

# EFFECTIVENESS OF BOXING HEADGEAR FOR LIMITING INJURY

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## INTRODUCTION

The goal in amateur boxing is to outscore your opponent. Points are given for the number of punches landed on an opponent. In an effort to limit head injuries for amateurs, heavily padded gloves and headgear were introduced. Both are designed to provide cushion and energy absorption. USA Boxing, the national governing body for amateur boxing, maintains the safety standards for both gloves and headgear

In 2004, a study was conducted involving a biomechanical surrogate (Walilko, et al. 2005). As part of this effort, the Hybrid III head, neck, and torso was impacted by trained amateur boxers instrumented with hand accelerometers. The results of this study provided a realistic input and a response with high level of biofidelity. The upper portion of a Hybrid III dummy provided the ability to concentrate on the area of greatest concern; the head. By using a Hybrid III, the interaction of the head and neck can more accurately be observed.

The purpose of this study is to evaluate the effectiveness of currently manufactured headgear. The recently established methodology involving the Hybrid III surrogate was utilized.

## METHODS

The punch force of 27 amateur boxers was recorded using the test methodology

established by Walilko et al. (2005). A Hybrid III head, neck, and torso system was fastened to an adjustable height table. Head linear and angular acceleration, head injury criteria (HIC), and punch force were used to evaluate the severity of the impacts. The surrogate was impacted by each of the boxers with a dominant hand hook. The punches were delivered with and without protective headgear.

The hand of each boxer glove was instrumented with three Endevco 7264-2K accelerometers. The three accelerometers were fastened to an aluminum fixture in an orthogonal array. The Hybrid III headform was instrumented with 12 Endevco accelerometers, nine linear and three angular. The upper and lower neck of the surrogate was instrumented with a six-axis load cells (Denton, Inc). The data was collected using a TDAS data acquisition system, at a sampling rate of 20 KHz.

Four criteria were used to analyze the difference in head impacts: peak rotational head acceleration, peak linear head acceleration, peak punch force, and HIC. Since the boxers were of different height, weight, and sex, the averages of these four criteria were compared.

The punch forces are calculated using a summation of forces. The punch force ( $F_p$ ) is set equal to the mass of the headform ( $m$ ) times its acceleration ( $A$ )

and the upper neck forces ( $F_n$ ). The equation is:

$$F_p = mA + F_n$$

This equation is used in all three axes and a resultant force is calculated from the  $F_p$  in the X, Y, and Z directions.

## RESULTS AND DISCUSSIONS

For all criteria, there was a significant decrease with the headgear in place. The average peak rotational acceleration decreased from 9,164.10 to 5,534.78  $\text{rad/s}^2$ . The peak resultant acceleration went from 78.04 to 51.79  $g$ 's. The punch force decreased from 4,260.51 to 2,815.59 N. HIC decreased from 79.23 to 47.34, although both were below the newly proposed threshold of 250 (Viano, et al. 2005). (See Table 1) Paired T tests were performed on each set of variables, and showed that the differences were statistically significant.

The punch velocities were obtained using the integration of the triaxial accelerometer in the gloved hand. The average velocities obtained were 9.57 and 8.43 m/s for impacts with and without headgear respectively.

This study is limited in the type of punch delivered to the dummy. It shows that the headgear lessens the blow of a hook, but does not give any information about

the protection provided for other punches.

In addition, this study only examined one set of headgear. Further studies should be done using different types of headgear and/or different materials.

## CONCLUSIONS

The utilization of boxing headgear significantly reduces the peak punch force delivered to an opponent. In addition, both angular and linear acceleration values are decreased when the headgear is in place. Thus, the resulting HIC is also diminished for the hook punch. Based on the current effort, the currently designed headgear and gloves are effective in reducing the risk of injury.

## REFERENCES

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- Waliko, T., et al. (2005). *Br. J. Sports Medicine*. **39**(10):710-719.

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**Table 1:** Data summary

Criteria	With Headgear	Without Headgear
Peak Angular Acceleration ( $\text{rad/s}^2$ )	5534.78	9164.10
Peak Linear Acceleration ( $g$ 's)	51.79	78.04
HIC	47.34	79.23
Punch Force (N)	2815.59	4260.51
Punch Velocity (m/s)	9.57	8.43