

Design Cross-sectional study.

Participants An online questionnaire based on the 5th Consensus Statement on Concussion in Sport (Berlin, 2016) and The FA concussion guidelines was distributed by The FA and the Professional Game Match Officials Limited (PGMOL) to their referee members (Queen Mary University of London Research Ethics Committee QMREC2014/24/162)

Main Results 208 questionnaires were completed of which 34 (16%) were from referees officiating in top two tiers of English football (Premier League and Championship). 48% felt confident recognising SRC on pitch, 62% confident in the immediate management of concussion, and 69% confident that their concussion knowledge was adequate to officiate games. Some concussion-related symptoms had high awareness, but seizure and aggression had lower recognition. 32% incorrectly believed only a direct blow to the head could cause a concussion. 30% felt the final say on player removal was not that of the medical team. Low rates of concussion specific education or training were found, but high interest in future education.

Conclusions Improvement in concussion knowledge amongst football referees is required. An emphasis on educational initiatives aimed at these stakeholders could improve the health and welfare of those participating in football.

326

PLAYING THE GAME OR GAMING THE SYSTEM: ARE US PRIVATE HIGH SCHOOL STUDENT-ATHLETES REPORTING, HIDING OR FAKING CONCUSSIONS?

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Background Sports- and recreation-related (SRR) activities are a major cause of concussions among adolescents. Most adolescent SRR concussion research has been conducted among public school students. As private schools are qualitatively different from public schools (e.g. location, socioeconomic status, sports played), this study explores the concussion experiences of a large group of private high school students.

Objective The purpose of this study is to describe concussion reporting and return to learn (RTL) and return to play (RTP) post-concussion in a sample of private high school students who play a sport or engage in a recreational activity. These outcomes were also stratified by gender, contact level of their primary sport, and grade.

Design We surveyed students who played sports or a recreational activity about the sports they played, and their self-reported concussion experiences between April - May, 2018. Descriptive, bivariate, and multivariate statistics are presented.

Setting Ten New England private preparatory high schools.

Patients (or Participants) Data was collected from 2,122 male and female students.

Interventions (or Assessment of Risk Factors) Sex, grade, contact level of primary sport played and age of first concussion.

Main Outcome Measurements The main outcome of interest was percentage of students who reported/hid a concussion, and the time it the student to return to school and then to sport.

Results One-third (33.0%) of students who reported engaging in sport-activities, self-reported experiencing a concussion in their lifetime. A higher percentage of males, students who

played contact sports, and those who played multiple seasons of school sports, reported a concussion. Sex, contact level of primary sport played and age of first concussion were also significantly associated with reporting a sports-related concussion. 3% of students reported faking concussions.

Conclusions A sizeable proportion of private preparatory high school students reported experiencing a concussion, with some students at higher risk.

327

LOWER DYNAMIC NECK STRENGTH IS ASSOCIATED WITH HISTORY OF CONCUSSION IN VARSITY FEMALE SOCCER PLAYERS

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Background There is mounting evidence that dynamic neck strength may play a role in protecting against concussion. It is also well established that athletes with a prior history of concussion are at higher risk than those with no prior history.

Objective To assess if there is a difference in dynamic neck strength between athletes with a self-declared history of concussion (HxC) and athletes with no history of concussion (No-HxC). Secondly, to determine if dynamic neck strength can be used as a predictor for previous concussion history through a receiver operating characteristic curve (ROC) and hence, be used as a proxy for future concussion risk.

Design Observational cohort design

Setting Varsity level female competitive soccer players

Participants 28 athletes (average age 19.4 years, range 18–21), separated by self-declared history of concussion (HxC n=10 and No-HxC n=18)

Assessment Dynamic neck strength was calculated as the peak Rate of Force Development (RFD) in pounds-force per second ($\text{lb}_f \cdot \text{s}^{-1}$) achieved during 50 revolutions on the TopSpin360 neuromuscular neck-training device.

Results RFD for HxC was $3.85 \text{ lb}_f \cdot \text{s}^{-1}$ (95% CI 2.53 - 5.17 $\text{lb}_f \cdot \text{s}^{-1}$) while RFD for No-HxC was $7.14 \text{ lb}_f \cdot \text{s}^{-1}$ (95% CI 5.17 - 9.12 $\text{lb}_f \cdot \text{s}^{-1}$) Independent samples t test $p = 0.012$. ROC cut-off value of $4.5 \text{ lb}_f \cdot \text{s}^{-1}$ provides a sensitivity of 72% and specificity of 80% for detecting those with a history of concussion.

