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CHAPTER 4

Shinguards effective in preventing lower leg injuries in football: population-based trend analyses over 25 years

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Abstract

Objectives

The majority of football injuries are caused by trauma to the lower extremities. Shinguards are considered an important measure in preventing lower leg impact abrasions, contusions and fractures. Given these benefits, Fédération Internationale de Football Association introduced the shinguard law in 1990, which made wearing shinguards during matches mandatory. This study evaluated the effect of the introduction of the shinguard law for amateur players in the Netherlands in the 1999/2000-football season on the incidence of lower leg injuries.

Design

Time trend analyses on injury data covering 25 years of continuous registration (1986–2010).

Methods

Data were retrieved from a system that records all emergency department treatments in a random, representative sample of Dutch hospitals. All injuries sustained in football by patients aged 6–65 years were included, except for injuries of the Achilles tendon and Weber fractures. Time trends were analysed with multiple regression analyses; a model was fitted consisting of multiple straight lines, each representing a 5-year period.

Results

Patients were predominantly males (92%) and treated for fractures (48%) or abrasions/contusions (52%) to the lower leg. The incidence of lower leg football injuries decreased significantly following the introduction of the shinguard law (1996–2000: -20%; 2001–2005: -25%), whereas the incidence of all other football injuries did not. This effect was more prominent at weekends/match days. No gender differences were found.

Conclusions

The results significantly show a preventive effect of the shinguard law underlining the relevance of rule changes as a preventive measure and wearing shinguards during both matches and training sessions.

Introduction

Association football, commonly known as football or soccer, is played by an estimated 265 million people, making it the world's most popular team sport ^[250]. In the Netherlands, over 1.7 million people (11% of the population) play football; of these players, over 1.1 million are members of football clubs ^[250]. Participation in sports and exercise activities is generally acknowledged to have long-term health benefits, but also entails the risk of sustaining sports injuries ^[251]. Football has a high injury rate, predominately to the lower extremities ^[252, 253]. The most common lower leg injuries are sprains, strains and contusions ^[252-254]. One of the less frequent, but more severe football injuries is a fracture of the tibia or fibula ^[254]. Recent epidemiological studies in the Netherlands underline these findings ^[213, 255, 256]. The majority of football injuries are caused by trauma, often due to contact with another player ^[252, 253, 256]; the lower extremities are often injured during tackling from the side or the front ^[253, 257].

Fédération Internationale de Football Association (FIFA), the sport's international governing body, has developed various preventive strategies to control the injury risk through measures directed at the game's physical aspects (the facility, equipment and environment), management aspects (e.g. laws of the game) or human aspects (e.g. player behaviour) ^[251]. One of the strategies was the introduction of the shinguard law in 1990, which made the wearing of shinguards compulsory during matches ^[258, 259]. The Royal Netherlands Football Association (KNVB) introduced this rule at the start of the 1992/1993-football season for all professional players and 1999/2000-season for all amateur players ^[260]. Few studies indicate that shinguards are effective in reducing the number of minor impact-related injuries such as contusions, abrasions and lacerations ^[254, 261, 262]; more recent findings indicate that shinguards provide some measure of protection against tibia fractures, although the level of protection varies significantly according to differences in shinguard design and material type among the commercially available shinguards ^[254]. Rule and regulation changes can reduce injuries in sport; however, there is a lack of research into the effects of these changes ^[209].

The aim of the present study was to assess the effectiveness of the introduction of the shinguard law in football on the incidence of lower leg football injuries at a population level. The main focus was on trends in the incidence of lower leg injuries among football players, concentrating on a change in this trend during the implementation period of the shinguard law in the Netherlands for all amateur players (1999/2000). Other factors that might have influenced this trend were taken into account. To our knowledge, the method of trend analyses has not been used previously to evaluate the preventive effect of shinguards.

