

# **The relation between hamstring flexibility and hamstring injuries in male amateur soccer players**

## **Masterthesis**

**Physiotherapy Science**

**Program in Clinical Health Sciences**

**Utrecht University**

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**"ONDERGETEKENDE**

**Mitchell Cornelis Maria van Doormaal,**

**bevestigt hierbij dat de onderhavige verhandeling mag worden geraadpleegd en vrij mag worden gefotokopieerd. Bij het citeren moet steeds de titel en de auteur van de verhandeling worden vermeld."**

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**Masterthesis, Physical Therapy Sciences, Program in Clinical Health Sciences,  
Utrecht University, Utrecht, 2014**

## **SAMENVATTING**

### ***Doelstelling***

De hamstringblessure is een veel voorkomende blessure bij amateurvoetballers. De blessure kan een lange afwezigheid van sportactiviteiten of zelfs een vroegtijdig einde van de sportcarrière betekenen. De identificatie van risicofactoren is een essentiële stap in de preventie van hamstringblessures. Hamstringflexibiliteit zou een grote rol kunnen spelen bij sprinttype blessures, de meest voorkomende van de hamstringblessures in het voetbal. Het doel van deze studie is de relatie te onderzoeken tussen hamstringflexibiliteit en hamstringblessures bij mannelijke amateurvoetballers.

### ***Methode***

In deze prospectieve studie voerden 1<sup>e</sup> klas amateurvoetballers in Nederland de Sit-and-Reach Test (SART) uit om de hamstringflexibiliteit te meten. Hamstringblessures werden geregistreerd in het daaropvolgende jaar door de teamverzorgers. De analyse werd gedaan door middel van univariate en multivariate logistische regressie. Correcties werden toegepast voor leeftijd en eerdere hamstringblessures.

### ***Resultaten***

Aan deze studie deden 470 amateurvoetballers mee. De gemiddelde score op de SART was 21,0 centimeter. In het daaropvolgende jaar werden er 24 hamstringblessures geregistreerd, waarvan er 17 gerelateerd waren aan een sprint. Er werd geen relatie gevonden tussen hamstringflexibiliteit en hamstringblessures bij de univariate ( $p=0,435$ ) en multivariate analyse ( $p=0,673$ ).

### ***Conclusie***

In deze studie kon er geen relatie worden gevonden tussen hamstringflexibiliteit en hamstringblessures. Leeftijd en eerdere hamstringblessures hadden geen invloed op de relatie.

### ***Klinische relevantie***

Het is onwaarschijnlijk dat verminderde hamstringflexibiliteit, gemeten met de SART, een hamstringblessure kan voorspellen bij amateur voetballers. Andere mogelijke risicofactoren zouden onderzocht moeten worden om spelers met verhoogd risico op hamstringblessures te kunnen identificeren.

## **ABSTRACT**

### ***Aim***

The hamstring injury is a common injury in amateur soccer players, which can cause long sport absence or an early end of sports career. Identifying risk factors is an essential step to prevent hamstring injuries. Hamstring flexibility could play a major role in sprint type injuries, the most common of hamstring injuries in soccer. The aim of this study is to investigate the relation between hamstring flexibility and hamstring injuries in male amateur soccer players.

### ***Methods***

In this prospective study, all participating players of first class amateur soccer teams in the Netherlands performed a Sit-and-Reach Test (SART) to measure their hamstring flexibility. Hamstring injuries were recorded in the following year by the paramedical staff. The analysis was performed using univariate and multivariate logistic regression. Adjustment was made for age and previous hamstring injuries.

### ***Results***

In this study, 470 amateur soccer players participated. The mean score on the SART was 21.0 centimeters. In the following year, 24 hamstring injuries were registered. Of these injuries, 17 were related to a sprint. No relation was found between hamstring flexibility and hamstring injuries when analyzed univariate ( $p=0.435$ ) or multivariate ( $p=0.673$ ).

### ***Conclusion***

According to this study, there is no relation between hamstring flexibility and hamstring injuries. Age and previous hamstring injuries did not confound this relation.

### ***Clinical Relevance***

It is unlikely that limited hamstring flexibility, measured with the SART, can predict a hamstring injury in amateur soccer players. Other possible risk factors should be investigated to identify players at risk for hamstring injuries.

