT (Y-balance test), TJ (tuck jump), THD (triple hop for distance), LSD (lateral step down) and the IAT (Illinois agility test). After the screening, injury registration was performed on a weekly basis using a mobile app (application) up until March 2017. Data about injury circumstances were collected by contacting the injured players. Single and multiple logistic regression analyses were used to calculate the odds and 95% confidence intervals for injuries.

Results: A total of 101 players were included for analysis, of which 49 players sustained a non-contact injury. No significant difference was seen in age, BMI (body mass index) and total hours of sport between the injured and non-injured group. The single logistic regression showed that “asymmetric foot placement” as a subscore of TJ (P-value= 0.014; 95%CI= 1.222-5.929, Odds= 2,692) and “lumbopelvic control” as a subscore of LSD (P-value= 0.053; 95%CI= 0.990-5.377, Odds= 2,307) are associated with non-contact lower extremity injuries.

Conclusion: Asymmetric landings after a jump and a poor lumbopelvic control were associated with non-contact lower extremity injuries in female soccer players. The predictive value of these risk factors needs to be confirmed in larger samples.

Key words: female; soccer; injury; risk factor; functional screening; lower extremity
ABSTRACT (Dutch version)

Achtergrond: Bij vrouwenvoetbal is er een hoge letsel incidentie. Er is echter weinig gekend over de risicofactoren en het gebruik van functionele testen als screeningsinstrument.

Doelstellingen: Het onderzoeken van intrinsieke modificeerbare risicofactoren voor letsels aan het onderste lidmaat bij vrouwelijke voetbalspeelsters.

Onderzoeksdessign: Prospectieve cohort study; level of evidence 3.

Methode: Zeven teams van de KBVB (Koninklijke Belgische VoetbalBond) zijn uitgenodigd voor een screening voorafgaand het competitieseizoen van 2016-2017. Deze screening begon met een basisvragenlijst over demografische gegevens gevolgd door enkele functionele testen zoals de YBT (Y-balance test), TJ (tuck jump), THD (triple hop for distance), LSD (lateral step down) en de IAT (Illinois agility test). Het registreren van letsels werd uitgevoerd op wekelijkse basis via een mobiele app (applicatie) vanaf de screening tot en met maart 2017. Data over de omstandigheden waarin het letsel is opgetreden werden verzameld door de gekwetste speelster te contacteren. Enkelvoudige en meervoudige logistische regressie-analyses werden gebruikt om de odds en het 95% betrouwbaarheidsinterval te berekenen.

Resultaten: In totaal zijn er 101 speelsters geïncludeerd voor de uiteindelijke analyse. Hiervan liepen er 49 een non-contact letsel op. Er werd geen significant verschil gevonden voor leeftijd, BMI (Body Mass Index) en aantal uren sport tussen de gekwetste en niet gekwetste groep. Met de enkelvoudige logistische regressie kon gesteld worden dat het asymmetrisch landen tijdens de tuck jump (P-waarde= 0,014; 95%BI= 1,222-5,929, Odds= 2,692) en lumbopelvische controle als onderdeel van de LSD (P-value= 0,053; 95%CI= 0,990-5,377, Odds= 2,307) geassocieerd zijn met non-contact letsels in de onderste ledematen.

Conclusie: Asymmetrisch landen na een sprong en slechte lumbopelvische controle zijn geassocieerd met non-contact letsels in de onderste ledematen bij vrouwelijke voetbalspeelsters. De voorspellende waarde van deze risicofactoren moet bevestigd worden in grotere steekproeven.

Key words: vrouwen; voetbal; letsel; risicofactoren; functionele screening; onderste lidmaat
**Introduction**

Soccer is one of the most popular team sports worldwide and its popularity is still growing. Not only in male but especially in female soccer, new players are attracted every year. UEFA (Union of European Football Associations) reported that the number of registered female players has multiplied with factor five since 1985, to a total amount of 1.199.584 in 2015-2016 [1]. Since there is no doubt that sports participation is related to good health, this expansion can only be encouraged. Adolescent athletes present a better mental, emotional and physical wellbeing. Benefits to the cardiopulmonary, musculoskeletal and endocrine systems are some examples of the physical profits. It is also described that impact sports, such as soccer, show significant favorable effects in bone density and bone geometry in contrary to non-impact sports, such as cycling and swimming [2-7]. Despite these benefits of playing sports, we must take into account that soccer is associated with a great injury risk [8-12]. These injuries have a negative effect on team performance and may cause a decreased participation level, change of sport and high direct and indirect medical costs [13,14]. The individual athlete can even suffer long-term physical consequences, such as interrupted soccer career and dramatic increase in the risk of early developing knee osteoarthritis [15,16]. Besides physical stress, injuries can also lead to psychological, social or emotional problems [17,18]. Therefore, to perpetuate the growth of female soccer, the related injury risk should be addressed.

In order to control injury incidence, five major steps are required. First, the size of the injury problem in this population needs to be uncovered. Then, the aetiology and mechanism of injuries needs to be established. The following step includes the search for possible preventive measures for the findings of the second step. When these measures are established, the interventions can be implemented. Eventually the effectiveness of these interventions needs to be observed. Compared to other sports, soccer has quite a high injury incidence [12]. The reported injury incidence for female players during practice is approximately 1,17-3,8 injuries per 1000 playing hours and 12,63-23,2 injuries per 1000h during games [8-11]. These varying numbers in injury incidence can mainly be attributed to playing level, surface type, geography and injury definition. The high incidence is not surprising as it is a high intensity contact sport characterized by quick accelerations, decelerations, change of directions and high eccentric load. Those high loads on
the lower extremity makes a player susceptible for injury. The high incidence of injuries is a growing concern and should be addressed. A clear understanding of underlying risk factors for lower extremity injuries is crucial to tackle this incidence number.

Up until now there is a large hiatus in literature on risk factors for lower extremity injuries in female soccer players. Most research discussing risk factors for musculoskeletal injuries is mainly based on studies with male soccer players. These identified risk factors, however, cannot simply be transferred to their female counterparts for several reasons. First, there is a difference in incidence of injuries [8,19-24]. Male soccer players are at higher risk for injuries than female players (match: 21.7-29.8 vs 12.5-22.5/1000 player hours and training: 3.0-4.7 vs 2.6-3.8/1000 player hours) [8,20-22.24]. Larruskain et al. found that the injury total incidence, in training and match, was 30-40% higher in men, but the total number of absence days was 21% larger in women [24]. Second, a difference is seen in type of injury. Hip and groin injuries are more common in male players, whereas female players endure more knee injuries [8]. For example, female athletes are eight to nine times more likely to sustain an ACL (anterior cruciate ligament) injury [25]. Another reason prohibiting extrapolation is that risk factors for sustaining the same injury can differ between sexes. As an increased talar tilt is reported by Beynnon et al. as a risk factor for sustaining ankle sprains for men, an increased tibial varum and increased calcaneal eversion were the described risk factors for women [19]. Above all, specific female related factors, such as menstrual cycle and the use of oral contraceptives, may have an influence on injury mechanisms [26-30]. Therefore, more research with female soccer players is necessary.

Prevention and intervention have become focal points for clinical research. This can only be attained if the aetiology of the injuries is clearly understood. In many of these studies, two types of risk factors are described, the extrinsic (outside the body) and intrinsic (within the body) factors. The focus of further studies in the female soccer population should be on identifying intrinsic modifiable risk factors for lower extremity injuries. Especially, to investigate risk factors for the most frequently endured injuries in female soccer. Male soccer players are more predisposed to hamstring strains and hip/groin injuries, and women to quadriceps strains, severe knee and ankle ligament injuries. In both sexes, the overall most commonly injured region were the hamstrings [8,24]. These intrinsic factors are, from a therapeutic/preventive point of view,
potentially modifiable through physical training or behavioral approaches, such as strength, flexibility, functional performance, and psychological variables that have been associated with an increased risk for sustaining lower extremity injuries.