Methods

Data were obtained from an existing database, the Dutch Injury Surveillance System (LIS). No additional data were gathered. LIS is a continuous monitoring system, which records all unintentional and intentional injury treated at emergency departments (EDs) in a random sample of Dutch hospitals, and is operated by The Dutch Consumer Safety Institute VeiligheidNL. The participating hospitals are geographically spread across the country, and are regarded repre-

sentative of general and teaching hospitals in the Netherlands with EDs^[255, 263]. Data are available from 1986 onwards and include details of the injury (type of injury, anatomical region), medical treatment, cause of injury, injury mechanism, and patients' age and gender. Within LIS, a physician or other health caregiver diagnoses all injuries, including sport injuries. A nationwide registration of hospital discharges was used to extrapolate ED treatments in the LIS sample to national estimates of ED treatments.

Hospitals collect the accident and injury information that is registered within LIS. All hospitals participating in LIS have given permission for the data registration, exchange and analyses by the Dutch Consumer Safety Institute. All data registered are anonymous; individuals cannot be identified based on these data, and the data are not incriminating for the patients attending the ED of the hospitals included. Therefore, and since the data were obtained from an existing database, no Ethics Committee approval was obtained, and no patient consent was required.

In this study, all injuries sustained in football in the Netherlands during organised activities (matches, training sessions, tournaments) and non-organised activities (leisure football) were included. The study population consisted of men and women aged 6–65 years. Lower leg injuries were defined as abrasions, contusions and fractures of the lower leg, excluding injuries to the ankle and knee. These injuries are expected to be preventable by shinguards, whereas sprains and strains are not. Injuries of the Achilles tendon and so-called Weber fractures (lateral malleolar fractures) were excluded, as these injury types were expected not to be preventable by shinguards. Weber fractures frequently coincide with ankle injuries. The type of injury was classified in accordance with the consensus statement on injury definitions and data collection procedures in studies of football injuries^[264].

Statistical analyses were performed as follows. Data covering 25 years of continuous registration (1986–2010) were used in this study to analyse time trends in the incidence of (1) lower leg football injuries treated at EDs, and (2) all other football injuries treated at EDs. Both trends were compared in order to monitor changes in injury incidence over time, focusing on changes in this trend during the implementation period of the shinguard law for all amateur players (1999/2000), since the number of professional players is relatively very small^[250]. Data were analysed with multiple regression analyses on monthly injury figures. A model was fitted that consists of a string of multiple straight lines, each representing a five-year period. The time trends were controlled for seasonal and weather influences. Trends were indexed (1986 was set at 100) for an informative comparison of the time trends. Unfortunately, no sports exposure data were available in LIS. We therefore assumed that the exposure time for lower leg football injuries and for all other football injuries were equal, and that only the incidence of lower leg football injuries would be affected by the shinguard law.

Separate trend analyses were performed on the incidence of lower leg football injuries treated at an ED (1) excluding female football players to establish whether the notable increased participation of female football players accounts for any changes in the time trends, and (2) for injuries sustained either on weekdays or at weekends (over the period 1997–2010; index 1999 = 100) to establish whether the effect of the shinguard law differed for matches (almost all matches are played at weekends) versus training sessions (mostly held on weekdays). Data on the day of the week on which an injury is sustained have been available in LIS since 1997.

The mean annual number of (lower leg) football injuries treated at EDs in the Netherlands was determined based on the LIS data (1986–2012) to illustrate the extent of this injury problem.

The statistical significance change of a trend was set at $p < 0.05$. Data for all respondents were analysed using SPSS PASW statistical software package, version 18.0.

Results

Over the period 1986–2010, a total of 152,043 ED treatments for football injuries were registered in LIS, of which 7,640 involved treatments for abrasions, contusions and/or fractures of the lower leg. Patients ranged from 6 to 65 years in age (mean age 22.4 years; SD 9.63) with the majority being male (92% men, 8% women).

Time trend analyses (1986–2010) for lower leg football injuries and for all other football injuries treated at an ED are shown in Figure 4.1. In 1996–2000, the incidence of football injuries showed a significant decrease for lower leg injuries (-20%; $p = 0.004$) and for all other football injuries (-23%; $p < 0.000$).

From 2001 onwards, the incidence of lower leg injuries continued to decrease significantly. They decreased by 25 per cent ($p = 0.004$) in 2001–2005 and stabilised in 2006–2010, while the incidence of all other football injuries stabilised in 2001–2005, and increased in 2006–2010 (18%; $p = 0.006$). The annual incidence rates for lower leg injuries are also shown in Figure 4.1; they too showed a steep decrease in 1999–2002.

