INTRODUCTION

From 2004 to 2009, the National Collegiate Athletic Association (NCAA) reported an overall injury rate of 8.1 injuries per 1000 exposures in college football [1]. For many collegiate football players, a serious injury can have considerable physical, psychological and socioeconomic consequences [2-4]. Athletes who sustain an anterior cruciate ligament (ACL) injury often suffer a short-term decline in academic performance [4]. A concerning number of athletes never return to their previous level of participation [3]. Several investigators have reported fear of reinjury and other interests as primary reasons for high school and collegiate football players not returning to play after ACL reconstruction [3]. Brophy et al. observed a direct correlation between shoulder stabilization for linemen in college football and their career length in the National Football League (NFL) [2].

The NCAA has also noted a difference in the timing of when injuries to athletes occur. From 2004 to 2009, the NCAA noted an overall injury rate of 9.7 for every 1000 exposures in the preseason compared to the 7.5 injuries per 1000 exposures noted while in season [2]. The NCAA data did not include spring football in their study. From 1998 to 2000 the Big Ten Conference observed an overall injury rate of 5.2 injuries per 1000 exposures [5]. Perhaps more importantly, a statistically significant difference was noted in the spring where the injury rate climbed to 16.4 injuries per 1000 exposures. From 2004 to 2009, the NCAA noted an overall injury rate of 5.2 injuries per 1000 exposures [5]. Perhaps more importantly, a statistically significant difference was noted in the spring where the injury rate climbed to 16.4 injuries per 1000 exposures.
analysis techniques, Hewett et al (2005) reported excessive knee valgus during a drop vertical jump as a highly sensitive and specific predictor of future ACL injury risk in adolescent females. Similarly, Zazulak et al (2007) cited poor trunk proprioception as a highly sensitive and specific predictor of future knee injury risk in a more heterogeneous sample of male and female collegiate athletes. The use of three-dimensional motion analysis techniques has demonstrated the ability to identify injury risk factors in adolescent males and females, [6-8] but has not been extended to identifying injury risk factors in more physically mature, college athletes.

The overall objectives of this study were to report injury rates and types of injuries suffered in a cohort of collegiate football players over the course of a single season. Specifically, we aimed to evaluate the incidence rate of injuries suffered and when and to whom those injuries occurred. The data in this study are an interim report of the findings from the first year of a prospective, longitudinal, epidemiological-biomechanical cohort study designed to identify injury risk factors in collegiate football athletes. The larger ongoing study, from which this report was produced, combines three-dimensional motion analysis, clinical examinations, strength and functional testing, anthropometric measurements, and questionnaires of self-reported function to develop a comprehensive profile of each participant.

METHODS AND STUDY DESIGN

All 105 football players that were listed on the official team roster at the start of the first preseason practice session were enrolled in the study. All athletes who participated in preseason biomechanical testing provided informed consent that was approved by the institutional review board. Consenting, incoming freshman athletes were the only athletes to participate in biomechanical testing, and were defined as athletes who graduated from high school during the previous calendar year and were entering their first fall season of collegiate athletics. All freshman who provided informed consent had their injuries tracked on an individual basis and will be used in a subsequent analysis to identify specific biomechanical risk factors for injury [6]. All other athletes who participated in this study had their daily attendance and injury information tracked, but were de-identified and reported as a cohort. Daily, individual attendance was tracked by the same team physician during the 2012 football season.

The season was divided into three periods: pre-season and the first and second halves of the regular season. The preseason was defined as the first preseason practice through the final practice prior to the first game of the regular season. The first half of the regular season was defined as the first game of the regular season through the 6th game of the regular season. The second half of the season was defined as the first practice after the 6th game of the season through the final game of the regular season. An Athletic Exposure (AE) was defined as a single practice session or a game in which the athlete was cleared to participate by a licensed team physician. An injury was defined as time missed from an AE secondary to not being cleared by the team physician. All athletes were evaluated in the training room after practices and games for injuries. Each athlete recovering from an injury was evaluated by the team physician prior to each day’s event in order to determine if he was eligible to participate.