In November 2015, we performed a systematic review on risk factors for lower extremity injuries in female soccer players. We searched through Pubmed (http://www.ncbi.nlm.nih.gov/pubmed) and Web Of Science (http://apps.webofknowledge.com) for articles that report possible risk factors (I; intervention) for lower extremity injuries (O; outcome) in female adult soccer players (P; population). A comparison (C) was not defined in order to obtain all available studies concerning the possible risk factors.

The results of this review were classified in three categories. As external factors, protection gear, playing position, competition level and load have an impact on injury occurrence [23,26,27,31-34]. In addition, the impact of the playing surface (turf versus grass fields) showed no major differences in incidence, severity, nature or cause of injuries in female soccer players [19-22]. For intrinsic factors, two subdivisions were made. Previous injury, age, hormonal condition, anatomical varieties and laxity were found as non-modifiable intrinsic factors [26-31,33-37]. From a therapeutic point of view the most important findings are the modifiable intrinsic factors, which are: (A) mental influences; trait anxiety, negative-life-event stress and daily hassle were significant predictors of injury among professional soccer players [35], (B) endurance; aerobic capacity has no influence on injuries, but more severe injuries were seen in the later part of the game or practice, which could possibly be explained by a lack of concentration or by muscular fatigue [34], (C) weight/BMI (body mass index); recent studies found that a high BMI may augment the risk of sustaining a non-contact injury, however more previous studies found no effect of body dimensions on injury risk [31,34,38], (D) musculoskeletal; more ankle ligament injuries were seen when a higher tibial varum and calcaneal eversion ROM (range of motion) were measured [19]. There was no consensus found about the effect of isokinetic strength on soccer injury occurrence, but in 5/5 athletes with an ACL (anterior cruciate ligament) tear a low concentric hamstring/quadriceps ratio was measured [32,34]. Also, pre-activity of semitendinosus - vastus lateralis and gastrocnemius - tibialis anterior has an impact on ACL and ankle ligament injuries respectively [34,39].
Prevention programs typically aim at improving strength, muscle length, postural control, neuromuscular control, agility, stress response and performance. Nevertheless, at this moment specific evidence is lacking in female football players as a starting point for injury prevention protocols.

Current literature (November ‘16) described that knee valgus is a risk factor for knee injuries [40-42]. Furthermore, Brooks et al. determined that concussed athletes were at higher risk (2.48x) of sustaining an acute lower extremity musculoskeletal injury during the 90-day period after return to play than controls [43]. Considering the scarce information, lack of consensus and limited evidence, the necessity of further appropriate research is heightened.

It can be said that muscle strength imbalances are associated with higher injury risk [32,44]. Isokinetic strength testing is currently the most popular way to screen these imbalances, nevertheless this approach is impractical and not cost effective. Above this, you can debate whether these tests can be translated to the field. A more comparable way to reproduce the field performance is the use of functional tests. Functional performance tests consist of dynamic measures which evaluate general lower body function. These tests are helpful because they combine multiple components, such as muscular strength, neuromuscular coordination, mobility and stability. Besides, in comparison to the isokinetic tests, they are costs effective, can be performed on the field, few materials are needed, it can be supervised by anyone and it is more enjoyable for the athlete. Most preventive tools are based on functional movements [41,42]. Soccer is a multifactorial sport in which the maintaining of unilateral balance and control of the lower extremity is essential for proper performance. There is also emerging evidence that a deficiency in controlling dynamic balance and poor functional movements are linked to a higher injury risk [40-42,45,46].

The purpose of this prospective study is to identify intrinsic modifiable risk factors for lower extremity injuries in female soccer players. Because of the scarce information about functional performances as risk factors for soccer injuries, the primary focus of this part of the study is to investigate this specific topic for the most frequently endured injuries in female soccer players: hamstring injury, ankle inversion sprain, groin pain, and quadriceps strain [8,24]. The postulated
hypothesis is that female soccer players scoring low on one, or a combination, of the screened parameters (agility and functional analyses) are more susceptible to lower extremity injuries.

Method

Study and participants

The current study is part of a prospective cohort study aimed at investigating risk factors for lower extremity injuries in female soccer players. Seven national Belgian teams were invited to participate in this study during the season 2016-2017. Data were collected during a pre-season screening, injury follow-up and a retrospective survey (figure 1). The Ethical Committee of the Ghent University Hospital approved the study (see addendum) and all participants signed the informed consent and, in case of adolescents, their parents as well.

KBVB = Koninklijke Belgische Voetbalbond
= Royal Belgian Football Academy = RBFA

Figure 1. Flow chart of participants.
Experimental procedure

In the generic study different topics were investigated. The screening was based on the Spartanova screening tool for soccer players (www.spartanova.com). First, the athletes had to fill in several questionnaires about administrative information, baseline sports and previous injuries. Date of birth was obtained from administrative unit records, and age was calculated on the day of the start of training. They were also asked for the date of their first menstruation. Secondly some anthropometric parameters such as: body height, body weight, arm- and leg length were measured. **Leg length** was defined with the athlete in standing position, heels in contact with the wall and feet shoulder width apart. Tape measure was held between the ASIS (anterior superior iliac spine) and the most prominent part of the medial malleolus. **Arm length** was defined in standing position with both arms abducted in 90 degrees, elbows extended, hands open and thumbs pointing to the ceiling. Tape measure was held between the spinous process of the seventh cervical vertebra and the most distal point of the distal phalange of the third finger.

After these measures, the athletes were needed to warm-up by themselves. Then, several screening tests were performed: (A) flexibility; hip internal and external rotation, maximal dorsal flexion of the ankle, adductor, hamstring and quadriceps flexibility were measured (B) strength; maximal isometric strength of the hamstring, quadriceps, hip extensors, hip abductors and adductors and hip internal and external rotators were tested and a hamstring break test was performed (C) endurance; yo-yo intermittent recovery test (D) functional performance; LSD (Lateral Step Down), THD (Triple Hop for Distance), TJ (Tuck Jump), YBT (Y-Balance Test) and IAT (Illinois Agility Test). Only field tests were implemented to increase general applicability.

College seniors in the physiotherapy and their supervisors, from the department of rehabilitation sciences and physiotherapy at Ghent University, presented themselves as examiners. As preparation they underwent a practicum session supervised by a Spartanova expert and used the given manual.

In this specific part of the study five functional tests were implemented. A block randomization of two was used to define whether to start testing on the right or left side.
The lateral step down is commonly used in the clinical setting to assess quality of movement. The test has a moderate to good reliability [47]. Our athletes performed the test standing barefoot on a 30cm high box. If the athlete was shorter than 1.70m a small step of 5cm was installed next to the box, so the test was performed over a height of 25cm. The contralateral foot was placed on the edge of the box, with the foot pointing forward (Figure 2). The test consisted of a slow unipodal squat, while looking forward, until the heel touches the floor, no weight transfer was allowed. During the test an upright position of the trunk had to be maintained, arms were crossed over the shoulders, the iliac crests had to be kept horizontal and the hip of the free leg needed to be slightly flexed. Clear instructions were given. Two test trials were allowed and after verbal feedback the actual test began, consisting of five repetitions [48]. The 2D kinematics were recorded with a camera, which was installed in line with the testing leg, and allowed the testers to score the quality by observing the video. The scoring criteria were set on balance, hip, knee and ankle movement, and was based on the main jump of the five repetitions [score form 1].

