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Reducing head injury in wrestling: a biomechanical and impact testing study using polyurea-coated foams as wrestling mats

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INTRODUCTION:

Wrestling is a sport that involves various moves, including throws and takedowns, which can cause the athletes to hit the mat with significant force. The impact of such falls can lead to various injuries, with head injuries being the most dangerous due to their potential negative consequences, including Chronic Traumatic Encephalopathy (CTE) or Second Impact Syndrome (SIS). These injuries may have severe, long-lasting effects on the athletes health, including permanent neurological damage and impaired cognitive functions. Therefore, developing wrestling mats that can reduce the risk of these injuries is crucial for ensuring the safety and well-being of athletes.

METHODS:

Three Hungarian male wrestlers were involved in a biomechanical study to determine the typical loads on wrestling mats. A BTS Smart DX400 system with six infrared cameras and two regular video cameras was used to analyze the motion of the athletes during the seven most typical wrestling movements. The maximum velocity of the head was determined from the collected data, which was then used as input data in the subsequent impact testing. An impactor equivalent to an average human head (Triax Touch E-Missile) was used to investigate the shock-absorbing capacity of a traditional (30 kg/m³ density, 50 mm thick cross-linked polyethylene foam) and a polyurea-coated wrestling mat. Head Injury Criterion (HIC) was calculated, and the probability of different severity head injuries was determined.

RESULTS:

The comparison of different wrestling movements showed that executing the forward bridge technique had the highest possible head impact velocity with 5.94 m/s. The impact tests conducted from a 180 cm drop height indicated a greater injury-preventing effect for the polyurea-coated mat, with a significant reduction in Head Injury Criterion to 793±1 compared to 1347±39 for the traditional foam. The probability of severe head injuries (associated symptoms: skull fracture, loss of consciousness, and neurological damage) decreased from 42.1% to 8.6% with the polyurea-coated mat. Compared to the traditional mat, the polyurea-coated mat also had a lower probability of minor (96.6 vs. 99.9%), moderate (74.7 vs. 97.9%), serious (33.3 vs. 81.3%), critical (0.9 vs. 10.1%), and fatal (0.0 vs. 0.8%) injuries.

CONCLUSION:

The use of polyurea-coated foam structures as wrestling mats significantly reduces head injury probability, making the sport safer for its athletes. The coating provides four times higher protection against severe injuries with neurological damage, decreasing potential long-term negative effects such as CTE. Moreover, the longer lifetime of the polyurea-coated mats suggests their implementation may be economically viable in the long term. However, further studies are necessary to evaluate the practicality of this technology in competitions.

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