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"Perspectives on Mixed Martial Arts"

Thank you for the invitation to testify at today's hearing on Perspectives on Mixed Martial Arts. My name is Dr. Kristen Dams-O'Connor. I am an Associate Professor of Rehabilitation Medicine and Neurology at the Icahn School of Medicine at Mount Sinai. I am a Clinical Neuropsychologist, and I am the Director of the Brain Injury Research Center of Mount Sinai. The testimony I will give today reflects my own professional opinion and I am not speaking on behalf of the Icahn School of Medicine at Mount Sinai.

As a Clinical Neuropsychologist, I see patients who require comprehensive evaluations; these evaluations employ a variety of tests and behavioral assessments to quantify an individual's cognitive performance, functional abilities, and to inform diagnosis and treatment planning. Most of the patients I see in my practice have sustained one or more Traumatic Brain Injury (TBI).

My research focuses on understanding and improving long-term outcomes experienced by individuals who have sustained a TBI. The Brain Injury Research Center at Mount Sinai has made substantial contributions to the development of methods to measure lifetime exposure to TBI, and to the refinement and validation of neurobehavioral interventions to improve functional independence and life quality after TBI. In the past decade, a large proportion of our work has been dedicated to characterizing the late effects of TBI.

The American Congress of Rehabilitation Medicine defines a TBI as a "traumatically induced physiological disruption of brain function" that results in a period of unconsciousness, any loss of memory for events before or after the injury, any alteration in mental state, or focal neurological deficits that may be transient or longstanding.[1] At least one of these manifestations

must be present to meet criteria for a TBI, and only one is sufficient: not all TBIs involve a loss of consciousness. A TBI may result from the head being struck, the head striking another object, or from a rapid acceleration and deceleration movement such as whiplash that does not involve a direct blow to the head. A mild TBI is frequently referred to as a concussion.

Most of my research pertains to individuals who have sustained a TBI that involves a loss of consciousness and requires hospital care. TBI is a major public health concern: more than 2.7 million people sustain a TBI each year in the United States, and TBI results in more than 150 deaths every day in our country.[2] TBI has long been recognized as one of the strongest environmental risk factors for the development of dementia later in life. In recent years we have come to better understand the multitude of factors that impact the association between TBI and dementia, and we have begun to identify similarities and differences between post-TBI neurodegeneration and other neurodegenerative conditions such as Alzheimer's disease or Parkinson's disease.[3]

The potential long-term consequences of TBI are not limited to dementia. Data from the TBI Model Systems (funded by the National Institute on Disability, Independent Living and Rehabilitation Research) suggests that among individuals who receive inpatient rehabilitation after TBI, within 5 years of injury 50% of people will have either died or declined from a previously achieved level of functioning.[4] Research using this nation-wide database has found that individuals who sustain a TBI experience a shortened lifespan of up to 9 years, and compared to the general population of similar age, gender, and race they more commonly die from causes that implicate multiple body systems such as respiratory conditions, sepsis, and digestive conditions.[5] Individuals who survive a TBI tend to have more medical comorbidities

and earlier onset of certain chronic health problems; together this research has led to the realization that TBI is more appropriately conceptualized as a chronic disease process, rather than an isolated injury event.[6]

Milder TBI (or concussion) can result in symptoms such as headaches, dizziness, imbalance, and changes in mood or cognition, but unlike more severe TBI, concussion symptoms usually disappear completely in a matter of weeks or months. Still, a minority of individuals experience persistent post-concussion symptoms. Most of what we know about concussion comes from studies involving contact sport athletes; from this work we have learned that individuals who sustain multiple concussions may experience slowed recovery and more severe post-concussive symptoms.

