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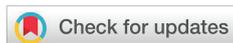
Research Article

Differences in baseline and post-season King-Devick times between recreational and competitive youth soccer players

Abstract

Objective: To determine if K-D scores differed between competitive youth soccer players and recreational youth soccer players ages 8-12.

Design: Prospective cohort study during the spring and fall soccer seasons of 2017. Participants were 8-12 years of age and were enrolled in recreational or competitive soccer.

Methods: Participants performed the K-D test before the first practice of the soccer season and during the last two weeks of the season. The main outcome measure was the time required to complete the K-D test before and after the soccer season in participants without a positive K-D screening for concussion.

Results: Forty participants (19 competitive and 21 recreational) completed the study. The pre-season recreational players (66.04s, SD = 15.22s) vs competitive players (59.88s, SD = 13.94s) had a mean difference of 6.16s (Z = .96, p = .34). The post-season recreational players (60.45s, SD = 13.46) vs competitive players (50.50s, SD = 8.49) had a mean difference of 9.95s (Z = 2.31, p = .02).

Conclusions: Level of play may influence performance on the K-D. Future studies of visual efficiency in youth athletes may also provide insight into differences in performance of the K-D.

Introduction

Concern for concussion in youth sports has grown as researchers begin to uncover the link between concussion and long-term clinical symptoms, such as memory loss, headache, and noise/light sensitivities [1,2]. Three to eight percent of all sports-related injuries in youth athletes in the United States are from concussion, with an annual incidence rate of 340,000 [3]. A 2014 study of 351 female middle school soccer players noted an incidence rate of 1.2 concussions per 1000 athletic-hours [1]; around half of those athletes returned to play with symptoms [4]. Immediate post-head injury screening tools such as ImPACT and SCAT5 were designed to be administered by healthcare professionals, the K-D test is the only side-line screening tool that can be administered by non-healthcare professionals such as coaches, trainers or parents [5]. Today, youth are engaging in organized sports, like soccer, as young as three years old, therefore there is a clear need for validated screening tools that can reliably identify concussion in children [6].

The King-Devick test (K-D) is a visual-cognitive sideline screening for concussion in adults. This screen involves reading three pages of numbers horizontally as fast as possible while being timed. This captures the afferent visual function, visual fixation and saccadic eye movements in multiple different regions of the brain, the disruption of which results in a slower K-D performance [7]. It has high interrater reliability with an intra-class correlation of 0.97 [8], and it demonstrates good sensitivity (86%) and specificity (90%) in adults [9]. According to a meta-analysis performed in 2015 with healthy athletes, the mean K-D time was 44.5 s (95% CI: 43.8, 45.2), with a weighted estimate of 43.8 s (95% CI: 40.2, 47.5) with a mean age of 18.3 years (95% CI: 18.0, 18.7) and a range of 5 – 63 years old [9]. The meta-analysis also reported an average increase of 4.8 seconds from baseline to post-concussion.

Recent studies suggest that engaging in sports may result in a significant increase in visuo-oculomotor skills, [10] and varying intensities of the same sport can result in an increased efficiency of cerebral cortical activity that facilitates visuomotor performance [11]. These findings suggest that the level of intensity in sports engagement, which differs substantially

between recreational and competitive players, may need to be considered when determining the results of sideline screening tools, such as the K-D, in youth soccer. It has been documented in clinical studies that K-D scores improve (get faster) over a season of youth sports [12-14], but currently no studies examine differences in pre and post-season K-D scores between recreational and competitive youth soccer players. The purpose of this study was to determine if pre and post-season differences exist between competitive youth soccer players and recreational youth soccer players ages 8-12 using the K-D screening tool.

Methods

This prospective observational study was approved by the UT Southwestern Medical Center institutional review board. One recreational soccer club and one competitive soccer club participated in this study during the 2017 spring and fall soccer season in Dallas, TX. The competitive players had to try-out and be chosen to participate in academy level soccer, which is the highest level of play for this age group in Texas. The recreational team is open to all players. All participants provided assent and their parents/legal guardians provided informed consent for participation in the study. A total of 45 youth soccer players were enrolled in the study (23 recreational, 22 competitive) and 40 completed the study; see table 1 for study participant characteristics and table 2 for age stratification of participants. Participants were excluded if they: (1) had a history of brain pathology that required hospitalization (including TBI, concussion, meningitis, encephalopathy, tumor), (2) had a history of eye movement disorder, (3) competitively participated in any other sporting activity concurrently during the soccer season, (4) participated in more than one soccer team or (5) played for both a recreational and competitive soccer team. Throughout the season, the recreational players on average participated in 7 hours of practice and 5.8 hours of game time.

