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Stewart, W. (2021) Sport associated dementia: Prevention remains the only cure. *British Medical Journal*, 372, 168. (doi: [10.1136/bmj.n168](https://doi.org/10.1136/bmj.n168))

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Deposited on 8 January 2021

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## **Prevention remains the cure for sport associated dementia**

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**Word Count: 797**

Among covid-19 and Brexit articles dominating the headlines in the final months of 2020, there was one other issue that attracted attention from the media. Multiple reports of high-profile former soccer and rugby players with neurodegenerative disease diagnoses generated concern over possible adverse brain health consequences of contact sport participation, with litigation threatened against sports organisations over perceived failures in duty of care to former players. But are these concerns justified? Is there evidence supporting a link between sport and dementia? If so, what might be done to mitigate risk?

Traumatic brain injury (TBI) is acknowledged as one major risk factor for neurodegenerative disease, contributing to around 3-15% of dementia in the community.<sup>1,2</sup> In context of sport, the link between TBI and neurodegenerative disease was first proposed almost a century ago in descriptions of the punch drunk syndrome of boxers,<sup>3</sup> with the associated pathology defined in the following decades as dementia pugilistica.<sup>4</sup> Throughout the twentieth century this issue remained largely confined to boxers. In the last twenty years, however, there has been growing recognition of the pathology of dementia pugilistica, now termed chronic traumatic encephalopathy (CTE), among non-boxer athletes from a range of contact sports, including soccer,<sup>5</sup> rugby<sup>6</sup> and American football,<sup>7</sup> and others with non-sports exposure to TBI.<sup>8</sup> As such, the pathology of CTE is now widely acknowledged as intimately associated with prior history of TBI or exposure to repetitive head impacts.<sup>8,9</sup> Elsewhere, neurodegenerative mortality among former professional soccer players and American footballers is considerably higher than expected.<sup>10,11</sup> Thus, neurodegenerative disease risk is high in former contact sports

athletes, with autopsy studies demonstrating the TBI-related neurodegenerative pathology CTE in a majority.

### **First, do no harm**

Addressing sports associated neurodegenerative disease, therefore, requires understanding of the brain health consequences of TBI, which, for athletes, might be considered in three broad life periods:

- Early-life: while participating in sport and exposed to injury
- Mid-life: retired from sport and no longer exposed to injury
- Late-life: when disease might emerge.

To date, the only identified risk factor for neurodegenerative disease associated with contact sports remains TBI. Therefore, adopting a precautionary principle approach to managing an athlete's early-life, every effort should be pursued to reduce head impact exposure and to better recognise and manage TBI in all sport.

### **Second, act to reduce harm**

While TBI prevention is the priority for risk reduction, retired athletes have already accumulated TBI and head impact exposure. In this mid-life period, therefore, the goal is to identify evidence of potential brain health issues and act to reduce their consequences. This is in line with current research and management of wider, non-sport neurodegenerative disease. Knowledge regarding the mid-life onset of neurodegenerative disease has been accumulating over the last decade<sup>12</sup> through programmes like PREVENT Dementia<sup>13</sup> and the European Prevention of Alzheimer's

Dementia programme.<sup>14</sup> These initiatives have informed the development of national policy (eg Brain Health Scotland)<sup>15</sup> and specialist Brain Health Clinics founded on three broad goals to: [1] provide detailed risk profiling; [2] detect early disease; and [3] provide personalised prevention plans.<sup>16,17</sup> This approach provides an ideal pathway for former contact sport athletes to obtain independent, specialist clinical review and advice on measures to improve brain health that might serve to reduce the long-term consequences of previous exposure to TBI.

### **Third, recognise the late consequences**

Consensus criteria for clinical diagnosis of CTE are yet to be established, however, data demonstrate neurodegenerative diagnoses in former athletes are broad and not confined to diseases that might be confused clinically with CTE.<sup>10,11</sup> Further, autopsy studies demonstrate that while CTE pathology is present in most former athletes with dementia, it is more often a co-morbidity rather than the primary disease responsible for dementia.<sup>5</sup> Thus, while efforts to better recognise CTE *in vivo* are welcomed, in the majority of former contact sports athletes the neurodegenerative disease diagnosis need not be CTE. Given this, clinical management in any patient should be guided by best practice protocols for whichever diagnosis is appropriate. The goals in this late life phase, therefore, are recognition that sport may be implicated in the individual's risk profile to record cases for surveillance purposes and, where possible, to engage patients in research directed towards understanding the influence of sport on lifelong brain health, including autopsy studies.

### **Prevention is the cure**

Current best evidence supports the association between elite-level contact sports participation and increased risk of neurodegenerative disease which, on the balance of probabilities, is a consequence of exposure to repetitive head impacts and TBI. In the coming years, whether global sports acted appropriately in past to reduce lifelong brain health issues associated with TBI and head impacts will be tested in the courts. In the meantime, the question for sport to consider in 2021 is, are current policies sufficient to reduce risk of TBI related neurodegenerative disease for today's athletes?

### **Competing Interest Statement**

The BMJ has judged that there are no disqualifying financial ties to commercial companies. The authors declare the following other interests: Funding received from the Professional Footballers Association and The Football Association for research into Football's Influence on Lifelong Health and Dementia Risk; Member of The Football Association's Head Injury and Concussion Expert Panel; Member of Fédération Internationale de Football Association's Independent Football Concussion Advisory Group; Research funding from the National Institute of Neurological Disorders and Stroke (U54 NS115322; R01 NS038104;R01 NS094003)

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