Foot and Ankle Injuries: Artificial Turf vs. Natural grass

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Abstract

The advent of third-generation artificial turf in the 1990s has sparked much controversy over an increased risk of injury associated with synthetic surfaces. Some studies suggest no statistically significant difference in injury incidences between artificial turf and natural grass, whereas other studies have found increased risk of non-contact injury to the ACL in the knee. Studies have noted significant biomechanical differences between cleat interactions with artificial turf and natural grass; however, none have looked solely at the risk associated with foot and ankle injuries. This study analyzes 60 foot/ankle injuries documented by the Wittenberg University Athletic Training Department over the course of three years for differences in frequency and chance of injury across 3 male and 3 female field-related sports. Frequency of total foot/ankle injuries was no different between artificial turf and natural grass, as wells as between genders across all surfaces. Natural grass was noted to have a higher frequency of male foot/ankle injuries than females ($\chi^2_{df=1}$=4.55, P=0.03). Field surface type does not have an effect on foot/ankle injury frequency.

Introduction

The use of artificial turf fields in the United States, particularly in high school, college, and professional athletic facilities has become increasingly popular compared to maintaining natural grass fields. At the advent of artificial turf, surfaces were comprised of carpet-like material placed on top of concrete. As of the 1990's, third-generation artificial turf has been introduced and consists of long, widely spread polypropylene or polyethylene fibers infilled with rubber granules (Ekstrand et al., 2006). Artificial turf, on average, is more expensive to maintain and has a much higher heat index than natural grass, and is shown to harbor infectious bacteria (Patton, 2016, Serensits et al., 2011). Despite these negative aspects, artificial turf has become increasingly popular due to its ability to maintain consistency while upholding heavy traffic compared to natural grass. Third-generation artificial turf is advised to be replaced after 8-10 years of use after installation, thus categorizing 'new' and 'old' artificial turf (Patton, 2016).

One of the main controversies surrounding third-generation artificial turf surfaces is a potential increase in risk of injury compared to natural grass. Professional athletes have shown a preference to natural grass over artificial turf due to a concern of an increased risk of injury associated with artificial turf (Patton, 2016). Although some studies have looked at the differences in lower limb injuries and injuries in general associated with artificial turf versus natural grass (Fuller et al., 2007, Ekstrand et al,, 2006), none have specifically looked at the foot and ankle and the differences in frequency of injury between the different surfaces.

Of all injuries associated with athletics, few are as ubiquitous as foot and ankle injuries (Garrick, 1977). Ankle injuries, in particular, are primarily classified as sprains (85%) and involve a majority of the same lateral structures caused by ankle introversion (Garrick, 1977). Such an injury due to inversion can persist for at least two years after occurring, so emphasis is directed towards prevention (Anandacoomarasamy and Barnsley, 2005). The concern for artificial turf having a higher potential for injury than natural grass could arise from differences in surface hardness and/or 'stickiness.' Such differences could alter the way an athlete runs on a particular surface. Although there is a lack of research on foot and ankle injuries associated with artificial and natural surfaces, one study observed higher frictional indexes between cleats and

artificial turf compared to cleats on natural grass (Smeets et al., 2012). Another study observed higher force values associated with the central forefoot and lesser toes on artificial turf compared to natural grass, which was associated with higher force values at the medial forefoot and lateral midfoot (Ford et al., 2006).

This study compares the frequency of gender-specific foot and ankle injuries in running and cutting sports on artificial and natural grass surfaces. Third-generation turf is advised to be replaced after 8-10 years of use, so this study seeks to determine differences in foot and ankle injury frequencies associated with old (at the age of replacement) versus new synthetic grass fields. This study also seeks to determine differences in frequency of injury as well as chance of injury between genders and field surface types. It is hypothesized that the risk of injuring a foot or ankle is different for the three field types in question.