Keywords: Soccer, Hamstring flexibility, Hamstring injury

## **INTRODUCTION**

Soccer is the most popular and most played sport in the world. In 2006, 265 million registered and unregistered players were active in soccer, of which 90% were male. Of the registered players, 42% are over 18 years old. (1) In general, sports can reduce the risk for many diseases. (2) Therefore, it can be assumed that playing soccer is beneficial for health. However, this statement is challenged by the relatively high risk of injuries that characterize soccer.

In the Netherlands, 525.000 injuries a year occur on 1.2 million registered soccer players. (3) Especially hamstring injuries can cause long term sports absence or even an early ending of sports career. (4) A hamstring injury is defined as a muscle or tendon injury of the semitendinosus muscle, semimembranosus muscle or biceps femoris muscle which prevents a player from taking full part in soccer activities like training or matches. (4,5) The risk on recurrences is high, compared with other types of sports injuries. (6) Of all injuries in the Netherlands, 15.9% are hamstring injuries. (6) Therefore, reducing the amount of hamstring injuries could contribute significantly to the reduction of injury suffering in soccer.

To reduce a specific type of injury, the nature of an injury must be discovered by identifying risk factors. Various risk factors for hamstring injuries have already been identified, such as an older age and a history of previous hamstring injuries. (7,8) According to some authors, limited hamstring flexibility is also a potential risk factor for hamstring injuries in soccer players. (9)

Especially in sprint type injuries, which are most common in soccer compared to other types of hamstring injuries, the flexibility of the hamstring muscles plays a major role. (10) In the last stage of the swing phase of a sprint, the foot almost touches the ground and the hamstring muscles are stretched. Because the leg is swinging to the front, the hamstring muscles endure a lot of force in a stretched position. (11) Because of this, a player with limited hamstring flexibility is assumed to have more risk for an injury during a sprint than a player who has more flexible hamstring muscles.

However, evidence that limited hamstring flexibility is related to hamstring injuries in soccer is conflicting. Some authors did not find this relation, while others authors confirmed the hypothesis. (7,8,12,13) It is reported that the assumed relation between hamstring flexibility and hamstring injuries is actually explained by other risk factors, which are therefore potential confounders. Two known risk factors, older age and a history of previous hamstring injuries, are possibly related to hamstring flexibility. (14,15) This could affect the findings of the relation between hamstring flexibility and hamstring injuries.

Because it is still unknown if there is a causal relationship between limited hamstring flexibility and hamstring injuries, good quality studies with adjustment for confounding are required to confirm or reject the hypothesis that limited hamstring flexibility increases the risk on hamstring injuries. Therefore, the aim

**of this study is to investigate the relation between hamstring flexibility and hamstring injuries in male amateur soccer players when adjusted for age and previous hamstring injuries.**

## **METHODS**

### ***Design***

This prospective study was part of the Hamstring Injury Prevention Strategies (HIPS) study, an intervention study on the occurrence and prevention of hamstring injuries in amateur soccer players in the Netherlands. The HIPS study was carried out in collaboration with the Royal Netherlands Football Association (KNVB). The Medical Ethics Committee of the University Medical Centre Utrecht approved the study (file number 12-575/C). Details of the HIPS study have been described previously. (16) The present study focused on one of the secondary aims of the HIPS study: to investigate the relation between hamstring flexibility and hamstring injuries.

### ***Participants***

In a study with a similar sample, the hamstring injury rate was 10.0%. (6) Therefore, the minimal required participants to investigate the relation between hamstring flexibility and hamstring injuries was 300, assuming one risk factor, two possible confounding variables and 10,0% risk on a hamstring injury. (17)

In October and November 2012, all male first class amateur soccer teams in the Netherlands of district West 1, West 2, South 1 and East were approached to participate. Players of the participating teams who met the criteria were included in this study. The inclusion criterion was: playing in a first class male amateur soccer team in district West 1, West 2, South 1 or East in the Netherlands at the time of intake in January 2013. Exclusion criteria were: 1) absence during measurement of the hamstring flexibility in January 2013, or 2) inability to perform the hamstring flexibility test correctly for any reason, or 3) a current hamstring injury. All participants received an information letter in which the aim of the study, the hamstring flexibility test and the collection of data were described. After receiving the letter, all participants were asked to give their informed consent.