To evaluate postural control, unilateral balance, range of motion and strength for the lower and upper extremities the Y-balance test was implemented. The YBT is one of the most dynamic balance tests used in sport science and is characterized by a good reliability [49-51]. The YBT kit consists of a stance platform with three pipes attached with reach indicators. The pipes target in the anterior, posteromedial and posterolateral direction for the lower quarter, or medial, inferolateral and superolateral direction for the upper quarter. The posterior/lateral pipes are positioned in 90° and in 135° from the anterior/medial pipe. Before testing the examiner demonstrated the test with standardized instructions. To set up a consistent testing protocol, a standard testing order was used. The procedure for the lower extremity was as follows: the athlete was asked to stand barefoot on one leg on the stance platform with the most distal aspect
of the foot behind the marked red line and the heel in line with the anterior pipe. While maintaining a single leg stance, the athlete was asked to reach with the free limb, in the anterior, posterolateral and posteromedial direction, pushing the reach indicator as far as possible [Figure 3]. First five trials for each leg were provided, then three attempts were registered. The testing order was three trials standing on the right foot reaching in the anterior direction, followed by three trials on the left foot. This procedure was repeated for the posteromedial and the posterolateral reach directions. The maximal reach distance of each attempt was measured and noted. An attempt was invalid if the athlete (A) failed to maintain unilateral stance (heel in contact with the floor), (B) failed to maintain contact with the reach indicator while it was in motion (for example kicking the target forward), (C) used the reach indicator for stance support (the reaching foot was only allowed to touch the side of the reach indicator) or (D) failed to return the reach foot to the starting position under control [50-56].

For testing the upper quarter, the athlete was asked to stand in a push-up position, with feet shoulder width apart, the testing hand on the stance platform and the thumb adducted while being aligned behind the red starting line and the reach-hand on top of the reach indicator in the medial direction. While maintaining this position, the athlete was asked to
reach with her free arm in the three directions, pushing the reach indicator as far as possible [Figure 4]. Here two test trials were permitted because performing the test with the upper extremities was harder compared to the performance with the lower extremities. Afterwards, three attempts were registered. First three attempts with the right hand in each direction were performed followed by three attempts with the left hand. An attempt was invalid if the athlete (A) failed to maintain unilateral stance (touched down to the floor with the reach hand or fell), (B) failed to maintain contact within the reach hand and indicator while it was in motion, (C) used the reach indicator for stance support, (D) failed to return the reach hand to the starting position under control, or (E) lifted either foot of the floor [49]. The maximum score of all three attempts was used for analysis.

All trials were scored to the closest 0,5 cm increment. The maximum score was divided by the subject's homolateral leg- and arm length to normalize each reach distance [50,51,56,57].

**The Tuck jump test** is a plyometric test, to analyze the jump and landing technique (58). For example, the TJ can be used in a clinician-friendly setting to identify high-risk landing mechanics and may provide direction for an intervention of several injuries (e.g. ACL) (59). It has a good to excellent intra-tester and inter-tester reliability and is a way to detect abnormal landing mechanics and high risk movements (60,61). The test took place on top of a ‘+’ shape tape on the floor and was performed with running shoes. It consisted of ten jumps straight up, with a quick rebound in between and pulling the knees as high as possible. During the test the athlete had to look forward and try to land on the same footprint. The test was performed in a frontal and sagittal point of view [58-60]. A test trial was allowed before the actual test. The quality of movement was scored using video-recording, with the same camera setting as mentioned above. A camera was used since it is described in literature to give the best intra and inter-tester reliability [60] [Score form 2].
The Triple Hop For Distance is described as a reliable measure of lower limb strength and power. [62,63]. This test was also performed with running shoes. The athlete was asked to stand in an unipodal position with the hands behind her back and her toes behind the line taped on the floor. The test consisted of three one-legged hops, on the same limb, covering as much distance as possible and with a stable landing at the end. When no stable landing was achieved a second test had to be done. The total distance was measured from the starting line to the heel in centimeters (no decimals). A standard procedure was used whereby one practice trial was allowed to decrease the influence of learning effect, but avoiding the effect of fatigue. Afterwards, three attempts were registered. The maximum score of all three attempts on each leg was used for analysis.

The Illinois Agility Test is a valid and reliable measure to assess the athlete’s agility and the ability to speed and change direction [64,65]. The test was set up using a standardized version from previous literature [64]. An area was set up with four corner cones (length 10m) and 2.5m distance from four centre cones (3.3m apart). The figure below shows the specific setting and the running direction. Two time gates were placed at the start- and endpoint. Before starting the test, the athlete was allowed to explore the course once, walking or jogging, after the examiner demonstrated the test while giving clear instructions. The athlete began the test in prone position on the floor behind the starting line with both arms on the back and her chin on the line. The tester gave the start sign and moved her hand past the first time gate to make sure the start of the test was registered. The athlete was encouraged to keep running as fast as she could to insure she reached maximum speed during the test. Time stopped when the athlete passed the second time gate and was recorded in seconds with two decimals. Disqualification was ascertained when (A) cones were knocked over, (B) the participant failed to finish the test or (C) did not run the course as instructed. Two trials were performed and the mean was used for analysis. This test was also performed a third time after a Yo-Yo test was completed. In this trial, fatigue was taken into account (Illinois fatigue test).
**Injury registration**

An accurate registration is very important in recording injuries, so a multilevel registration method was used. A weekly based app registration was used as a primary method. The participants were asked to complete some questions on a specifically designed app from Spartanova. Questions about difficulties in soccer participation, reduction in training volume, affected performance and symptoms/complaints due to injury, illness or health problems. The injury follow up started after the preseason screening and continued until the last injury survey on 12 March 2017. If an injury was registered, a student contacted the athlete by mail or phone to complete an UEFA injury card about the circumstances of the injury (see addendum). As a secondary registration method, the players were retrospectively questioned, face to face in their training complex in Tubize (Belgium), about their sustained injuries that season (February 2017).

Based on a consensus statement, injury was defined as any tissue damage and/or physical complaints caused by a non-contact event in a soccer match or training, irrespective of the need for medical attention or time loss in football participation [66].

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**Fig. 6 Illinois Agility Test**

[Diagram of Illinois Agility Test]
Statistics
SPSS was used for presenting descriptive data and statistical analysis. Only the first registered injury was recorded for statistical analyses, unless this injury met the exclusion criteria. In this situation the next suitable injury was used. Exclusion criteria were: (A) contact injury, (B) collision, (C) injury incurred from a non-soccer activity, (D) type: cuts, lacerations, skin abrasions, contusions and hematoma (E) body part: dental, head and upper limb.
First the Kolmogorov-Smirnov test was executed to investigate the normality. Frequencies and descriptives were executed with a significance level set at P<0.05. Demographic data was compared between the injured and non-injured groups using the Mann-Whitney U-test and unpaired Student’s t-Test (if the variable was normally divided). The preferred kicking leg was regarded as the dominant leg. Only the scores of the injured leg in the YBT were used for analysis.
For further analysis, a non-contact lower extremity injury was used as the main outcome variable in the logistic regression. No separate analyses per injured body part or type of injury were performed because of a small number of participants per subgroup. A single binary logistic regression was performed to identify potential intrinsic modifiable risk factors for injuries (see table 3). All variables with a p-value <0.2 in the ‘Wald Chi Square tests’ were seen as significant and were investigated further in a multiple model. A Spearman’s correlation matrix was made to search for correlations between the different tests. The data of the IAT and BMI were centered to the median and mean respectively. Different logistic regression models were made (ENTER-method) with different uncorrelated significant variables of the single logistic regression. For the final analyses, the significance level was set at P<0.2. The 95% confidence interval, ‘Nagelkerke R²’ and ‘Hosmer and Lemeshow Goodness-of-fit’ test were calculated to evaluate the quality of the model.

