THE EFFECT OF SYNTHETIC PLAYING SURFACES ON SPORTS INJURY RATES

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Synthetic playing surfaces were developed in the 1960s as a cost-effective alternative to natural grass. Purported advantages of artificial turf surfaces include the durability and versatility of the surface, allowing multi-sport use and even indoor use, and the relative ease of maintenance compared to natural grass surfaces. Synthetic surfaces also provide a more consistent surface in inclement weather conditions, helping to prevent the cancellation of events.

The first generation synthetic surfaces, such as AstroTurf, were comprised of a dense carpet constructed from durable nylon fibers with no fill over an asphalt base. This resulted in a hard surface with an absence of impact absorption and a high friction surface with high rates of skin abrasion. Eventually, the asphalt base was replaced first by a combination of stone and earth, and then with a fully permeable shock-absorbing pad layer consisting of rubber, polyurethane, and mineral aggregate. Also, water was added to reduce friction and the resultant skin abrasions.

Second generation surfaces, developed in the 1970s, were made of softer polyethylene fibers which were twice as long as the first generation fibers. The fibers were also spread farther apart to accommodate sand fill, which provided a softer, more uniform surface. Turf shoes were also developed during this time, to better interface with the new surfaces. However, with the increased traction between the turf shoes and the turf surface came the concern for higher injury rates, particularly knee ligament injuries.

Third generation surfaces (FieldTurf), or the so-called infill surfaces, were developed in the mid- to late-90s to more closely replicate natural grass in terms of consistency and fiber morphology. The infill surfaces consist of longer and denser polyethylene fibers woven on a mat with spaces filled with rubber and sand particles to a level of 60% to 70% of the fiber height, thus, recreating the dirt between the blades of grass on natural fields and providing a more natural feel.
These newer surfaces also were more compliant and allowed for greater energy absorption than the older generation artificial surfaces.

Although synthetic playing surfaces have been found to be more versatile, durable, and cost-effective, several studies, particularly on the first and second generation surfaces, have found higher injury rates when playing on the artificial surfaces versus natural grass. The purpose of this article is to review the literature on the impact of the newer generation surfaces (FieldTurf) on injury rate and to investigate whether these newer surfaces accomplish their goals of decreasing the high injury rate reported for the original artificial surfaces.

### Injury Incidence and Severity

An overall higher incidence of injuries has been reported for the first and second generation synthetic surfaces compared to natural grass. Powell et al. found that there was a statistically significant higher rate of knee sprains and ACL sprains, specifically playing on AstroTurf versus natural grass in National Football League players. Similarly, Scranton et al. reported a higher rate of non-contact ACL injuries on artificial turf in practice situations. But, interestingly, their study demonstrated a higher rate of non-contact ACL injuries for natural grass in game conditions. This could potentially be due to the fact that the natural grass is manicured better on the game fields than on practice fields, thus, providing better traction and increasing the risk of a significant non-contact twisting injury. But, this needs to be explored further. Concussions and neurotrauma have also been found to be more frequent and more severe on artificial surfaces than on natural grass when playing on the earlier generation synthetic surfaces.

More recent studies, however, have found that while FieldTurf may be associated with a higher risk of injuries in some groups, it may have no effect, or even may be protective of other sport-related injuries. In a prospective study on high school football injuries, Meyers et al. reported that there was a higher incidence of non-contact injuries, skin lesions, muscle related trauma, injuries during higher temperatures, and minor 0-day time loss injuries when playing on FieldTurf versus natural grass. Conversely, they noted that there was a decreased rate of greater time loss (22+ days) injuries, head and neural trauma, and ligament injuries on FieldTurf compared to natural grass. So, the severity of injury appeared to be less on FieldTurf. In another study on game-related college football injuries, Meyers reported that there were significantly lower total incidence rates, minor injury rates, substantial injury rates, and severe injury rates on FieldTurf versus natural grass. Furthermore, they noted less injury time loss, lower grade of injury, and lower number injuries under various field conditions on FieldTurf. Therefore, they concluded that FieldTurf in many cases is safer than natural grass for football players.

In an investigation on women’s collegiate soccer injuries, Meyers found that there was a significantly lower total injury incidence rate and lower rate of substantial injuries on FieldTurf when comparing the same variables studied in the men’s collegiate soccer study. Therefore, it appears that overall FieldTurf may be safer for soccer players than natural grass.