Table 1: Subject characteristics and King-Devick scores.

	Recreation (N=21)	Competitive (N=19)
Age	9.9 (8-12)	10.3 (8-12)
Gender	Male − 12 Female − 9	Male − 15 Female − 4
Baseline average K-D time	66.28s, SD 15.55	62.13s, SD 13.90
Post-Season average K-D time*	60.45s, SD 13.46	50.50s, SD 8.49
Positive K-D Screen for concussion	0	2

* Participants with a positive K-D Screen for concussion are not included in this calculation.

Table 2: Age Stratification of Participants.

Age	Recreation (N=21)	Competitive (N=19)
Eight	1	4
Nine	7	0
Ten	8	6
Eleven	2	4
Twelve	3	5

The competitive players on average participated in 32.5 hours of practice and 16 hours of game time. The primary outcome for this study was time (seconds) required to complete the K-D before and after a season between the competitive cohort and the recreational cohort. The K-D was performed by trained examiners before the first practice of the soccer season and in the last two weeks of the season on the sidelines of the practice fields, and was performed twice per standard instructions [14]. The fastest time without errors from the two attempts was recorded as the official score. If a player demonstrated a K-D time difference of >4.8s from pre- to post-season testing, his/her parents were notified and asked if their child experienced any concussion symptoms, per recommended guidelines established at the 4th International Conference on Concussion in Sport [15]. The parents were then advised to take their child to seek further medical attention if necessary. All data collected were entered into a Microsoft Excel spreadsheet and analyzed with R (R foundation for statistical testing). Data are presented as mean (± SD) per group of players. A D'agostino skewness normality test and a Kurtosis test were performed and a non-normal distribution was found. Both the pre-season and post-season differences in mean time to perform the K-D between recreational and competitive players were compared using the Mann-Whitney U test. Statistical significance was set at $\alpha = .05$.

Results

This study had a follow up completion rate of 88.9%. Each competitive player had 48.5 hours of structured soccer activity with a United States Soccer Association licensed coach. The recreational players had 12.8 hours of structured soccer activity with an un-licensed coach who was a parent of one of the players. Participant characteristics are summarized in table 1. The mean baseline pre-season recreational player K-D times (66.04s, SD=15.22s) vs mean competitive player K-D times (59.88s, SD=13.94s) had a mean difference of 6.16s (Z = .946 p = .34); for post-season the mean time for recreational players (60.45s, SD=13.46) vs competitive players (57.60, SD=26.39) had a difference of 2.85s (Z = 1.63, p = .10). Two players from the competitive team had scores indicative of a concussion. When participants with positive K-D screening for concussion were removed, post-season recreational players (60.45s, SD=13.46) vs competitive players (50.50s, SD=8.49) had a mean difference of 9.95s (Z = 2.31, p = .02) (Figure 1).

Discussion

The K-D has been validated in numerous studies as a useful sideline screening tool for concussion when individual baseline data is used for comparison. However, normative values and the generalizability of this test have yet to be established in both youth and adult populations [16]. Research suggests that age and education level in adults have significant impact on K-D time [16], yet there is little research into other factors that may influence K-D times especially in youth athletes under the age of 12. The difference in K-D times reflect a potential difference in visual efficiency, captured by the K-D, between competitive soccer players and recreational soccer players between the ages of 8 and 12 after a complete season. This
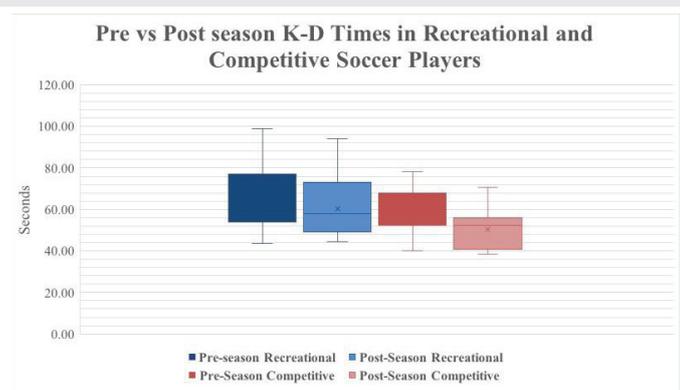
Figure 1: There is an improvement (faster) in K-D times between pre-season and post-season times except for the 2 participants that screened positive for concussion in the competitive team. There is a bigger improvement in the pre and post-season measure in the competitive players compared to the recreational players.