Results
Player and injury characteristics
A total of 101 players were included for analysis. Nine players were excluded after screening, because no injury registration or no confirmation not being injured was present (figure 1). A total of 49 players (48.5%) sustained an injury of which 25 injured their dominant leg and 24 their non-
dominant leg. The non-injured (NI) players and those with an excluded injury were used as a control group and were matched by randomization through number lottery (D (Dominant) n=26, ND (Non-Dominant) n=26). The injured (I) group contained more strikers (I: 24.5% vs NI: 17.3%) and less keepers (I: 4.1% vs NI: 19.2%). Most affected body parts were thigh, knee and hip/groin (resp. 13.9%, 9.9% and 8.9%). Next to that, injuries in the lower leg, ankle, foot and toe occurred. Overuse and muscle rupture / strain (both 13.9%) were the two most common injuries. Also dislocations, subluxations, sprains, lesions of meniscus and cartilage, tendon ruptures and tendinosis were present. 11.9% of the injuries were classified as ‘other injuries’. No significant difference was found between the groups in age, BMI or mean hours of sport, so we did not include these variables in further statistics. Demographic data of the participants are listed in table 1 and viewed in histograms (figure 7,8,9).

Fig. 7 Age distribution of the injured and non-injured group

Fig. 8 BMI distribution of the injured and non-injured group

Fig. 9 Total sport distribution of the injured and non-injured group
TABLE 1
Demographic data for non-injured and injured group.

<table>
<thead>
<tr>
<th>Demographic data</th>
<th>Non-injured n=52</th>
<th>Injured n=49</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr)</td>
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<td></td>
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</tr>
<tr>
<td>Pc 25</td>
<td>14</td>
<td>14.5</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>16</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Pc 75</td>
<td>18</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>13</td>
<td>12</td>
<td></td>
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<td>Maximum</td>
<td>30</td>
<td>33</td>
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<tr>
<td>Mean sport per week (h)&lt;sup&gt;²&lt;/sup&gt;</td>
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</tr>
<tr>
<td>Pc 25</td>
<td>8.75</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>12</td>
<td>14.50</td>
<td></td>
</tr>
<tr>
<td>Pc 75</td>
<td>20</td>
<td>18.5</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>5</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Maximum</td>
<td>44</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>BMI (kg.m&lt;sup&gt;²&lt;/sup&gt;)</td>
<td></td>
<td></td>
<td>0.181&lt;sup&gt;¹&lt;/sup&gt;</td>
</tr>
<tr>
<td>Mean</td>
<td>21.30</td>
<td>20.60</td>
<td></td>
</tr>
<tr>
<td>SD</td>
<td>2.21</td>
<td>2.54</td>
<td></td>
</tr>
</tbody>
</table>

Differences between groups were measured with the Mann-Whitney U-test or 'unpaired Student’s t-Test
Significant p<0.05
<sup>²</sup>Sport per week includes soccer, sport at school, strength training and others
<sup>¹</sup>Yr=year; h=hours; Pc=percentile; SD= standard deviation
Risk factors lower extremity
Descriptives of the tests are listed in table 2.

| TABLE 2 |
|-----------------|-----------------|-----------------|-----------------|
| Descriptives of the tests. |
| Missings | Median | Minimum | Maximum |
| Illinois mean (sec.) | 26 | 17.66 | 15.92 | 20.56 |
| Illinois fatigue (sec.) | 55 | 18.17 | 15.48 | 22.83 |
| Tuck jump | 27 | 11 | 4 | 18 |
| YBT UQ D MED | 0 | 1.04 | 0.66 | 1.30 |
| YBT UQ ND MED | 1 | 1.04 | 0.60 | 1.30 |
| YBT UQ D IL | 0 | 0.98 | 0.70 | 1.30 |
| YBT UQ ND IL | 1 | 0.98 | 0.67 | 1.35 |
| YBT UQ D SL | 0 | 0.76 | 0.52 | 1.07 |
| YBT UQ ND SL | 1 | 0.79 | 0.58 | 1.09 |
| YBT LQ AR | 0 | 0.72 | 0.58 | 1.01 |
| YBT LQ PM | 0 | 1.21 | 0.88 | 1.42 |
| YBT LQ PL | 0 | 1.21 | 0.86 | 1.43 |
| LSD | 24 | 6 | 3 | 10 |
| THD (cm) | 30 | 426 | 297 | 524 |

YBT= Y-balance test; UQ= Upper Quarter; D= Dominant; ND= Non-Dominant MED= Medial; IL= InferoLateral; SL= SuperoLateral; LQ= Lower Quarter; PM= PosteroMedial; PL= PosteroLateral; LSD= Lateral Step Down; THD= Triple Hop For Distance

According to the single logistic regression with the significance level set al p <0.2, following tests are found as possible associated, positively and negatively, with sustaining an injury: IAT, lumbopelvic control in the LSD, YBT UQ (Upper Quarter) dominant arm superolateral, TJ and some subscores “thighs not horizontal”, “thighs asymmetric”, “foot placement not shoulder width”
and “foot placement asymmetric”. Also age and BMI were found significant. Per year the player gets older, the odds for injury increase with 1,106 (p=0,05). For an increase in BMI the odds for being injured decreases with 11% (p=0,181) (see table 3).

<table>
<thead>
<tr>
<th>TABLE 3</th>
<th>Single logistic regression</th>
</tr>
</thead>
<tbody>
<tr>
<td>p-value</td>
<td>Exp (B)</td>
</tr>
<tr>
<td>IAT</td>
<td>0,019**</td>
</tr>
<tr>
<td>IAT fatigue</td>
<td>0,707</td>
</tr>
<tr>
<td>LSD</td>
<td>0,406</td>
</tr>
<tr>
<td>LSD – dynamic balance</td>
<td>0,710</td>
</tr>
<tr>
<td>LSD – knee valgus</td>
<td>0,703</td>
</tr>
<tr>
<td>LSD – lumbopelvic control</td>
<td>0,053*</td>
</tr>
<tr>
<td>LSD – ankle pronation</td>
<td>0,213</td>
</tr>
<tr>
<td>TJ</td>
<td>0,095*</td>
</tr>
<tr>
<td>TJ – knee valgus</td>
<td>0,288</td>
</tr>
<tr>
<td>TJ – thighs not horizontal</td>
<td>0,048**</td>
</tr>
<tr>
<td>TJ – thighs asymmetric</td>
<td>0,074*</td>
</tr>
<tr>
<td>TJ – foot not placed shoulder width</td>
<td>0,199*</td>
</tr>
<tr>
<td>TJ – foot placement asymmetric</td>
<td>0,014**</td>
</tr>
</tbody>
</table>
If the time to perform the IAT increases with one unit, the odds for being injured decreases with 59% (p=0.019). For the subscore ‘lumbopelvic control’ of the LSD, an increase by one is equal with an increase in odds for injury of 2,307 (p=0.053). If the score in the TJ performance was worse (higher scores), the odds for injury will decrease with 14% per unit (p=0.095). And the same for the subscores with a decrease of 35% for “thighs not horizontal” (p=0.048), 48% for “thigh asymmetric” (p=0.074) and 29% for “foot placement not shoulder width” (p=0.199). In opposite, the odds for being injured increases with 2.7 fold per unit worse performance in asymmetric foot placement (this is an increase in score) (p=0.014). Finally, an increase with one unit in the YBT UQ for the dominant arm in superolateral direction will give an increase in odds for an injury with 17,175 (p=0.08). Here the 95% CI is also very wide (0.710-415,612). The Nagelkerke R² shows that only 12% of the variance in the outcome variable could be explained by the considered logistic model per variable as a maximum, this is the case for the IAT and foot placement asymmetric in the TJ. The percentage for all other variables were even lower.