A growing body of research has indicated that repeated exposure to sub-concussive head trauma, even in the absence of head trauma that would meet clinical criteria for concussion, may be associated with serious long-term consequences. Chronic traumatic encephalopathy (CTE) is a disease that is thought to be triggered by repeated exposure to sub-concussive head trauma, and is diagnosed postmortem by abnormal accumulation of a protein called tau in the brain. Our team participated in the expert panel convened by the National Institute of Neurological Disorders and Stroke which determined that CTE is a unique pathological disease that is distinguishable from other neurodegenerative conditions. CTE was first diagnosed in boxers and has since been found in many other contact sport athletes. The majority of research on CTE has been conducted in football players, and nearly 90% of former football players whose brains were donated to a CTE brain bank were diagnosed with CTE.[7] Although CTE cannot be yet diagnosed during life, many

individuals who have been diagnosed postmortem with CTE experienced symptoms such as mood changes, agitation and aggression, and cognitive impairment which worsened over time.

Because most of the research on long-term consequences of head trauma sustained during contact sport participation has been conducted in male football players, we don't know whether the findings from these studies generalize to other sports, or to women. Evidence suggests that there are important sex differences in concussion rates and recovery trajectories.

An important factor that distinguishes many forms of Mixed Martial Arts (MMA) from football is that many football players can avoid sustaining a concussion during their athletic careers, whereas inflicting a TBI with loss of consciousness is essentially the goal of some MMA forms. Like football and other contact sports, MMA also involves repeated exposure to sub-concussive head trauma through the course of training and competition. This means that MMA athletes are at risk for the long-term consequences that have been well documented following clinically significant TBI, and are also at risk for the long-term outcomes associated with repetitive head trauma.

It is clear that more scientific research is needed to better understand the factors that impact the risk for neurodegeneration and other late life health and functional outcomes among individuals exposed to TBI. Nonetheless, it is no longer defensible to claim that there is no relationship between TBI and degenerative health consequences. Current scientific knowledge indicates that greater exposure to TBI and/or repetitive sub-concussive head trauma is associated with worse outcomes, and earlier exposure to head trauma may be associated with worse outcomes. It is not

clear to what extent sex or other biological or genetic factors influence individual-level risk. There is no amount of exposure to head trauma that can be considered safe. There is no age after which it is safe to sustain a TBI. There is no biological marker that definitively indicates when it is safe to resume sport after a TBI. Without this information, an individual athlete (or caregiver of a youth athlete) is unable to make informed decisions about risk tolerance.

In the absence of empirically-based information on safe levels of exposure to head trauma, coupled with growing evidence that TBI is associated with elevated risk for a variety of health consequences, the most conservative approach might be to ban participation in contact sports altogether. However, sports participation offers tremendous benefits to children and young adults, and MMA in particular is an art form that honors tradition, respect, and self-discipline in addition to sportsmanship and athleticism. This truth must be balanced alongside the knowledge that many TBIs are preventable. Accordingly, every effort should be made to make sports safer. MMA can be made safer by reducing exposure to preventable TBI. Exposure to head trauma in MMA can be substantially reduced by delaying the age of exposure to high-contact MMA forms, limiting head trauma exposure during training and sparring, reducing the number of competitive matches an athlete can participate in, and possibly even penalizing athletes for deliberately inflicting blows to the head during competition.

Until scientific evidence allows clear delineation of individual-level risks associated with varying levels of head trauma exposure, it is impossible to weigh the benefits of sports participation against the potentially devastating effects of preventable TBI. More research is needed to inform these important decisions. Considerable resources are needed to fund

prospective longitudinal studies of unselected cohorts with autopsy endpoints. These particular methods are necessary to define the pathological substrate of TBI-associated neurodegeneration, identify clinical markers that allow diagnosis during life, and to develop targeted neurobehavioral and biological interventions that can meaningfully improve health and life quality for individuals experiencing functional problems or neurodegenerative decline after TBI.

Our understanding of the long-term effects of TBI and repeated sub-concussive head trauma has advanced rapidly in recent years, and we owe it to the individuals and families who are currently living with the effects of TBI to further accelerate the pace of this work. As we continue to pursue scientific answers, increased regulatory oversight is necessary to make sports safer for all athletes.

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