The injury trend shown in Figure 4.1 is based on both male and female football players. Injury trends were no different after injuries sustained by female football players (8% of total football injuries) were excluded from the analysis. The trend in the incidence of lower leg injuries for male football players (-20% in 1996–2000; $p = 0.003$) was similar to the trend in the incidence of lower leg injuries for both male and female football players (-20% in 1996–2000; $p = 0.004$).

Time trends were analysed for injuries sustained on weekdays versus those sustained at weekends, as almost all matches are played at weekends. In 1997–2001, both trends showed a significant decrease for lower leg injury incidence: injuries sustained at weekends decreased by 25% ($p = 0.004$), and injuries sustained on weekdays decreased by 24% ($p = 0.022$). Figure 4.2 shows the annual incidence of football injuries sustained at weekends versus on weekdays. Both at weekends and on weekdays, a decrease in the annual number of lower leg football injuries is visible since 1999. However, a slightly steeper decrease is visible for injuries sustained at weekends since 1999. Injuries sustained on weekdays follow the same pattern but with a delay of two years.

Over the period 1986–2012, a mean annual number of 2,600 lower leg fractures (48%) and abrasions/contusions (52%) sustained in football were treated at Dutch EDs for patients aged 6–65 years accounting for five per cent of all football injuries in the Netherlands for players in this age category.

Figure 4.1 Time trend in the incidence of football injuries treated at an Emergency Department (1986–2010; male and female players); index 1986 = 100

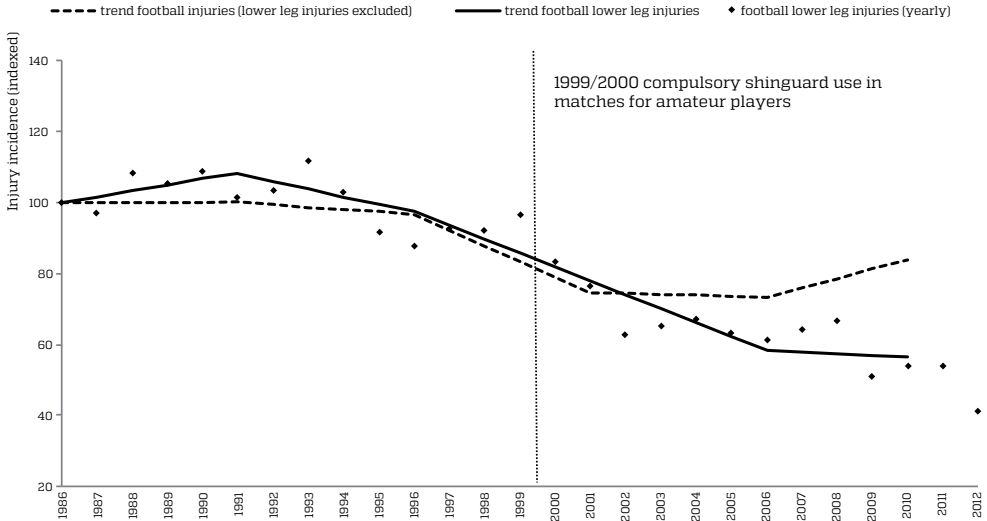
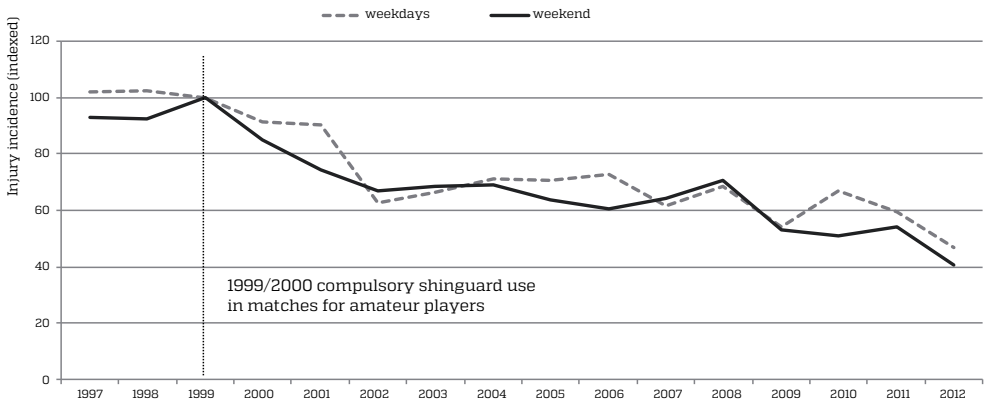


