Effects of Variable Helmet Weight on Human, Gender-Specific Response During Frontal –GX Impact

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ABSTRACT

With the demographic of the United States Air Force changing to include more female pilots, it is important to reevaluate present injury criteria to include a more comprehensive study of both genders. Advances in technology have led to many new helmet-mounted systems (HMS), such as night vision goggles. The addition of HMS, however, can affect pilot safety by increasing the potential for neck injury during ejection due to the increase in dynamic forces generated in the cervical spine as a result of the change in helmet inertial properties. Tests were conducted on the AFRL/HEPA Horizontal Impulse Accelerator (HIA) using both male and female subjects to investigate the effects of helmet inertial properties on gender response to short-duration frontal impacts of variable magnitude. Head accelerations and displacements were measured and neck loads and moments were calculated to compare the head and neck responses using helmets of varying weight. The neck loads and helmet weights were also extrapolated to higher levels in order to examine injury thresholds for pilots wearing even heavier helmets at maximum seat accelerations.

Overall, males experienced neck loads averaging 7.6% higher than females. However, females experienced overall forehead displacements averaging 10.7% higher than males. The data indicate that under extreme conditions, females tended to report more adverse affects than did males (pain or muscle stiffness). However, the data also show that pilots, regardless of gender, would not incur a significant neck injury even under these extreme conditions (such as the parachute opening phase) if they are wearing lighter weighted helmets. Extrapolation has shown, however, that the likelihood of severe whiplash increases when helmet weights exceed 5.0 lbs. Parameters such as the pilot's anthropometry and bracing techniques may also play a vital role in determining the likelihood of injury, and gender differences in these parameters can affect whether the pilot escapes unharmed.