### ***Measurements***

#### **Characteristics**

Player characteristics were recorded in a questionnaire at the baseline of the HIPS study. These characteristics were age, years of soccer experience, field position and hamstring injuries in the year prior to the study.

#### **Hamstring flexibility**

To measure hamstring flexibility, all participants performed the Sit-And Reach Test (SART) by making use of a Sit-and-Reach box. This test was performed once, according to the protocol of the American Academy of Orthopedic Surgeons. (18) Participants were not allowed to warm up prior to testing. The score of the test is



the amount of centimeters the participant is able to reach on the box. The SART is a reliable and valid test to measure hamstring flexibility. (19)

### **Hamstring injuries**

A hamstring injury was defined as any physical complaint affecting the posterior side of the upper leg irrespective of the need for medical attention or time loss from soccer activities. (20) Each hamstring injury was registered in an injury form by the paramedical staff of the soccer team. These forms included the date, description of the injury moment, location of the injury, and duration of the injury.

### ***Procedure***

Prior to the start of the study, the researchers instructed the paramedical staff of all participating teams how to perform the SART and how to diagnose a hamstring injury. In January 2013, the paramedical staff measured the hamstring flexibility of all participating players. During 2013, the paramedical staff registered all hamstring injuries of the participating players of their team. When a player transferred to another team during the year, the researchers periodically contacted the individual players about possible hamstring injuries.

### ***Statistical analysis***

Analysis was performed with SPSS version 20. For the player characteristics age and years of soccer experience, the mean, standard deviation (SD) and range were calculated. A percentage was calculated for the characteristics previous hamstring injury and field position.

First, to investigate the relation between hamstring flexibility as independent variable and the occurrence of hamstring injuries as dependent variable, univariate logistic regression analysis was used. Possible confounding variables age and previous hamstring injuries were also analyzed in an univariate logistic regression. To investigate the relation between hamstring flexibility and the occurrence of hamstring injuries, with adjustment for the possible confounding effects of age and previous hamstring injuries, a multivariate logistic regression analysis was used. As possible confounders do not have to be significant predictors, the "enter method" was used in the multivariate logistic regression. Flexibility was considered a significant predictor when  $p < 0.05$  in the multivariate logistic regression analysis.

## **RESULTS**

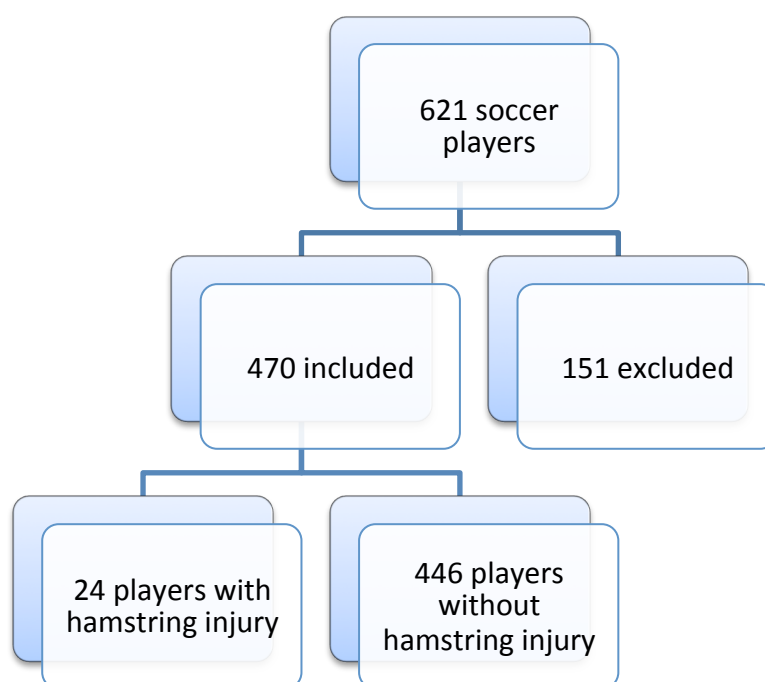
**In total, 621 amateur soccer players were willing to participate in the HIPS study. (Figure 1) Based on the criteria, 151 players were excluded, mainly because of absence of SART scores. This resulted in 470 participants. Characteristics are summarized in table 1. The mean age of the included participants was 24.6 years, and a mean of 18.2 years of soccer experience. Of these participants 101 (21.5%) reported a hamstring injury in the year prior to the study.**