Methods

All field-related, NCAA athlete injury histories from 2013 to 2015 were collected from Wittenberg University's Athletic Training Department. The teams specified as "field-related" include football, men's and women's lacrosse, men's and women's soccer, and women's field hockey. Every team during the three year period had playing incidences on all three surface types (natural grass, new turf, and old turf). A total of 60 foot/ankle injuries were documented and classified by sport, sex, age, and type of surface played on while sustaining injury. The foot/ankle injuries documented were non-impact related, meaning that no outside force was applied to cause the injury (i.e. being struck by another player), and this was determined by mode of injury reports for each foot/ ankle injury documented. Because artificial infilled turf is recommended to be replaced after 8-10 years, 'new turf' consisted of fields younger than 8 years old, and 'old turf' consisted of fields 8 years and older (note: new and old refers to third-generation turf only) (Patton, 2016). This study only looked at three years' worth of injuries in order to account for sampling discrepancies. Wittenberg University replaced the old artificial turf in the summer of 2015 when it was 10 years old, so data collection prior to 2013 would be classified as 'new turf' skewing sampling efforts towards new artificial turf injuries.

Number of team play incidences with uncertainties for 2013-2015 were estimated from each team's fall and spring schedules as well as coordination with team coaches and the athletic training staff. A team play incidence is defined as any time a team played or practiced on the specified field surface type (Table 1.). Because playing incidences were taken from schedules printed before each season started, schedules and number of playing incidences per surface type were subject to change, and uncertainties were calculated based on a team's likelihood to stay on schedule. In order to quantify the frequency of foot/ankle injuries, the number of injuries per surface was divided by the total number of team play incidences on that surface. Chi squared tests for independence were conducted in Microsoft Excel to find any differences in frequency of injuries per surface for each sport and in total. Chi squared tests were also run to test for any differences in injury frequency by gender on each surface (Tables 2-3). Significance was determined at the 95% confidence level.

Because team sizes varied from small (<30 players) to large (>100 players), chance of foot/ankle injury per sport was analyzed via chi squared test for independence for differences in

number of injuries per number of athletes participating on each team (Microsoft Excel). The total number of players participating on each team was calculated by adding up the number of players on the rosters for the years 2013-2015. Even if a player returned from one year to the next, he or she was considered a new player each year to standardize chance of injury by team (Table 4). The same procedure was conducted in order to observe differences in number of injuries per number of players by gender (Table 5).

Results

Of the 60 foot/ankle injuries documented, males contributed 42 injuries and females contributed 18 injuries. The average age for the injured male athletes was 19.45 years old with a standard deviation of 1.16 years, and the average age of injured females was 19.39 years old with a standard deviation of 1.01 years. The total number of field-related foot/ankle injuries showed no association with field surface type ($\chi^2_{df=2}$ =0.65, P=0.72). For football, men's and women's lacrosse, women's soccer, and women's field hockey, no differences in frequency of injury attributed to field surface type was observed (max: $\chi^2_{df=2}$ =0.05, P=0.82; min: $\chi^2_{df=2}$ =2.67, P=0.26). Men's soccer displayed an association between injury frequency and field surface type, with new turf having a higher frequency of injury than old turf and grass ($\chi^2_{df=2}$ =11.09, P=0.004).

For male athletes participating in field-related sports, no association was seen between frequency of injury and field surface type ($\chi^2_{df=2}$ =0.89, P=0.64). For female athletes participating in field-related sports, no association was seen between frequency of injury and field surface type as well ($\chi^2_{df=2}$ =2.17, P=0.34). For new turf and old turf, no association between frequency of foot/ankle injury and gender was noted (New Turf: $\chi^2_{df=1}$ =1.97, P=0.16; Old Turf: $\chi^2_{df=1}$ =1.13, P=0.29). For grass fields, however, there was an association between frequency of foot/ankle injury and gender, with males having a higher frequency of injury on grass than females ($\chi^2_{df=1}$=4.55, P=0.03) (Figure 1).

No association between chance of a foot/ankle injury and type of field-related sport played was noted ($\chi^2_{df=5}$ =6.78, P=0.24). Also, no association between chance of foot/ankle injury and gender was noted ($\chi^2_{df=1}$ =1.35, P=0.25).