Conclusions In this pilot study of varsity female soccer athletes, those with a history of concussion demonstrate significantly lower dynamic neck strength measurements compared to teammates with no history of concussion. Knowing that HxC athletes are at higher risk of future concussion, the ROC cut-off value of $4.5 \text{ lb}_f \cdot \text{s}^{-1}$ provides a starting point for future studies using dynamic neck strength values for assessing baseline concussion risk in athletes.

328

THE ROLE OF NECK STRENGTH IN MITIGATING SPORT RELATED CONCUSSION: A SYSTEMATIC REVIEW AND META-ANALYSIS

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Background In recent years there has been an increase in focus on the potential role neck muscle strength and strengthening may play in helping to mitigate the risk of sports related concussion (SRC). However, to date there has not been any systematic reviews or analysis to help quantify this role and provide guidance.

Objective To systematically review the literature surrounding the neck strength and strengthening in reducing the risk of SRC.

Design Systematic review and meta-analysis.

Data sources SportsDISCUS, Ovid Medline, Web of Science, CINAHL and EMBASE

Patients (or Participants) Athletic population regardless of age or sex.

Study selection The above databases were searched using a combination of keywords and medical subject headings to identify studies that examined the association between SRC and neck strength and or neck strengthening programs.

Results The initial search produced 593 studies, of which 6 were included for review and meta-analysis. Intervention programs that included neck strengthening were shown to be effective at decreasing the incidence of SRC RR 0.54 (95% CI 0.50–0.95)

Conclusions Neck strengthening intervention programs can reduce the incidence of SRC in an athletic population. Athletes who participate in high-risk sports or are from high-risk populations (i.e. adolescents and females) should incorporate neck strengthening into their respective training programs.

329 ABSTRACT WITHDRAWN

330 ABSTRACT WITHDRAWN

331 ABSTRACT WITHDRAWN

332 **LEG COMPARTMENT PRESSURES IN COLLEGIATE RUNNERS: A COMPARISON OF SYMPTOMATIC AND ASYMPTOMATIC ATHLETES**

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Background Chronic exertional compartment syndrome (CECS) is an uncommon cause of leg pain in running athletes. Post-exercise compartment pressure measurements are an invasive test that many clinicians rely upon for making the diagnosis of CECS.

Objective The authors sought to determine if intracompartmental pressures in the anterior leg compartments of asymptomatic collegiate distance runners meet established criteria for diagnosis of exertional compartment syndrome and to

compare these measurements with those of symptomatic athletes.

Design Thirty collegiate running athletes underwent 1-minute post-exercise compartment pressure measurements of bilateral anterior leg compartments. Each was asked to run for 15 minutes at a moderately intense pace and then underwent measurements performed at 1 minute post-exertion with a slit catheter manometer. Fifteen male and 15 female collegiate running athletes age 18–23 years (average 20.8 years) underwent post-exercise compartment pressure testing of the legs. The pressure measurements were then compared with those of 30 symptomatic age- and activity-matched control athletes.

Setting Collegiate (University) Athletics.

Patients (or Participants) Collegiate Track and Field and Soccer (Football) Athletes.

Interventions (or Assessment of Risk Factors) Post-exercise leg compartment pressure testing with slit catheter pressure measurements.

Main Outcome Measurements Bilateral leg anterior muscular compartment pressures immediately following provocative exercise.

Results Measurements of leg compartment pressures performed at 1-minute post-exercise were indicative of exertional compartment syndrome in more than one-third of asymptomatic running athletes tested (11/30, 36.7%). Six male and 5 female runners demonstrated 1-minute post-exercise compartment pressure measurements > 30 mmHg in at least one leg. Of these 11 athletes, 4 demonstrated positive measurements bilaterally (2 men, 2 women). Intracompartmental pressure measurements ranged from 16 mmHg to 88 mmHg. The range of pressure measurements were nearly identical in the symptomatic runners.

Conclusions Elevated intracompartmental pressures were prevalent in collegiate runners despite a lack of symptoms. Post-exercise compartment pressure measurements should be viewed as only an indicator of exertional compartment syndrome and should not be relied upon as a confirmatory test.

333 ABSTRACT WITHDRAWN

334 **TRAINING FACTORS AND ACUTE ILLNESS IN MARATHON RUNNING EVENT PARTICIPANTS**

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Background Acute illness during training for an endurance running event reduces the likelihood of completing the event. A greater understanding of the risk factors for acute illness during training may inform prevention strategies and advice.

Objective To describe training factors and acute medical conditions amongst participants in mass-participation community-based marathon events.

Design Observational questionnaire-based study.

Setting Two large UK city mass-participation marathon events.

Patients (or Participants) Entry to both events was open to novice runners, with no qualifying time for general entry. All registered participants were invited to complete an online