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Original Research

The Potential for Brain Injury on Selected Surfaces Used by Cheerleaders

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Abstract

Context: Although playground surfaces have been investigated for fall impact attenuation, the surfaces that cheerleaders use have received little attention.

Objective: To determine (1) the critical height for selected surfaces used by cheerleaders at or below which a serious head impact injury from a fall is unlikely to occur, (2) the critical heights for non-impact-absorbing surfaces for comparison purposes, and (3) the effect of soil moisture and grass height on g_{max} (which is defined as the multiple of g [acceleration due to gravity at the earth's surface at sea level: ie, 32.2 feet·s⁻¹·s⁻¹] that represents the maximum deceleration experienced during an impact) and the Head Injury Criterion (HIC) at the critical height for a dry grass surface.

Design: Observational study.

Settings: A local cheerleading gym, indoor locations within the authors' institution, and various outdoor locations.

Main Outcome Measure(s): g_{max} , HIC, and critical height.

Results: Critical heights for the surfaces tested ranged from 0.5 ft (0.15 m) for concrete and vinyl tile installed over concrete to more than 11 ft (3.35 m) for a spring floor. Increases in grass height and soil moisture resulted in an increase in the critical height for grass surfaces. Only spring floors and 4-in (0.10-m)-thick landing mats placed on traditional foam floors had critical heights greater than 10.5 ft (3.20 m), thus providing enough impact-absorbing capacity for performance of 2-level stunts.

Conclusions: The potential for serious head impact injuries can be minimized by increasing the shock-absorbing capacity of the surface, decreasing the height from which the person falls, or both. Cheerleaders and cheerleading coaches should use the critical heights reported in this study to compare the relative impact-

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absorbing capacities of the various surfaces tested, with critical height as an indicator of the impact-absorption capacity of the surface. The findings of this study can be used to select the most appropriate surface for the type of maneuver to be performed, based on the maximum height expected to be achieved by the cheerleader(s) during execution of the maneuver. Cheerleaders should not perform maneuvers at heights that exceed the critical height for the surface on which they are performing.

Keywords: [surface impact attenuation](#), [Triax](#), [critical height](#), [Head Injury Criterion](#)

Brenda J. Shields, MS, contributed to conception and design; acquisition and analysis and interpretation of the data; and drafting, critical revision, and final approval of the article. Gary A. Smith, MD, DrPH, contributed to conception and design and critical revision and final approval of the article.

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