The final statistical analyzes consisted of a multiple logistic model were the non-correlated significant results of the single logistic regression are adjusted with each other. Significant models are listed in table 4. Adjusted for IAT, asymmetric thighs in the TJ and BMI, the odds for sustaining an injury increases with a 4-fold per increase in the unit of the asymmetric foot placement (p=0.007; R²=0.32) and with a 3.3-fold when adjusted for thighs not horizontal, thighs asymmetric and lumbopelvic control (p=0.018)(R²=0.27). In the same model, the adjusted odds value increases with 1,943 per increase in score of the lumbopelvic control (p=0.169). The odds for an increase in unit lumbopelvic control also increases with 1,927 adjusted for TJ (p=0.147; R²=0.10) and with 2,263 adjusted for YBT UQ dominant arm superolateral (p=0.06; R²=0.10).
<table>
<thead>
<tr>
<th>Table 4</th>
<th>Multiple logistic regression</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sign</td>
</tr>
<tr>
<td>1</td>
<td>Illinois</td>
</tr>
<tr>
<td></td>
<td>TJ - thighs asymmetric</td>
</tr>
<tr>
<td></td>
<td>TJ – foot placement asymmetric</td>
</tr>
<tr>
<td></td>
<td>BMI</td>
</tr>
<tr>
<td></td>
<td>Constant</td>
</tr>
<tr>
<td>2</td>
<td>TJ - thighs not horizontal</td>
</tr>
<tr>
<td></td>
<td>TJ - thighs asymmetric</td>
</tr>
<tr>
<td></td>
<td>TJ - foot placement asymmetric</td>
</tr>
<tr>
<td></td>
<td>LSD - lumbopelvic control</td>
</tr>
<tr>
<td></td>
<td>Constant</td>
</tr>
<tr>
<td>3</td>
<td>TJ</td>
</tr>
<tr>
<td></td>
<td>LSD - lumbopelvic control</td>
</tr>
<tr>
<td></td>
<td>Constant</td>
</tr>
<tr>
<td>4</td>
<td>TJ</td>
</tr>
<tr>
<td></td>
<td>BMI</td>
</tr>
<tr>
<td></td>
<td>Constant</td>
</tr>
<tr>
<td>5</td>
<td>YB UQ dominant arm superolateral</td>
</tr>
<tr>
<td></td>
<td>LSD - lumbopelvic control</td>
</tr>
<tr>
<td></td>
<td>Constant</td>
</tr>
<tr>
<td>6</td>
<td>YB UQ dominant arm superolateral</td>
</tr>
<tr>
<td></td>
<td>Age</td>
</tr>
<tr>
<td></td>
<td>Constant</td>
</tr>
<tr>
<td>7</td>
<td>LSD - lumbopelvic control</td>
</tr>
<tr>
<td></td>
<td>Age</td>
</tr>
<tr>
<td></td>
<td>Constant</td>
</tr>
</tbody>
</table>

Values based on significant non correlated values of the single logistic regression
*significant p<0.02; **strong significant p<0.5
TJ= Tuck jump; LSD= Lateral step down; YBT UQ= Y-balance upper quarter
Discussion
To our knowledge this is the first study using several functional tests in a pre-season screening followed by an injury registration through a mobile app, calling, e-mail and/or text or WhatsApp to assess potential risk factors for lower extremity injuries in elite female soccer players. The main finding was that a more asymmetric landing in jumps is found as a predictor for non-contact lower extremity injuries. Also worse lumbopelvic control and an increase in age were found as predictors for these injuries.

Demographic variables and injury risk:
As found in a similar study, the dominant and non-dominant leg were equally injured [38]. Contradictory, Faude O. et al described more injuries on the dominant leg, but no comparison could be made because most of them were contact injuries [31]. Looking at the player position, Nilstadin et al and Mohamed et al described more lower leg and knee injuries in forward players and less injuries in goalkeepers, similar to our findings [33,38]. This variable was not recorded in the analysis of functional risk factors in this study. Body dimensions have previously been investigated in various risk factors studies in soccer players and a lot of discrepancy is described. Some studies did not find any effect [28,31,32,34,67,68]. Present study shows, in contrast with two latest studies on elite female soccer players, that a higher BMI negatively associated with the occurrence of an injury [31,38]. This is also in contrast with the fact that an increased BMI is assumed to increase the stress on ligamentous and muscular structures during sports and thereby increasing the injury risk. The significance in the Wald Chi Square test was not strong (p=0.181) and the statement that BMI has no influence on injury occurrence could not be rejected. Furthermore, only 2.4% of the variance of BMI could be explained by this model, so it could be a case of coincidence. Age is often assumed as a risk factor for injuries. Supportive findings were found in this study and were described several times in literature [27,34,35,38]. The fact that higher hassle scores were seen in the older population in the study of Ivarsson et al., and a link was found with a higher injury risk need to be kept in mind [35]. Two other studies did not find any effect of age on sustaining injuries [31,32]. In present study, BMI, age or total sport were not included in the single regressions of the tests, because no significant difference was found between the injured and the control group (table 1).
**Functional factors and injury risk**

According to our results, an increase in the score of the TJ, so a worse performance, more specifically also for thighs not horizontal, thighs asymmetric and foot not placed shoulder width were associated with a decrease in odds for injuries. No possible explanation for these results could be found. Besides this, an asymmetry in foot placement in jumps was found as the strongest predictor for sustaining an injury, but a knee valgus did not have any significant influence. Myer et al. also found that poor landing techniques during the TJ are associated with ACL injuries and in contrast to our findings, they showed that knee valgus was the main risk factor, even so that the movement of the hip was associated with the degree of knee valgus and indirect with an injury [59]. But only ACL injuries were included in the study, other than including all non-contact lower extremity injuries like in present study. Tuck jump was used as a test because it is described as a better screening test than the drop jump test. Due to the plyometric aspect, more stress is executed on the structures, so this test is more sensitive [60]. In case of the IAT, running the course slower, so having poor speed, accelerations and agility performance, was found as a negatively associated with sustaining an injury. No possible explanation could be found. Currently no study describes the association between the IAT and injury prevention, so also no comparison could be made. More research about this specific topic is suggested, especially because it is commonly used in case of return to sport investigations [64]. Gonnel et al. found poor balance, tested by the YBT of the lower quarter, as a predictor for injury. No such findings were seen in our results [51]. Like the IAT, no associations between upper quarter YBT and injuries are earlier described in current literature. A poor lumbopelvic control in the LSD is, besides the asymmetric landings, also found as a predictor for injuries. Only associations between ROM in the joints of the lower extremity and the performance on the LSD were found in current literature, so no comparison could be made [47,48]. This parameter needs to be further investigated with greater samples to confirm the values of this variable as a predictor for injuries. No association was found between injuries and the score on the triple hop test, so no correlation was found between sustaining an injury and lower limb functional strength and power.

Several full significant models were found adjusting the variables. Teyhen et al found a correlation between the LSD and YBT, but again specific for the LQ and nothing about the UQ [53]. No other correlations, as found in present study, are earlier described. Multiple models are preferred for describing risk factors in injuries, because non-contact injuries mostly results from a
complex interaction of multiple factors and events. In these models the association between the different variables could be seen, though functional performance test already combine multiple components.

According to our findings, core stability could possibly be seen as a basic component. Two other studies discussed earlier the association between core strength and performance. Prieske et al. found that core training, both on stable and unstable surfaces, improves the sprint, trunk muscle strength and kicking performance, but no significant difference in the counter movement jump and the T-agility test [69]. Thomas et al. described only a moderate relationship between the core stability, and strength and functional performance as outcome variables[70]. Besides this, poor balance, altered motor control, or lack of neuromuscular control were also found as predictors of injury risk in the lower limbs of athletes [51].