**The mean scores of the SART were described in table 2. The overall mean score was 21.0 centimeters. The category "age >28.5 years" had the highest score on the SART, while the category "age 20.5 – 28.5" had the lowest score on the SART of the three age categories. Players with a hamstring injury in the year prior to the study and players without a previous hamstring injury had the same mean score on the SART.**

**In the study period, 24 hamstring injuries were registered, which resulted in an injury rate of 5.1%. In 17 cases, the injury was related to a sprint of the participant. The mean absence from soccer because of the injury was 34 days, with a standard deviation of 26.2.**

**In the univariate analysis, hamstring flexibility was not significantly related to hamstring injuries ( $p=0,507$ ) (table 3). The multivariate analysis gave the same result ( $p=0.577$ ) (table 3). The possible confounding variables did not influence this into the direction of a more significant relation.**

**Figure 1: Flow Chart**



**Table 1: Player characteristics**

<b>Characteristics (n=470)</b>	<b>Mean (SD) / n</b>
<b>Age (years)</b>	<b>24.6 (3.9)</b>
<b>Years of experience</b>	<b>18.2 (4.3)</b>
<b>Previous hamstring injury*</b>	<b>101 (21.5%)</b>
<b>Field position**</b>	<b>n</b>
<b>Goal</b>	<b>50 (10.7%)</b>
<b>Defense</b>	<b>169 (36.0%)</b>
<b>Midfield</b>	<b>168 (35.8%)</b>
<b>Offence</b>	<b>124 (26.4%)</b>

\* In the year prior to the study

\*\* A player can hold up more than one field position

**Table 2: Sit-and-Reach-Test scores**

Subgroup	n	Mean (SD)
Total	470	21.0 (9.2)
Age <20.5*	62	21.8 (7.4)
Age 20.5 – 28.5	335	20.5 (9.2)
Age >28.5**	72	23.0 (9.9)
Players without previous hamstring injuries	368	21.2 (8.8)
Players with a previous hamstring injury	101	21.2 (10.3)

\*Mean age minus standard deviation

\*\*Mean age plus standard deviation

**Table 3: Regression analysis; factors related to hamstring injuries**

	Univariate analysis			Multivariate analysis		
	B	OR	p	B	OR	p
SART	-0.016	0.985	0,435	-0.009	0.988	0.673
Age	0,026	1.054	0,543	0.072	1.063	0.141
Previous hamstring injury	0.550	1.779	0,020*	0.592	1.798	0.021*

\* Significant at 0.05 level

## **DISCUSSION**

The aim of this study was to investigate the relation between hamstring flexibility and hamstring injuries in male amateur soccer players. In this study, no relation was found between these variables. Therefore, hamstring flexibility could not be considered as a predictor for hamstring injuries. Adjustment for confounding by age and previous hamstring injuries did not influence the results.

This study is the first that focused only on the relation between hamstring flexibility and hamstring injuries, without investigating other risk factors. Furthermore, the study is conducted in a specific group, male amateur soccer players, who are most at risk for hamstring injuries. (21) An advantage of this study was the more than appropriate sample size. This limited the risk on a type II error. The correction for the possible confounders age and previous hamstring injuries was also an advantage of this study. Despite possibly not being statistically significant risk factors for hamstring injuries, age and previous hamstring injuries could have confounded the relation.