A few reasons for the decreased incidence and severity of injuries on FieldTurf compared to natural grass have been postulated. First of all, the high shock absorbency of FieldTurf decreases the force of impact on the playing surface. The importance of the shock absorption may even be more evident at higher levels of sport where the degree of speed, power, and impact is greater. The turf quality of natural grass tends to decrease with time due to excessive use and wear and environmental conditions, such as high temperatures, low moisture content, or wet conditions. With increasing natural surface temperatures, there is enhanced shoe-surface interaction which could potentially result in an increased risk of knee trauma. Similarly, Scranton et al. showed that dry surface conditions increase the risk of noncontact anterior cruciate ligament injury. FieldTurf surfaces, on the other hand, stay consistent with time and with different climatic conditions. The greater surface uniformity and optimal vertical deformation along with the shock absorbency of FieldTurf may decrease the rate of both non-contact and contact injuries.
Knee Injuries

In terms of knee injuries, the literature is somewhat conflicting on the safety of FieldTurf versus natural grass. In a systematic review of the literature, Williams et al. reported an inconsistent association between knee injury and playing on third and fourth generation artificial turf. In a more recent systematic review, Balazs et al. observed a trend in football toward increased risk of ACL injury on modern artificial turf that seems to increase with the higher level of competition, with a substantial increased risk at the National Football League level. In an analysis of lower extremity injury rates in National Football League games, Hershman et al. found that the observed injury rate of knee sprains and specifically ACL sprains was significantly higher on FieldTurf than natural grass. At the high school level, Meyers and Barnhill found that although there was no significant difference in injury rates between playing surfaces across specific knee cases, there was a higher rate of overall knee trauma on natural grass than on FieldTurf when all knee injuries were combined. The higher rate of knee injury on natural grass at this level of play could be related to inadequate resources needed to maintain natural grass fields at the high school level compared to higher levels of competition and the increased chance of having uneven, inconsistent playing surfaces, predisposing to injury. This needs to be investigated further, though. Finally, in terms of collegiate men’s and women’s soccer, studies have shown no significant increased risk of knee trauma on FieldTurf versus natural grass, with two studies actually showing a decreased incidence of ACL injury on FieldTurf. Meyers, on the other hand, reported that collegiate football players actually had a significantly lower incidence of distal tibiofibular ligament sprains on FieldTurf compared to natural grass. Similarly, Meyers showed that there is a lower incidence of distal tibiofibular joint derangements on FieldTurf in collegiate female soccer players. The authors attributed this finding to the fact that FieldTurf is more compliant and has higher energy absorption, thus decreasing the energy of impact transferred to the lower extremity.

Concussions

Although the most common mechanism for concussion is player-player contact (76.2%), 15.5% of concussions are caused by contact with the playing surface. The coefficient of restitution is a measure of the ability of a playing surface to absorb shock, and fields with low coefficients of restitution absorb more shock, which can potentially lower the concussion risk. Guskiewicz et al. found that athletes who sustained concussions were more apt to lose consciousness on artificial turf than on natural grass. The artificial fields investigated in this study, though, were second and early third generation artificial turf fields, which are harder and have less ability to absorb sock. When
comparing natural grass to the newer generation FieldTurf surfaces, two studies showed that there was no difference in head trauma between the surfaces in collegiate men’s and women’s soccer.\textsuperscript{13,14} Similarly, in an investigation on collegiate football injuries, Meyers\textsuperscript{12} found that there was no difference in head trauma rate between artificial grass and FieldTurf. In a study on high school football injuries, Meyers\textsuperscript{11} showed that there was actually a greater incidence of first-degree and total concussions combined during games on natural grass than on FieldTurf. The authors surmised that the drier, non-compliant qualities of natural grass and its subsurface when compared to the more compliant FieldTurf resulted in minimal energy absorption at ground impact.\textsuperscript{11} And, the resultant greater energy of impact on grass is transferred back into the cranial/cervical region, increasing the potential for concussion.\textsuperscript{11}

**Conclusion**

Synthetic playing surfaces are much more durable and versatile and more cost-effective with easier maintenance than natural grass fields, which is important, particularly at the lower levels of competition, where financial resources are often limited. However, with first and second generation artificial playing surfaces, there was an unacceptable increased rate of injury, which also needed to be considered in the cost analysis and the societal impact. The third and fourth generation artificial services partly were developed to address these injury concerns. And, overall, it appears these newer synthetic surfaces may be just as safe and, in some cases, safer than natural grass surfaces with a few exceptions at higher levels of competition. Still, more work needs to be done to assess the risk of injury on synthetic playing surfaces and to determine how to minimize these higher injury rates on artificial surfaces at higher levels of competition.
REFERENCES