**Methodological considerations**

As aforementioned, the popularity of women’s football is at an all-time high and little research has been done on the incidence and risk factors for injuries sustained by female football players. This study provides more insight in the possible risk factors of injuries in female elite football. That is a first step in the prevention of sport injuries which must be seen as an essential aspect to include in future management of women’s football. The prospective design with a longitudinally follow up is another strength of this study, because recall bias is minimized.

While interpreting the findings of this study, several limitations need to be kept in mind. First of all, the small sample size has to be taken into account. Several missings were described in some variables, so the sample size was even smaller for this model. This because less participants performed the test in the preseason due to musculoskeletal complaints, hot environment temperature or limited by the RBFA (a risk for injuries for the red flames preseason). However, according to Bahr and Holme (2003), moderate to strong associations could be made with this amount of injured participants [71]. Yet, in present study no high percentages were described in the explanation of the variance in the outcome variable with the considered model (Nagelkerke $R^2$). Confidence intervals were several times very wide and not frequently the hypotheses that the variable has no influence of being injured could be rejected, this could only be stated for the asymmetric foot placement after jumping. Also no good fit is described, because none of the models has significant values in the Hosmer and Lemeshow Goodness-of-fit test. However, this
test is very sensitive for sample size. This low quality of the models needs to be kept in mind while interpreting the findings. The predictive value of our risk model warrants validation and replication in larger samples to ascertain the findings. Besides this, a major limitation of this study is not excluding participants who were injured six months before the pre-season screening. This exclusion criteria was not implemented because of the major dropout and so analyzing an even smaller sample size. In elite male soccer players, high re-injury rates are well known [16,72,73]. This is also described for their female counterparts [27, 67,68, 74]. Other studies founded no effect [31,32,38]. Discrepancy could be explained by differences in population (age, playing level and the level of medical treatment and rehabilitation). For example, an increased risk for injuries was seen in youth soccer players [67,68] but no association was found by senior players [31,32]. Also differences in definition and length of time before injuries were screened could affect the interpretation. Besides this, we relied on interviews with the players for injury registration and classification. This subjective recording could lead to problematic interpretation of injuries, this was also a problem in recording the hours of sports per week. In other studies, injuries were more objectively recorded by medical staff and coaches. According to Nilstadt et al., text messaging appeared to be an effective method for recording injuries individually in team sports [77]. The compliance with the app was also not as expected, so other communication media were also used (calling, texting, WhatsApp, e-mail,..) and still injuries could have been missed. The retrospective interview was executed to minimize these missings, but recall bias needs to be considered. The participants were playing in different teams and at different levels, so a similar trainings program was not possible during the follow up. The possibility of training on weaknesses in some participants could not be covered. Another fact to keep in mind are the differences between the procedures of the tests. In two other studies, the tuck jump test was performed as; as many jump as possible in ten second, instead of performing ten jumps [58,60]. Other ways of testing and scoring were described for the LSD and they also used a 20cm step height instead of 30cm [47,48]. In the study of Hamilton et al., arm swing was allowed when performing the THD test which was not the case while performing the test for this study [63]. Without a doubt, other important predictable factors for injuries must be considered like anatomical, hormonal and psychological factors. Previous injuries and external factors (weather conditions, equipment, variable surfaces, load, years of experience eo.), which are also described as important risk factors, were not considered in present study [71]. As non-contact injuries likely result from an
interaction of multiple factors, present study cannot give a full description of risk factors for injuries in female soccer players [68,71,75].

**Conclusion**

According to our findings, an asymmetric landing and poor lumbopelvic control are associated with non-contact injuries in the lower extremity in female soccer players. More studies with larger sample sizes are suggested to confirm the importance of these factors. Hereby, future studies investigating risk factors for injuries, that also consider previous injuries and other important factors such as anatomic, external, psychological and hormonal factors would be great to improve preventive measures, so good interventions could be applied to tackle the high injury rate in female soccer.
References

1. fr.uefa.com/MultimediaFiles/Download/Women/General/02/03/27/84/2032784_DOWNLOAD.pdf


72. Arnason, A., Sigurdsson, S. B., Guðmundsson, A., Holme, I., Engenbretsen, L., & Bahr, R.


ABSTRACT (layman version)

Background: A lot of injuries occur in female soccer players. However little is known about possible risk factors and the use of functional tests as a screening tool.

Objectives: To investigate player-related risk factor, which can be trained, for lower extremity injuries in female soccer players.

Study design: A study in which a specific part of a population is monitored for a certain period of time and where the investigated outcome took place after the start of the study. Level of Evidence 3; An observational study with a control group.

Methods: Players of the RBFA (Royal Belgian Football Academy) (n=7 teams) were invited for a preseason screening before the 2016-2017 competitive season. This screening started with a baseline questionnaire about players-related data followed by some functional test like the YBT (Y-balance test), TJ (tuck jump), THD (triple hop for distance), LSD (lateral step down) and the IAT (Illinois agility test). After the screening, injury registration was performed on a weekly basis using a mobile app (application) up until March 2017. Data about injury circumstances were collected by contacting the injured players. Statistical analyses were executed to search for an association between injuries and one or more predictors. In a model was looked for significant influences of scores on the test on the occurrence of injuries. Besides this, the ratio of likelihood that the player was injured relative to the likelihood of being uninjured was calculated per change in the score of the analyzed test (odds), as well as a 95% confidence interval (CI) of the outcome in the model.

Results: A total of 101 players were included for analysis, of which 49 players sustained a non-contact injury. No significant difference was seen in age, BMI (body mass index) and total hours of sport between the injured and non-injured group. The single logistic regression showed that “asymmetric foot placement” as a subscore of TJ (P-value= 0,014; 95%CI= 1,222-5,929, Odds= 2,692) and “lumbopelvic control” as a subscore of LSD (P-value= 0,053; 95%CI= 0,990-5,377, Odds= 2,307) are associated with non-contact lower extremity injuries.

Conclusion: Asymmetric landings after a jump and a poor lumbopelvic control were associated with non-contact lower extremity injuries in female soccer players. The predictive value of these risk factors needs to be confirmed in larger samples.
ABSTRACT (lekentaal)
Achtergrond: In vrouwenvoetbal komen er veel letsels voor. Er is echter weinig gekend over mogelijke risicofactoren voor blessures in deze populatie en het gebruik van functionele testen als screeningsinstrument.

Doelstellingen: Het onderzoeken naar risicofactoren, die speelsters-gerelateerd zijn en waaraan gewerkt kan worden, voor letsels aan het onderste lidmaat bij vrouwelijke voetbalspeelsters.

Onderzoeksdesign: Een studie waarbij een deel van een populatie gedurende een bepaalde tijd opgevolgd wordt en waarbij de feiten die bestudeerd worden pas plaatsvinden nadat de studie begonnen is. Level van evidentie 3; een observerende studie met een controlegroep.

Methode: Zeven teams van de KBVB (Koninklijke Belgische VoetbalBond) werden uitgenodigd voor een screening voorafgaand het competitie seizoen van 2016-2017. Deze screening begon met een basisvragenlijst over speelsters-gerelateerde gegevens (oa. leeftijd, team, voet- en handdominantie, ..) gevolgd door enkele functionele testen zoals de YBT (Y-balance test), TJ (tuck jump), THD (triple hop for distance), LSD (lateral step down) en de IAT (Illinois agility test). Het registreren van letsels werd uitgevoerd op wekelijkse basis via een mobiele applicatie vanaf de screening tot in maart 2017. Data over de omstandigheden waarin het letsel is opgetreden werden verzameld door de gekwetste speelster te contacteren. Statistische analyses werden uitgevoerd om blessures te linken aan een of meerdere voorspellers. In een model werd er gekeken of de scores op de testen significant een invloed hebben op de mate van het voorkomen van een blessure. Hiernaast werd de verhouding van de waarschijnlijkheid dat de speelster gekwetst was t.o.v. dat ze niet gekwetst was berekend per verandering van de score op de geanalyseerde test (odds), alsook een 95% betrouwbaarheidsinterval (BI) van de uitkomst bij het model.

