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Editorial

Sport Safety for Adolescents: Linking Biomechanics of Repetitive Head Impacts With Health and Wellbeing

Sport-related concussions are a major public health concern in adolescent athletes, with the potential to affect academics, behavior, cognition, vision and vestibular function, mental health, and overall quality of life [1]. The recent literature is replete with examples of studies directed toward objectively quantifying the brain dysfunction experienced by concussed young athletes to help with diagnosis and treatment plans. In parallel, concern about the potential for negative effects from repetitive head impacts—impacts that do not result in concussion symptoms—has intensified. This literature is less robust, particularly for adolescents [2]. Kercher et al. in this issue begin to address this topic by identifying how one season of head impact exposure, combined with the age at which they were first exposed to football and psychological need satisfaction, influences acute mental health outcomes [3].

The scope of the concern of repetitive head impact exposure is broad: more than 60% of youth in the U.S. age 13–17 years participate in team sports [4] with nearly half engaged in contact or collision sports [5]. Sports have multiple positive impacts on youth; adolescent athletes have lower risks of obesity, improved mental and cardiovascular health, better educational outcomes, and enhanced self-esteem and leadership skills [6,7,8]. It is critical that we as a scientific community conduct rigorous research to provide guidance to families as they weigh the benefits of sport participation against perceived risks of repetitive head impacts.

Studies on repetitive head impact exposure that rigorously quantify both the biomechanics of the impacts the athlete sustain and clinical outcome measures are rare. Measures of head impact exposure are often limited to retrospective and subjective self-report or use proxies such as years playing the sport. As a result, the literature is mixed on whether exposure influences neurological outcomes [2,9]. Kercher et al. admirably tackle quantitative measurement of head impact exposure over one season, using instrumented mouth guards with four high-school football teams. They follow recently developed best practice guidelines for on-field collection, processing, and reporting of such data [10]—including the critical step of time winnowing and detailed video review to filter out false positive recordings from the sensor. In the absence of these methods, estimates of head impact exposure can be greatly overestimated.

Armed with an accurate and quantitative measure of head impact exposure, they then assessed the effect of exposure on important acute mental health outcomes such as depression and anxiety symptoms and a measure of thriving (e.g., a positive component of mental health including happiness, accomplishments, and supportive relationships). Importantly, their analyses showed that neither the quantitative measure of cumulative head impact exposure over the season nor the exposure proxy of age at which they started playing tackle football were associated with any acute postseason mental health outcomes. The analyses did reveal that a measure of satisfaction with psychological needs was associated with less depressive and anxiety symptoms and greater thriving scores at both preseason and postseason. This helps contextualize responses to head impacts during sport as not simply a biomechanical event; the idea that there is an absolute threshold of head acceleration that automatically results in brain injury or dysfunction is likely not true. Rather there are characteristics of the individual athlete or the pattern of his/her exposure that modulate that threshold and influence outcomes [11,12]. These characteristics may be both intrinsic (e.g., genetics, physiology, or previous concussion history) or extrinsic (e.g., team culture, other social supports). The good news is that in this study, by self-reported measures of mental health and wellness, very few adolescents started or ended the season with elevated levels of depression or anxiety symptoms or low thriving. This points to the importance of thinking about adolescents who may be at risk because of a pre-existing mental health diagnosis and how their response to repetitive head impacts may be different. Studies that measure the effect of these modifiers on the biomechanics to clinical outcome relationship are greatly needed.

Kercher's study provides important areas that serve as a roadmap for future efforts in this field. They measured acute

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mental health outcomes immediately after the season. With adolescents, it will be important to examine the effect of contact sport participation on long-term neurological outcomes. Recent studies have identified a link between repetitive head impacts from sports and outcomes several decades after an athlete's playing career [13]. However, the athletes examined in these studies largely played in a different era of sport injury prevention and concussion management, without objective measures of head impacts. Putting the research infrastructure in place to prospectively follow the adolescent athletes of today, objectively quantify their head impact exposure, and measure long-term neurological outcomes years in the future, is a much needed yet tremendously resource intensive effort.

Like many concussion studies, the population in Kercher et al. was predominantly non-Hispanic White adolescent males. Female athletes play contact sports with elevated head impact exposure [14] and have been described as experiencing a greater mental health burden postinjury [15]. Other athlete sociodemographics influence these outcomes as well. This leaves an important area for further study of a more diverse population when examining mental health outcomes as a result of repetitive head impact exposure. This extends to similar studies of outcomes from concussions, which occur from both sport and nonsport mechanisms.

Understanding the effects of repetitive head impacts on clinical outcomes and wellbeing is an important avenue of study to understand how to protect young athletes as they engage in contact sports. High quality studies such as that conducted by Kercher et al. can help form the necessary foundation to a comprehensive prevention strategy, providing answers for parents, youth, and clinicians as they work to ensure our children can continue to play the sports they love for as long as they desire.

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