Discussion

The results obtained by this study support other studies that observed general risk of injury associated with artificial turf versus natural grass in NCAA athletes. Fuller et al. looked at the incidence, nature, and cause of collegiate soccer injuries during training, and found that there were no major differences between artificial turf and natural grass with respect to gender, which remains consistent with the frequency of foot/ankle injuries in all field sports contained within this study. In the case of men's soccer, the significant difference seen in frequency of injury on new turf compared to old turf and natural grass is most likely associated with a lack of team playing incidences on natural grass. Although studies have found equal risk of injury to the foot/ankle regardless of gender, this study reveals an increased frequency of males sustaining injuries on grass compared to their female counterparts. Such a discrepancy could arise from the sampled males playing on grass more than women as well as the nature of the sport played on

natural grass (i.e. football, a much more physical sport, having almost four times as many playing incidences as well as team size compared to the next closest women's teams).

When looking at the chance of sustaining a foot/ankle injury during field-related sports play, the results confirm previous research indicating that each sport and each gender are at equal risk of sustaining injury (Garrick, 1977). Garrick found that one out of every seventeen high school sports participants sustained ankle injuries, which is consistent with the number of combined foot and ankle injuries per participant found in this study using collegiate athletes (Garrick, 1977). These findings suggest the idea that foot/ankle injuries are ubiquitous amongst different age groups (i.e. high school athletics and college athletics).

It is important to note that this study looked at the number of injuries per playing time or per number of athletes rather than the number of injuries per number of training hours completed. The number of injuries per number of playing hours gives a much more logical and accurate idea of the frequency of injury than the method used in this study per individual athlete; however, this study's findings are consistent with studies using the playing hours method, suggesting that using number of playing incidences is a useful and effective method for comparing frequency of injury.

The findings of this study are very useful for athletic departments interested in what type of field to build for training and competition. Although athletes show a concern for artificial turf increasing the risk of injury, this study suggest new turf, old turf, and natural grass do not differ in risk of injury to the foot or ankle. This allows athletic departments to choose the most practical field surface for their situation without the worry of increasing their athlete's risk of foot/ankle injury. Some studies, however, have found an increased risk of ACL tears with third-generation artificial turf compared to natural grass fields, suggesting a preference towards natural grass when minimizing overall risk of injury to the lower limbs (Balazs et al. 2015). Although no differences were noted with regards to the age of artificial turf and frequency of foot/ankle injuries, more research needs to be conducted on other lower body injuries such as injuries of the knees, hips, and the lower back and their association with age of turf played on in order to suggest that age of third-generation turf has no effect on risk of injury.

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Appendix

Table 1. Number of injuries and number of team play incidences with their associated ratios and p values on each field surface by each sport from 2013 to 2015. NT=new turf, OT=old turf, G=natural grass.

		# Injuries	# Playing Incidences	Ratio	P value
Football	NT	5	47 ± 1	0.106	0.640
	OT	12	104 ± 2	0.115	
	G	9	117 ± 3	0.077	
M. Lacrosse	NT	2	59 ± 3	0.034	0.264
	OT	6	118 ± 6	0.051	
	G	3	24 ± 3	0.125	
W. Lacrosse	NT	1	60 ± 5	0.017	0.779
	OT	2	120 ± 10	0.017	
	G	0	30 ± 6	0	

		# Injuries	# Playing Incidences	Ratio	P value
M. Soccer	NT	5	55 ± 5	0.091	0.004
	OT	0	110 ± 10	0	
	G	0	12 ± 3	0	

		# Injuries	# Playing Incidences	Ratio	P value
W. Soccer	NT	3	58 ± 3	0.052	0.483
	OT	2	58 ± 3	0.034	
	G	0	28 ± 4	0	

		# Injuries	# Playing Incidences	Ratio	P value
W. Field Hockey	NT	3	63 ± 3	0.048	0.823
	OT	7	126 ± 6	0.056	
	G	0	0	0	

		# Injuries	# Playing Incidences	Ratio	P value
TOTAL	NT	19	342 ± 20	0.056	0.724
	OT	29	636 ± 37	0.046	
	G	12	211 ± 19	0.057	

Table 2. Number of injuries and number of team play incidences with their associated ratios and p values for each gender by type of field surface played on from 2013 to 2015. NT=new turf, OT=old turf, G=natural grass.

