Background Finite element analysis (FEA) is a computational modeling method widely used in materials and mechanical engineering to simulate the strain in a given physical system. The SIMon (Simulation Injury Monitor) is a fine element head model developed by the National Highway Traffic Safety Association in order to study how various impact conditions affect the human brain.

Objective Compare brain strain in high and low velocity impacts, between short track (ST) and ice hockey (IH) helmets.

Design Two-group experimental design.

Setting Data from previous impacts used in SIMon to model the human brain response to impacts.

Patients (or Participants) 5 different helmet models; 3 ST models and 2 IH models.

Interventions (or Assessment of Risk Factors) Assessment of ST and IH helmet impact attenuation under various conditions.

Main Outcome Measurements Cumulative Strain Damage Measure (CSDM) 15, 20, and 25. CSDM is the percentage of brain volume that crosses the 15%, 20% and 25% threshold. This has been shown to correlate with deformation-related brain injuries, such as Diffuse Axonal Injury.

Results One-way-between-helmet ANOVAs for CSDM 15, 20 and 25 in low and high velocity impacts revealed statistical differences in CSDM 15, 20, and 25 (CSDM 15, F(4, 34) = 70.7, p<0.05; CSDM 20, F(4, 34) = 63.4, p<0.05; CSDM 25, F(4, 34) = 32.5, p<0.05). The trend was that ST helmets outperformed IH helmets in rear, rear-boss and front-boss impacts, but that IH helmets outperformed ST in side impacts.

Conclusions The results of the FEA reveal a difference between the ST and IH helmets, with ST helmets generally outperforming IH helmets. Interestingly, these results are different than the results obtained when comparing linear and rotational acceleration results for these same impacts. Currently, certifications only require peak linear acceleration values be below a certain threshold. However, these studies demonstrate the importance of using various outcome measures to determine the efficacy of helmets in sport.

Background Proper helmet fit is an important consideration for preventing head injuries, including concussions, in helmed sports like youth ice hockey and ringette. Helmet fit assessments are typically completed in-person; however, this was not possible given COVID-19 restrictions. Thus, alternative considerations for virtual assessments were required.

Objective To examine the feasibility and inter-rater reliability of virtual ice hockey and ringette helmet fit assessments.

Results Acceptable PA (>80%) was demonstrated for 8/12 criterion for ice hockey and 9/12 for ringette. Below acceptable agreement was found for all four criterion assessing the helmet facemask fit (PA range: 48%-74%) in ice hockey players and criteria for the chin straps fit (PA=66%), helmet positioning (PA=73%), and facemask fit (PA=63%) in ringette players. Common barriers were related to technology (e.g., audio/video quality) and environment (e.g., noisy, lighting).

Conclusions Virtual helmet fit assessments are feasible and reliable for most criteria, with more training required for criteria below acceptable agreement. Virtual assessments provides another option for assessing helmet fit for concussion prevention in helmeted sports.

Background The high concussion burden in youth ice hockey is concerning. An important yet understudied area for prevention is protective equipment (e.g., wearing a mouthguard, age of helmet).

Objective To compare rates of concussion between players based on mouthguard use and helmet age.
FUNCTIONAL MOUTHGUARD DESIGN TO ENHANCE THE PROTECTIVE CAPABILITY AND ATHLETE COMFORT

Introduction Athletes of contact sports are prone to cranial, orofacial and dental injuries in case of a traumatic head impact. Mouthguards can be potentially beneficial in reducing the injury risk by changing the dynamics of an impact to prevent the transfer of force. However, the effect of geometrical/structural attributes should not be neglected on the mouthguard protective performance. Design and Setting A detail anatomical human upper jaw model was developed including teeth, periodontal ligament and maxilla bone. The incisor impact with an ice hockey puck was then simulated by finite element analysis with and without mouthguard. Various mouthguard configurations were designed by employing different material properties, laminated composite arrangement, layers thickness, and space inclusion.

Main Outcome Measurements The maximum effective stress on the incisors, contact force profile and stress distribution were compared to evaluate effect of different parameters on mouthguard protective performance. Results While larger thickness always reduces the risk of injury in all configurations, the effectiveness of space inclusion and composite layers arrangement are design dependent. The optimal configuration was obtained when we combined graded stiffness layers (2000 to 20 Mpa) arrangement with a predefined gap (1 mm) in front of incisors. In this specific design, limiting the mouthguard thickness to 3 mm resulted in acceptable protective performance compared to 4 mm case and was preferred for the sake of athletes comfort.

Conclusion Both structural and material properties are playing a key role in shock absorbing capabilities of mouthguard. There is a need to practice multi-materials 3D printing for fabrication of customized mouthguards to maximize their performance and comfort.