Figure 4.2 Annual incidence of lower leg football injuries on weekdays versus at weekends treated at an Emergency Department (1997–2012; male and female players); index 1999 = 100



Discussion

Few studies have evaluated the preventive effect of shinguards with regard to the incidence and severity of lower leg injuries. Studies concerning this effect are multifactorial prevention programmes [26, 252], observational studies [262] or studies analysing the biomechanical proper-

ties of shinguards ^[254, 261]. More methodologically well-designed studies are recommended to evaluate the effectiveness of shinguards in preventing lower leg injuries, especially fractures of the tibia or fibula ^[26, 251, 252].

Ethical concerns and the compulsory use of shinguards during matches in the Netherlands since 1999/2000 make it nearly impossible to set up a controlled study to answer this question. One possibility is to evaluate the effect during training sessions, since the use of shinguards is compulsory only during matches. However, the literature shows that the injury risk of lower leg football injuries is much higher during matches compared to training sessions ^[253, 265]. Observational studies, by using an association between the football injury and exposure, can also be an option. In this population-based study, we used data on football injuries treated at EDs over a period of 25 years. It is interesting to see that the incidence of lower leg football injuries decreased significantly following the introduction of the shinguard law at the start of the 1999/2000-football season for all amateur players (compulsory use of shinguards during matches), whereas the incidence of all other football injuries remained the same. These results indicate a strong preventive effect of shinguards in football and substantiate earlier findings regarding their effectiveness.

Separate analyses were done to determine whether factors other than the implementation of the shinguard law could have affected the trends in the incidence of lower leg injuries and that in the incidence of other football injuries. These factors were shinguard use during training sessions and an increase in the number of female players. In addition, the introduction of artificial turf in the late 1990s and other contemporaneously introduced football rules were taken into account.

The shinguard law applies only to matches, although the KNVB has, and many football clubs may also have, stimulated the use of shinguards during training sessions. In the Netherlands, almost all matches are played at weekends, and training sessions are mainly held on weekdays. The results of the trend analyses showed a similar decrease in the incidence of football injuries at weekends (matches) and on weekdays (training sessions) in 1997–2001, with a delayed effect on the decrease in the incidence of injuries sustained on weekdays compared to injuries sustained at weekends. It is possible that the compulsory use of shinguards during matches has a positive effect on the uptake rate during training sessions. In the Netherlands, 73% of football players used shinguards at all times during training sessions in 2011 ^[266]. Two studies report the use of shinguards during almost all football matches but less frequently during training sessions, namely by 38% of all football players in Iceland, and during 59% of all training sessions in New Zealand ^[267].

With the notable increased participation of female football players in recent years ^[250, 268] possible differences between male and female players with regard to the incidence, nature and cause of injuries might have contributed to the significant decrease in the trend in lower leg football injuries. Limited information on injuries in female football players is available ^[252, 268]. Although it is clear that female football players are at an increased risk of suffering anterior cruciate ligament (ACL) injuries ^[265, 268], the relation between gender and lower leg injury is unclear ^[265]. Our results indicate that the injury trends remained the same when female football players were excluded from the analysis. With only a small percentage of all patients in our

registration being female (8%), the number of injuries sustained by female football players was too small to estimate reliable annual incidence rates and separate trends.

Another possible confounding factor is the introduction of artificial turf surfaces as an alternative to natural grass. The first generation of artificial turf appeared in the late 1960s, the second in 1980–1990 and the third in the late 1990s (which was when the shinguard law was introduced in the Netherlands). The effect of these synthetic surfaces on injury rates has been established in football. Studies found no major differences between the incidence, severity, nature or cause of either training or playing injuries sustained on new-generation artificial turf and grass by either men or women^[50, 268, 269].