		# Injuries	# Playing Incidences	Ratio	P value
Males	NT	12	161 ± 9	0.075	0.641
	OT	18	332 ± 18	0.054	
	G	12	153 ± 12	0.078	

		# Injuries	# Playing Incidences	Ratio	P value
Females	NT	7	181 ± 11	0.039	0.337
	OT	11	304 ± 19	0.036	
	G	0	58 ± 10	0	

Table 3. Number of injuries and number of team play incidences with their associated ratios and p values for each field surface by gender from 2013 to 2015. NT=new turf, OT=old turf, G=natural grass.

	Sex	# Injuries	# Playing Incidences	Ratio	P value
New Turf	Males	12	161 ± 9	0.075	0.16
	Females	7	181 ± 11	0.039	

	Sex	# Injuries	# Playing Incidences	Ratio	P value
Old Turf	Males	18	332 ± 18	0.054	0.287
	Females	11	304 ± 19	0.036	

	Sex	# Injuries	# Playing Incidences	Ratio	P value
Grass	Males	12	153 ± 12	0.078	0.033
	Females	0	58 ± 10	0	

Table 4. Number of injuries and number of roster positions per sport from 2013 to 2015.

Sport	# injuries	# players
Football	26	394
M. Lax	11	98
W. Lax	3	56
M. Soccer	5	93
W. Soccer	5	52
W.F.H.	10	73
Total	60	766

Table 5. Number of injuries and number of roster positions per gender from 2013 to 2015.

Sex	# injuries	# players
Male	42	585
Female	18	181
Total	60	766

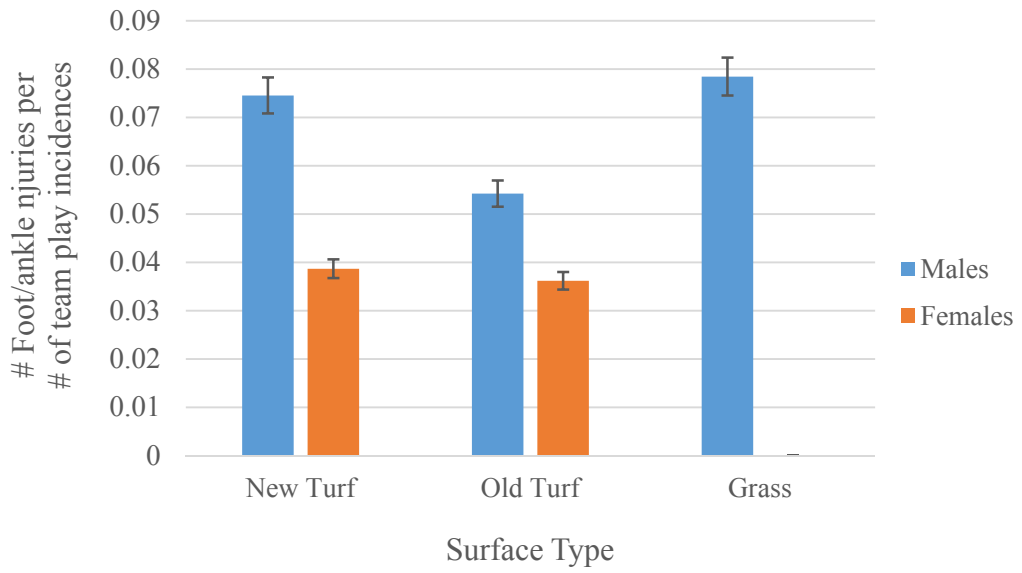

Figure 1. Frequency of foot/ankle injuries on each surface type classified by gender.