suggests a need to account for a number of factors in youth athletes including level of competition when interpreting K-D scores. Our study suggests that athletes in competitive soccer demonstrate a superior pre-season level of ocular efficiency and greater improvements in ocular efficiency over the course of the season compared to recreational soccer players. This may indicate that a single K-D time threshold may not be sensitive enough to capture change in competitive youth players.

There was a mean difference of approximately six seconds between pre-season competitive players and pre-season recreational players (p=.34) . This difference was significantly greater (mean of 9.95 second, p=.02) in post-season recreational players compared to post-season competitive players. This demonstrates a potential difference in ocular efficiency in recreational versus competitive youth soccer players. The competitive players' potential for superior ocular efficiency may be due to the competitive nature of their training, the number hours played per season, or a biological predisposition for ocular efficiency. Previous studies indicate that those who engage in competitive sports that require keen visual and proprioceptive awareness demonstrate superior ocular efficiency compared to non-athletes. For example, fencers have a significantly higher saccade accuracy compared to non-athletes, and tennis players demonstrate significantly greater gains in smooth pursuit tasks compared to non-athletes and gymnasts [10]. Elite rifle shooters demonstrate superior visual-motor skills compared to amateur shooters [11]. These studies suggest that those who in engage in higher-level competitive sports demonstrate superior ocular efficiency compared to those who do not engage in high-level competitive sports. One study examined this phenomenon in youth. Omar et al. compared teenage athletes to non-athletes and found that there was no statistically significant difference between athletes and non-athletes in oculomotor alignment and vergence facility on a battery of visual exams [17]; however, the majority of study participants were myopes, or near sighted, with at least minimal astigmatism at baseline. Also, the study compared teenage non-athletes to recreational athletes, excluding the more elite athletes who are more likely

to present with higher efficiency in ocular motor skills [18]. Further study of this phenomenon and its impact on the process of establishing validity of a sideline concussion screening for youth athletes is warranted based on our findings.

Our study raises the point that if competitive youth players are able to perform the K-D faster than recreational players at baseline and a possible training effect further widens that gap, then setting a single threshold for a positive concussion screen across all youth soccer players could result in false positive scores among recreational players and false negative scores among competitive players. For example, a K-D threshold score indicating concussion in a nine-year-old recreational soccer player may not be sensitive enough to pick up a concussive event in a nine-year-old competitive soccer player whose ocular motor-skills are more likely to improve over the course of the season and potentially mask a decline that would result from a concussion. Our findings align with the results of a recent study of players aged 10 to 18, which found that K-D reliability was poorer in younger participants. The investigators concluded that within-player variability should be considered when making removal-from-play decisions [19]. Limitations to this study included only a small number of youth athletes and reproduction in larger cohorts is needed to fully elucidate differences between teams. This study was not designed to diagnose concussion. There were also no formal exams performed to determine if a concussion occurred, apart from the K-D test, which is only a screen for concussion. The report of concussion could not be verified by observation or medical evaluation but was garnered by retrospective self-report by the coaches, participants, and parents.

Conclusion

Recent studies suggest that concussion in youth can have detrimental long-term consequences on health and well-being, particularly if it goes undetected and, therefore, untreated. Our study highlights the further need to identify between-group differences in K-D performance based on level of competition. It is imperative that concussion is detected and treated as early as possible. A reliable concussion screening for youth athletes is the first step in ensuring that sports-related head injuries are identified and managed as early as possible post-injury. Future studies of the K-D screening tool are warranted to determine normative scores, the appropriate frequency of baseline testing in youth athletes, and meaningful score changes that may indicate concussion based on factors such age, sex and level of play.

Acknowledgements

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