The study had also several methodological considerations. First of all, hamstring injuries were diagnosed by the paramedical staff of the amateur soccer teams. As non-professional paramedics, their diagnoses of hamstring injuries can be questioned. However, they are well instructed by the researchers how to diagnose hamstring injuries by simple criteria, prior to the study. By making use of this procedure, a large sample was made possible. Another disadvantage was the fact that all types of hamstring injuries were recorded, although it was the hypothesis that hamstring flexibility was related to sprint type hamstring injuries. It was not possible to identify the specific sprint type injuries by the staff of the amateur soccer teams. However, more than 70 percent of the injuries was at least related to a sprint, as was described in the injury form. This indicates that sprint type injuries were most common of the recorded hamstring injuries.

The use of the SART to measure hamstring flexibility has some negative and positives aspects. Although the reliability of the SART is high, the validity to measure hamstring flexibility is questioned by to some authors. (22,23) The validity is possibly reduced by spinal postures during the test. (24) The most valid test for measuring hamstring flexibility is the Straight Leg Raise (SLR), which is considered as a golden standard. (22,24) However, evidence that the SLR is a golden standard to measure hamstring flexibility is lacking. Also the practical applicability of the SLR can be questioned because the test must be performed by a professional. (18) Therefore, a field test is more applicable for the paramedical staff of an amateur soccer team, which generally consists of non-professionals. Because the SART is the most valid field test, this is the most suitable test to measure hamstring flexibility in amateur soccer players. (19) Despite the fact that measuring hamstring flexibility with a clinical test could give slightly different results than measuring with the SART, the relation between hamstring flexibility and hamstring injuries in amateur soccer players only has value when it

can be measured in usual amateur soccer training.

The mean score of the hamstring flexibility in this study, measured with the SART, was 21.0 centimeters. This is comparable with other studies, in which mean scores of 22.8 and 23.5 centimeters were reported in recreational active male subjects. (22,23) The hamstring injury rate of this study was 5.1%. This is less than the hamstring injury rate of 21.5% of the previous year, which was retrospectively reported by the players themselves. A similar study in male amateur soccer players in the Netherlands, reported a hamstring injury rate of 10,0%. (6) An explanation of this difference could be the preventive exercise program that was investigated in the HIPS study. (16) This could have reduced the amount of injuries during the year. Underreporting of the paramedical staff is another possible explanation of the difference.

The negative result of this study to the relation between hamstring flexibility and hamstring injuries corresponds with two previous studies on risk factors of hamstring injuries in soccer. (25,26) In one study, it is claimed that limited hamstring flexibility increases the risk on a hamstring injury. (9) However, with a very small difference in hamstring flexibility between injured and uninjured players in this study, the clinical relevance can be disputed. According to Van Beijsterveld, the difference in findings between the studies can possibly be explained by the way of measuring hamstring flexibility. (7) The studies in which no relation was found between hamstring flexibility and hamstring injuries, the Passive Knee Extension Test (PKET) was used to measure hamstring flexibility. In the study that identified hamstring flexibility as a risk factor, the SLR was used as measurement. No appropriate study to the relation between hamstring flexibility and hamstring injuries was performed, by making use of a field test.

The hypothesis of the relation between hamstring flexibility and hamstring injuries lies within the kinematic process of the sprint, in which the hamstrings endure a lot of force in a stretched position. The hamstring muscles lengthened 50-90% of the gait circle during a sprint. (11,27) However, there is no evidence that the hamstrings are maximally stretched during the last swing phase. The peak musculotendon stretch of the hamstring muscles does not vary in speeds ranging from 80% to 100% of a maximal sprint. However, musculotendon force increases significantly. (28) Therefore, it is possible that not reduced hamstring flexibility is responsible for a hamstring injury, but reduced eccentric hamstring strength of a soccer player during a sprint. (27,29)

In summary, hamstring flexibility, measured with the SART, is not related to hamstring injuries according to this study. Other factors, like eccentric strength of the hamstring muscles, need to be investigated to explain the mechanism of a sprint type hamstring injury. Other measurements should be developed to identify amateur soccer players at risk for a hamstring injury.

## **CONCLUSION**

**According to this study, there is no relation between hamstring flexibility and hamstring injuries in male amateur soccer players. The possible confounders age and previous hamstring injuries does not confound this relation. Therefore, it is not possible to identify players at risk for hamstring injuries by measuring their hamstring flexibility. To clearly identify soccer players at risk at the beginning of the season, other risk factors than hamstring flexibility should be investigated.**

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