The type, location, and mechanism (contact or noncontact) of each injury were recorded. Injury Rates (IR) were computed and used in mid-p exact tests to test for differences in IRs across each third of the season and among body parts. Results of these comparisons are presented as Injury Rate Ratios (IRR) with 95% Confidence Intervals (CI). Statistical significance was set at p < 0.05.

RESULTS

103 athletes completed the study; two athletes left the team for personal reasons. 46 injuries were sustained during 9245 exposures for an overall IR of 4.98 injuries per 1000 AE (CI 3.69 – 6.58). 15 injuries were sustained in 2587 exposures during the pre-season (IR 5.80; CI 3.37 – 9.35). 15 injuries were sustained in 3087 exposures during the first half of the season (IR 4.86; CI 2.82 – 7.84). 16 injuries were sustained in 3550 exposures in the second half of the season (IR 4.51; CI 2.67 – 7.16). There were no statistically significant differences in IRs between each third of the season: pre-season vs. first half of the regular season (IRR 1.19; CI 0.58 – 2.48; p = 0.63), pre-season vs. second half of the regular season (IRR 1.29; CI 0.63 – 2.63; p = 0.49), and first vs. second half of the regular season (IRR 1.08; CI 0.53 – 2.21; p = 0.83).

There was a greater number of head (n=13) and lower extremity injuries (n=25) compared to upper extremity injuries (n=8). The head was the most-commonly injured single body part, with thirteen concussions reported and an overall IR of 1.41 concussions per 1000 AE (CI 0.78 – 2.34). The IR of concussions was significantly greater in the pre-season (IR 3.09; CI 1.44 – 5.87) than in the first half of the regular season (IR 0.32; CI 0.02 – 1.60) (IRR 9.546; CI 1.53-213.5; p < 0.05). There was no difference in the IR of concussions between the second half of the regular season (IRR 1.12; CI 0.36 – 2.72) compared to the first half of the regular season (IRR 3.48; CI 0.44 – 86.07; p = 0.28). There was also no difference in the IR of concussions between the pre-season and the second half of the regular season (IRR 2.74; CI 0.83 – 10.45; p=0.10). The freshman sustained all of their concussions in the pre-season (n=3; IR 7.042; CI 1.79 – 19.17).

DISCUSSION

The purpose of this study was to document the interim findings from a prospective, longitudinal study targeted at identifying the underlying injury risk factors in collegiate football players. The majority of the comparisons that we made to the NCAA and previous Big Ten data yielded no statistical differences, including injury rate, distribution and timing of when the injuries occurred. One finding of note was the significantly high rate of concussions attributed to freshman football players during the preseason period. This finding was not our primary outcome, but repeatability of this finding may shed some insight into when and to whom these injuries occur.

The injury rate of football players in this study during the 2012 football season (4.98 injuries per 1000 AE) was considerably lower than that of the NCAA (8.1) but similar to previously recorded injury rates in the Big Ten Conference (5.2). Freshman demonstrated a higher injury rate in the preseason when compared to the first and second halves of the regular season (Figure 1). One can only theorize that this may be secondary to a larger focus on athlete safety, training techniques taught to the athletes from the Midwest, or equipment preference used by the schools. As there is no single attributable reason cited, it is unclear why exactly this phenomenon occurs.
Distribution of when injuries occur is also consistent with previous data that the majority of injuries occurred in the preseason when compared to the regular season; however, this study did not include the spring football season which has previously demonstrated a three times higher rate of injury to players than any other time period. Factors that can be attributed to this anomaly include the intensity of the workouts, weather conditions faced by the athletes and the lack of rest between workouts. Authors of the Big Ten epidemiology study suggested that the increase in injury rates in spring football could have been to a number of different factors including coaching differences and rule changes by the NCAA [5]. Due to the higher injury rates surrounding the regular season, it seems that focusing on safety surrounding areas of the season that scrimmages take place would make a significant impact on the injury rate faced by collegiate football players.