Resultaten: In totaal zijn er 101 speelsters geïncludeerd voor de uiteindelijke analyse. Hiervan liepen er 49 een non-contact letsel op. Er werd geen significant verschil gevonden voor leeftijd, BMI (Body Mass Index) en aantal uren sport tussen de gekwetste en niet gekwetste groep. Met de enkelvoudige logistische regressie kon gesteld worden dat asymmetrisch landen tijdens de tuck jump (significantie= 0,014; 95%Bl= 1,222-5,929, Odds= 2,692) en controle van de bekken tijdens de LSD geassocieerd (significantie= 0,053; 95%Cl= 0,990-5,377, Odds= 2,307) zijn met het oplopen van een letsel.
**Conclusie:** Asymmetrisch landen na een sprong en slechte controle van de bekken zijn geassocieerd met non-contact letsels in de onderste ledematen bij vrouwelijke voetbalspeelsters. De voorspellende waarde van deze risicofactoren moet bevestigd worden in grotere steekproeven.
**Addendum**

1) SCORE FORM 1  
Lateral Step Down

<table>
<thead>
<tr>
<th></th>
<th>0= excellent</th>
<th>1= good</th>
<th>2= moderate</th>
<th>3 = poor</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dynamic balance</strong></td>
<td>No oscillations</td>
<td>little oscillations</td>
<td>normal compensations</td>
<td>Bad on every criteria</td>
</tr>
<tr>
<td>Scoring based on:</td>
<td>Hands on shoulders; Looking forward; Smooth performance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Knee valgus / internal rotation</strong></td>
<td>2º metatarsal without oscillations</td>
<td>2º metatarsal with oscillations</td>
<td>1º metatarsal with or without oscillations</td>
<td>medial from 1º metatarsal or lateral shift hip</td>
</tr>
<tr>
<td>Scoring based on:</td>
<td>In deepest point of the movement: perpendicular from center patella → which metatarsal?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Lumbopelvic control</strong></td>
<td>0º</td>
<td>0º - 10º</td>
<td>10º - 20º</td>
<td>&gt;20º</td>
</tr>
<tr>
<td>Scoring based on:</td>
<td>Angle between horizontal line and line between two ASIS in the deepest point of the movement</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ankle pronation</strong></td>
<td>No dynamic hyper-pronation</td>
<td>dynamic hyper-pronation</td>
<td>/</td>
<td>/</td>
</tr>
</tbody>
</table>
2) **SCORE FORM 2**  
**Tuck Jump**

<table>
<thead>
<tr>
<th></th>
<th>0= no single jump</th>
<th>1= in one to five jumps</th>
<th>2= in five to nine jumps</th>
<th>3= in all ten jumps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knee valgus</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thighs not horizontal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thighs asymmetric</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foot not placed shoulder width</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foot placement asymmetric</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No plyometric (rebound)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toe-to-midfoot landing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Different footprints</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(not jumping on the same spot)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### UEFA injury card

#### Player Details
- **Name:** [Blank]
- **Team:** [Blank]
- **Code no.:** [Blank]
- **Date of Injury:** [Blank]
- **Date of return to full participation:** [Blank] (Send injury card even if player is still in rehabilitation)

#### Injured Body Part
<table>
<thead>
<tr>
<th>injury side</th>
<th>Right</th>
<th>Left</th>
<th>Bilateral/contral</th>
</tr>
</thead>
</table>

#### Injured Side
<table>
<thead>
<tr>
<th>Head/face</th>
<th>Shoulder/clavicle</th>
<th>Forearm</th>
<th>Hip/glutein</th>
<th>Lower leg/Achilles tendon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neck/ cervical spine</td>
<td>Upper arm</td>
<td>Wrist</td>
<td>Thigh</td>
<td>Ankle</td>
</tr>
<tr>
<td>Sternum/upper back</td>
<td>Elbow</td>
<td>Hand/finger/thumb</td>
<td>Knee</td>
<td>Foot/toe</td>
</tr>
<tr>
<td>Abdomen</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low back/pelvis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Type of Injury
- **Concussion**
- **Lesion of meniscus/cartilage**
- **Hematomas/contusion/bruise**
- **Faceture**
- **Muscle rupture/strain**
- **Abrasions**
- **Other bone injury**
- **Tendon rupture/tendinopathy**
- **Laceration**
- **Dislocation/sublux**
- **Synovitis/effusion**
- **Nerve injury**
- **Sprain/stingament**
- **Overuse unexpected**
- **Dental injury**
- **Other Injury (please specify):** [Blank]

#### Indicate type of training or match where injury occurred?
- **when did the injury occur?**
  - **Training**
  - **Match** (min. of injury)
  - **N/A** (overuse injury)

#### Injuries mechanism
- **Was the injury caused by overuse (gradual onset) or trauma (sudden onset)?**
  - **Overuse**
  - **Trauma**
  - **N/A**
- **Was the injury caused by contact or collision?**
  - **No**
  - **Yes, with other player**
  - **Yes, with object (usually)**

#### Other injury:
- **Running/sprinting**
- **Dribbling**
- **Sliding**
- **Heading**
- **Blocked**
- **Twisting/tumbling**
- **Jumping/landing**
- **Overuse**
- **Tackled by other player**
- **Use of arm/elbow**
- **Slipping/landing**
- **Fainting/diving**
- **Hit by ball**
- **Tackled other player**
- **Other acute mechanism**
- **Passing/crossing**
- **Stretching**
- **Collision**
- **Kicked by other player**
- **Unknown mechanism**

#### Injury mechanism (classify in words): [Blank]

#### Other information
- **Was this a re-injury?**
  - **No**
  - **Yes agree date of return from previous injury**

#### Referee's sanction (acute match injuries only)
- **No foul**
- **Opponent foul**
- **Own foul**
- **Yellow card**
- **Red card**

#### Examination
- **Clinical only**
- **X-ray**
- **Ultrasonography**
- **MRI (enclosed MRI form)**
- **Arthroscopy**
- **Other (specify)**

#### Diagnosis (specify results of examination)
[Blank]

#### Best guess as to why the injury occurred: (medical teams opinion)
[Blank]

#### Other comments:
[Blank]
4) **Form during the screening**

**Naam/Nom:**

---

**Red Flames en nationale jeugd - 04-07-2016**

**Football Health Monitoring**

(Date: 04.07.2016)

---

<table>
<thead>
<tr>
<th>Antropometrics</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lichaamslengte</td>
<td>cm</td>
<td></td>
</tr>
<tr>
<td>Lichaamsgewicht</td>
<td>kg</td>
<td></td>
</tr>
<tr>
<td>Beenlengte</td>
<td>cm</td>
<td>cm</td>
</tr>
<tr>
<td>Armlengte</td>
<td>cm</td>
<td>cm</td>
</tr>
<tr>
<td>Heupomtrek</td>
<td>cm</td>
<td></td>
</tr>
<tr>
<td>Buikomtrek</td>
<td>cm</td>
<td></td>
</tr>
<tr>
<td>Borstomtrek</td>
<td>cm</td>
<td></td>
</tr>
<tr>
<td>Menstruatie (datum)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