One last relevant factor is the effect of contemporaneously introduced rule changes by FIFA and KNVB. Since 1998, a tackle from behind that endangers the safety of an opponent must be sanctioned as serious foul play^[259]. In the preceding years, there had already been increased focus by referees on violent tackles. Tackling is one of the major causes of lower leg football injuries^[253, 257, 270]. With injuries resulting from trauma^[271], player-to-player contact^[272, 273], and tibial fractures due to tackles^[274] being more common during matches than during training sessions, this rule change has probably resulted in fewer tackles during matches and therefore affected the incidence of lower leg football injuries during matches. It cannot, however, explain the similar trend seen during training sessions. Since 2005, any tackle that endangers the safety of an opponent must also be sanctioned as serious foul play^[259]. Being tackled from the side was found to have the greatest propensity for causing injury in male football players^[257, 270], while sliding tackles have been reported to have the highest injury potential in women's football^[268]. This could have affected the incidence of lower leg football injuries and the incidence of other football injuries during matches, but cannot explain the trend differences found in 1996–2000.

Our study had some limitations, for example missing exposure data. Over time, the exposure to football has increased considerably and the increase in the number of female players is especially notable^[250]. We assumed that any changes in exposure level for lower leg injuries were equal to changes in exposure level for all other football injuries. A second assumption was that the shinguard law would not affect the incidence of football injuries other than lower leg injuries. However, the introduction of personal protective equipment usually implies a change or modification in the behaviour of the athlete (e.g. tackling) and might have increased the injury risk^[26]. Possible changes in players' behaviour has not been monitored over time. Furthermore, no information was available on the uptake rate of shinguards over time or the type of shinguards used by players over time (design, material type and size). Various types of shinguards are available and allowed in football. FIFA rules dictate that shinguards must be covered entirely by the socks, must be made of rubber, plastic or a similar suitable material, and must provide a reasonable degree of protection^[258]. The level of protection against tibia fractures may vary significantly among commercially available shinguards^[254]. Additional data, such as the uptake rate of shinguards during training sessions and matches, and the type of shinguards used, are valuable in order to further evaluate the preventive effect of shinguards on lower leg injuries in football.

To prevent lower leg injuries, shinguards must be not only effective, but also accepted, adopted and complied with by the athletes and sports organisations they are targeted at^[17]. More

consistent use of shinguards during training sessions and matches can help to prevent contact injuries. Referees, trainers and sports clubs can be supportive by ensuring adherence to these rules and by educating players^[26].

Conclusions

Shinguards are considered an important measure in preventing lower leg impact injuries. However, few studies have evaluated this effect. In this population-based study, trend analyses confirm earlier findings regarding the effectiveness of shinguards in preventing impact-related injuries of the lower leg in football, i.e. abrasions, contusions and fractures of the tibia and fibula. We used data covering a period of 25 years on injuries sustained in Dutch football and treated at hospital emergency departments. The incidence of lower leg football injuries decreased significantly following the introduction of the shinguard law in the Netherlands in the 1999/2000-football seasons, i.e. the compulsory use of shinguards for amateur players in matches, whereas the incidence of all other football injuries did not decrease significantly over time. The use of shinguards during training sessions should therefore also be strongly recommended. During the implementation period of the shinguard law, another rule change was introduced. This regarded the sanctioning of tackles, and has probably contributed to the effect of the shinguard law on the incidence of lower leg injuries during matches, but cannot explain the similar trend differences seen during training sessions.

Practical implications

- Preventive strategies directed at changes to rules and regulations can be effective to prevent sport injuries.
- This study emphasises the relevance of wearing shinguards by football players as a preventive measure during matches, training sessions and all other football activities.
- Trainers, coaches, physicians, physical therapists and parents (in case of youth players) should strongly recommend the use of shinguards by football players at all times.
- Long-term registration of sports-related injuries by physicians and physical therapists is an important and relevant tool to gain insight in trends in the incidence of sport injuries.
- An observational study, with data based on a continuous registration system, can deliver valuable information to evaluate the effectiveness of preventive measures at a population level within the 'real-world' implementation context in addition to experimental and controlled study designs.

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