One of the most interesting findings in this study is that the rate of concussions reported in this study was found to be much higher in the preseason than during the regular season (Figure 2). The overall concussion rate of freshman football players was significantly higher than the rest of the team in the preseason. A reason for this difference in our study may be secondary to underreporting of concussion after each exposure for upperclassmen. Upperclassmen athletes tend to have larger roles on the team in terms of playing time and accountability. Time missed from sport gives an opportunity to other (potentially younger) athletes in the same position so it would stand to reason that many injuries (including concussion) may go unreported. The high rate of concussions in freshman football players during this time period may also be attributed to the biomechanical differences in players graduating from high school from those more mature in their physical development that they are competing against. This idea is further supported by Guskiewicz, et al. that found Division I college football players to have a concussion rate of 0.94 per 1000 AE compared to high school athletes who had a concussion rate of 1.63 per 1000 AE [9]. We hope that the prospective cohort, of which this paper was derived, will help to answer this hypothesis and eventually lead to strategies to prevent future injury.

Other studies have attempted to classify the “severity” of injury, but this can lead to debate. For example, a concussion may only hold an athlete out of practice for a week whereas a torn ACL may hold them out for months. The long term consequences of concussion can be argued to be much more severe than that of a torn ACL and lead to severe neurocognitive deficits. This is why we chose to define injury as time lost from an exposure secondary to not being cleared by a physician. Studies have also attempted to breakdown injuries by position which also carries some discrepancies. A lineman with a sprained MCL may be more likely to practice or participate in a game when compared to a position that requires more cutting maneuvers (that would place strain on the ligament) such as a wide receiver or running back. Our one year sample size was also not large enough to power for such variables.

In order to properly assess the validity of an investigator’s conclusions from a coupled biomechanical-epidemiologic cohort prospective trial, one would need to examine the fidelity with which injuries were prospectively tracked before a study of any task can be effectively evaluated for injury risk assessment. Limitations of our study include a small sample size, brief period of surveillance and a small sample of subjects utilized for biomechanical screening (freshman). As this cohort progresses, these limitations will become less relevant. There are also many potential bias problems introduced in poorly designed cohort and intervention trials. Potential biases abound – selection bias, reporting bias, absence of blinding, etc. For example, a recent study published as a Level One trial in The American Journal of Sports Medicine (AJSM), significant limitations in the design of the study may have affected the results and their interpretation [10]. Each coach and all the athletes knew whether or not they were assigned to the intervention program, and all were well aware of the expected outcomes of using the program, which had a track record of reducing injuries. That could potentially lead to a placebo effect among players using the intervention – there was a placebo or “sham” treatment to blind the researchers or study subjects. One would expect more injuries in bigger, taller athletes independent of the intervention. It’s simple physics, the bigger the study subject may be, the harder they fall. The findings of these coupled biomechanical-epidemiologic studies should provide a foundation for approaching both the mechanistic questions underlying injury risk disparities between individuals and groups as well as increase our ability to direct high-risk athletes to effective, neuromuscular interventions targeted at
specific, measured deficits. We performed these within 4 months in August through November of 2012. The goals of these studies were to develop the risk profiles in a large cohort in order to conduct a large randomized controlled trial. We tested and validated different biodynamics laboratories (at The Ohio State University) to collect data on the same medium sized cohort of subjects. This resulted in adequate statistical power and allowed us to examine injury events as both secondary and primary outcomes.

SUMMARY AND CONCLUSIONS

A lower overall IR was observed in this study than what has been reported by the NCAA between 2004 and 2009 (8.1 injuries per 1000 AE). Interestingly, we observed the highest rate of concussion in the preseason compared to the remainder of the football season and a much higher rate of concussion to freshman football players in the preseason compared to their upper classmen counterparts. Our future prospective longitudinal combined biomechanical-epidemiological studies will seek to identify independent risk factors that identify collegiate, football athletes at increased risk of the suffering athletic injuries.

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