<table>
<thead>
<tr>
<th>Flexibility</th>
<th>Links</th>
<th>Rechts</th>
</tr>
</thead>
<tbody>
<tr>
<td>1ste meting: L / R</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heup ER ROM</td>
<td>°</td>
<td>°</td>
</tr>
<tr>
<td>Heup IR ROM</td>
<td>°</td>
<td>°</td>
</tr>
<tr>
<td>Adductor flexibility</td>
<td>°</td>
<td>°</td>
</tr>
<tr>
<td>Straight Leg Raise</td>
<td>°</td>
<td>°</td>
</tr>
<tr>
<td>Ely’s test</td>
<td>°</td>
<td>°</td>
</tr>
<tr>
<td>Weight-bearing Lunge: gebogen</td>
<td>°</td>
<td>°</td>
</tr>
<tr>
<td>Weight-bearing Lunge: gestrekt</td>
<td>°</td>
<td>°</td>
</tr>
</tbody>
</table>

---

<table>
<thead>
<tr>
<th>Strength</th>
<th>Links</th>
<th>Rechts</th>
</tr>
</thead>
<tbody>
<tr>
<td>1ste meting: L / R</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hamstrings make</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Quadriceps</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Hamstrings break</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Heupextensie</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Heupabductie</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Heupadductie</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Heupexorotatie</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Heupendorotatie</td>
<td>N</td>
<td>N</td>
</tr>
</tbody>
</table>

---

<table>
<thead>
<tr>
<th>Endurance and agility</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Illinois</td>
<td>sec</td>
<td>sec</td>
</tr>
<tr>
<td>Yoyo test IR Level 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Illinois fatigue</td>
<td>sec</td>
<td>sec</td>
</tr>
</tbody>
</table>

---
### Functional analyses

<table>
<thead>
<tr>
<th>1ste meting: L / R</th>
<th>Links</th>
<th>Rechts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral step down</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tuck Jump</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tripple hop For distance</td>
<td>cm</td>
<td>cm</td>
</tr>
</tbody>
</table>

### Postural control

<table>
<thead>
<tr>
<th>Y-balance Lower extremity</th>
<th>Rechts</th>
<th>Links</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior reach</td>
<td>cm</td>
<td>cm</td>
</tr>
<tr>
<td>Posteromedial</td>
<td>cm</td>
<td>cm</td>
</tr>
<tr>
<td>Posterolateral</td>
<td>cm</td>
<td>cm</td>
</tr>
<tr>
<td>Y-balance Lower extremity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mediaal</td>
<td>cm</td>
<td>cm</td>
</tr>
<tr>
<td>Inferolateraal</td>
<td>cm</td>
<td>cm</td>
</tr>
<tr>
<td>Superolateraal</td>
<td>cm</td>
<td>cm</td>
</tr>
</tbody>
</table>

### Bodystat

<table>
<thead>
<tr>
<th></th>
<th>H2O</th>
<th>Vetpercentage</th>
<th>Impedantie</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bodystat</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
DOCUMENT E (scripties – Z-lijn)

VERZOEK TOT ADVIES VAN HET ETHISCH COMITE BETREFFENDE EEN prospectief observationeel ONDERZOEKSPROJECT OP GEZONDHEIDSGEVEENS voor het maken van scripties en Z-lijn als deel van een reeds goedgekeurd akademisch onderzoek
(enkel verzameling van patiëntengegevens, vragenlijsten en interviews)

Dit document moet maar 1x ingediend worden indien de scriptie of Z-lijn kadert in een eerder goedgekeurde akademische studie van de promotors (staflid UZ Gent of U Gent).

De studenten moeten eerst contact opnemen met Prof.dr. R. Rubens voor verdere inlichtingen robert.rubens@UGent.be.

Wanneer de scriptie of Z-lijn niet verbonden is aan een globaal akademisch onderzoek, maar enkel opgezet is voor de scriptiestudent, dan moet de indiening gebeuren via de standaardprocedure (document D)

1. TITEL VAN HET ONDERZOEK:

RISICOFACTOREN VOOR LETSELS AAN DE ONDERSTE EXTREMITEITEN IN VROUWENOETBAL (RED FLAMES EN NATIONALE JEUGD), EEN PROSPECTIEVE STUDIE.

2. PROJECTNUMMER (EC), NAAM AANVRAGER VAN HET REEDS INGEDIENDE AKADEMISCH ONDERZOEK + DATUM GOEDKEURING:

- PROJECTNUMMER: EC UZG 2016/0093
- NAAM ONDERZOEKER: PHILIP ROOSEN
- DATUM GOEDKEURING: 10/02/2016

3. ONDERZOEK IN FUNCTIE VAN:

☐ MASTERSCRIPTIES OF Z-LIJN
  - NAAM STUDENT(EN): ELISE VANSANT EN EVI WAUTERS
  - OPLEIDING: REVALIDATIEWETENSCHAPPEN EN KINESITHERAPIE
  - NAAM FACULTEIT: GENEESKUNDE EN GEZONDHEIDSWETENSCHAPPEN
  - EMAIL STUDENT: EVI.WAUTERS@UGENT.BE
  - EMAIL: ELISE.VANSANT@UGENT.BE
  - TEL. STUDENT: 0478/10864

4. SOORT ONDERZOEK

X VERZAMELEN VAN PATIENTEGEGEVENS, DIE KLINISCH STANDAARD GEGEVEN ZIJN (GEEN ENKEL AANVULLENDE ONDERZOEK, BLOED- OF ANDERE STAALAFNAME)

X VRAGENLIJSTEN

VERSIE 19-09-2011
5. **TAAK VAN DE STUDENT BIJT DIT ONDERZOEK:**

Voor dit onderzoek worden voetbalspelsters van de Belgische nationale ploeg, U19 en jeugdteams, geselecteerd voor een screening. Deze screening wordt uitgevoerd door de studenten in het kader van risicofactoren voor letsel aan de onderste extremiteiten. Daarnaast zorgen de studenten ook voor de verdere opvolging van eventuele letsel.

6. **GEGEVENS VAN DE PROMOTOR + AFFILIATIE:**

- **NAAM:** Roel De Ridder
- **Functie:** Promoter
- **UZ Dienst:**
  - **Faculteit/Vakgroep:** Faculteit Geneeskunde en Gezondheids- en Revalidatiewetenschappen
  - **Kinesitherapie**
- **Telefoonnummer:** 09 332 04 53
- **Fax:**
- **E-mail:** roel.deridder@ugent.be
- **Naam UZ Diensthofd:**
  - Of naam vakgroepvoorzitter: Philip Roosen

7. **PERIODE VAN HET SCRIPTIE GEDURELT (BEGIN- EN EINDDATUM MAAND/JAAR):**

1/9/2015-1/6/2016

IK VERKLAR DE GEHELE VERANTWOORDelijkHED VAN HET HIERBOVEN VERMELD PROJECT OP MIJNE NEMEN EN BEVESTIG DAT VOOR ZOVER DE HUIDIGE KENNIS HET TOEELAAT, DE GEGEVEN INLICHTINGEN MET DE WERKELIJKHEID OVEREENSTEMMEN.

**DE HOOFDONDERZOEKER**

**DATUM:** 12/3/2016
**NAAM:** Philip Roosen
**HANDETEKENING:**

**PROMOTOR VAN DE SCRIPTIE**

**DATUM:** 15/03/2016
**NAAM + AFFILIATIE:** Roel De Ridder, Phd, Revalidatiewetenschappen en Kinesitherapie, Ugent
**HANDETEKENING:**

**NAAM STUDENTEN**

**DATUM:** 19/9
**NAAM:** Vansant Elise Waters Evi
**HANDETEKENING:**

**VERZOEK 19-09-2011**