# NEEDS ASSESMENT FOR A TODDLER WINTER ACTIVITY PROTECTION HEAD GEAR

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## INTRODUCTION

Objective: To describe the dynamic impact characteristics for three types of head gear used by toddlers participating in winter activities. Winter in the northern hemisphere is characterised by ice and snow as a result when children play outdoors the types of hazards change and often increase risk with the colder weather. Winter activities including tobogganing, skating, skiing and snow boarding all involve an increase in the risk of head injury [1, 2]. The mechanism of head injury involved in these activities range from slipping and falling and hitting their head on the ground, running into another person, falling off a moving sled and hitting their head on the ground to running into a tree or pole while sliding or skiing [1,2,3]. There are two basic mechanisms that describe how heads and brains are injured. The first involves the head moving and running into a non-moving or a slow moving object like the ground or a tree. The second mechanism involves an object moving and impacting a slow moving or stationary head [4].

There are a number of unique characteristics that apply specifically to toddlers, first they have smaller (lower mass) heads and they are shorter and therefore closer to the ground when they fall. However in activities like tobogganing and skiing they are able to attain very high velocities, especially when either tobogganing or skiing with their parents or older siblings. This creates a disproportionate amount of risk considering the underdeveloped skills necessary to protect themselves during unexpected events like falling or hitting an object [5].

## TEST PROTOCOL

Three types of toddler helmets were used in this study, an ice hockey helmet, an alpine ski helmet and a bicycle helmet. These three helmets were chosen because they are the most common helmets used for winter activities. Each helmet is affixed to the small hybrid III, head-form (6 year old) with a 3-2-2-2 accelerometer array to measure angular and linear accelerations of the head form during impact. The Hybrid III head form was attached to a children's hybrid neck. The sensors mounted inside the Hybrid III head form were 9 single-axis Endevco-7264C-2KTZ-2-300 accelerometers, measurement range 500 peak g (Fig. 4, left). They were positioned in an orthogonal arrangement following the 3-2-2-2 array[6]. Three sensors were mounted near the center of gravity, two on the anterior surface of the skull, two on the lateral surface and two on the superior surface. The processing of the nine signals l allow the determination of the complete three-dimensional motion of the head. The accelerations were collected at a frequency of 20 kHz.

Each helmet was impacted one time only at the front location at the following testing velocities (2.0 m/s, 4.0 m/s, 6.0 m/s and 8.0m/s). A guided monorail drop system was used to impact the helmets on a MEP impact pad. After each impact any damage to the helmet was recorded. Four (4) helmets of each type (3) were impacted at each velocity (4) for a total of 48 impacts. The resulting peak linear and peak angular acceleration values were recorded.

## RESULTS

The impact results revealed the ice hockey helmet protected the child the best at 2 m/s and 4m/s when using peak linear acceleration and for 2m/s, 4m/s and 6 m/s when considering angular acceleration. The bicycle helmet protected the best at 6 m/s and 8 m/s when comparing peak linear acceleration values and for 8m/s when comparing peak angular acceleration values. The alpine helmet did not perform the best at any of the impact velocities (Table 1).

| Linear Acceleration | | | | Peak Linear Acceleration Mean and sd ($m/s^2$) Velocity (m/s) | | | |
|---|---|---|---|---|---|---|---|
| Helmet Type | Mass (g) | Material | Front Offset (mm) | 2.0 | 4.0 | 6.0 | 8.0 |
| Hockey | 777 | VN | 16.2 | 34.9 (2.6) | 73.3 (5.6) | 152.4(3.4) | 308(13.3) |
| Alpine | 405 | EPS | 22.7 | 57.5 (3.9) | 109.0 (3.7) | 161.0(2.6) | 226(5.4) |
| Bike | 372 | EPS | 26.2 | 48.1 (1.7) | 89.7 (5.3) | 128.1(5.4) | 205.9(5.3) |

| Angular Acceleration | | | | Peak Angular Acceleration Mean and sd ($Rad/s^2$) Velocity (m/s) | | | |
|---|---|---|---|---|---|---|---|
| Helmet Type | Mass (g) | Material | Front Offset (mm) | 2.0 | 4.0 | 6.0 | 8.0 |
| Hockey | 777 | VN | 16.2 | 1426 (182) | 3552 (599) | 6500 (474) | 15180 (1638) |
| Alpine | 405 | EPS | 22.7 | 3493 (303) | 8178 (964) | 11644(1337) | 14061 (516) |
| Bike | 372 | EPS | 26.2 | 2713 (194) | 5448 (293) | 8158 (1212) | 11506 (1496) |

Table 1: Peak Linear and Angular Accelerations for Each Helmet Type

## CONCLUSIONS

Choosing the best helmet is really dependent on the type of activity and the expected hazards. For example if the activity is ice skating or sliding on a very short or gradual slope then it seems an ice hockey helmet provides the best protection. However if the activity involves high speeds and the hazards are severe like trees then it is clear the bicycle helmet provides the best protection. Ideally a helmet that provides

increased coverage like ice hockey and alpine helmets but is designed to handle both low and high energy impacts would be most suitable for protecting our toddlers during winter activities.
Previous research investigating ways to mitigate injury risk for those involved in winter activities have provided a number of suggestions. These include children should toboggan and skate under adult supervision, tobogganing slopes should be managed by limiting the slope-length of the run to manage velocities, closing runs when they become too slippery (icy), separate tobogganing for toddlers and toddlers should not be passengers on adult runs and of course there should be no hazards on any sliding slopes.

Data presented in this paper reveal that alpine helmets did not manage high energy impacts as well as bicycle helmets nor low energy impacts as well as ice hockey helmets. Considering the types of accidents that lead to head injuries in winter sports consideration should be given to developing a standard for a winter recreational helmet that would protect against both low and high energy impacts.

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