

## ***Relationship between Tackle Form and Head Kinematics in Youth Football***

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**Introduction:** American football has a high rate of concussion and subconcussive head impacts resulting from player-to-player collisions.<sup>1</sup> A tackle is a foundational skill of football that must be properly executed to maximize safety for all athletes involved.<sup>2</sup> Researchers have identified that instruction and reinforcement of proper form can decrease injury risk.<sup>3-</sup><sup>4</sup> Improved understanding of proper tackling form may reduce head injuries in football. The objective of this study was to develop a tackle form grading rubric and evaluate the relationship between tackle form and head kinematics in youth football.

**Methods:** A multi-step tackle form grading rubric was co-developed with football stakeholders and informed by current standards for safe and effective tackling.<sup>2</sup> Head kinematic data were collected during 1-on-1 style tackling drills from fourteen male youth football athletes (ages 12-14) on one youth football team using an instrumented mouthpiece.<sup>6</sup> Head acceleration events (HAEs) were video-verified and graded by expert reviewers. Summary statistics of peak resultant linear acceleration (PLA), rotational acceleration (PRA), and rotational velocity (PRV) were calculated and mixed-effect models were used to assess relationships between tackle form and head kinematic. A least absolute shrinkage and selection operator (LASSO) regression was performed to identify rubric criteria possessing the strongest relationship to kinematics.

**Results:** A total of 154 video-verified HAEs were collected during 1-on-1 style tackling drills. After signal analysis, a total of 149 HAEs that occurred over the course of 125 tackles were collected for analysis. Of the 125 tackles, 45 HAEs (36.0%) were collected with only the ball carrier was instrumented, 58 tackles (46.4%) with only the tackler instrumented, and 23 tackles (18.4%) with both ball carrier and tackler instrumented. Of the 125 tackles collected, 86 (68.8%) were deemed successful tackles and 39 (31.2%) were deemed unsuccessful tackles. The median PLA, PRA, and PRV measured from tackling HAEs were 12.9 g, 926 rad/s<sup>2</sup>, and 9.8 rad/s respectively. A pairwise comparison indicated that the head of the tackler crossing the body of the ball carrier and a tackler failing to squeeze the ball carrier around the hips and thighs were significantly associated with increased PLA (both  $p < 0.05$ ). A LASSO analysis of each grading rubric substep is presented in Table 1.

**Table 1. Summary of LASSO regression model coefficients for tackles.**

Fixed Effects	All Tackles (n = 125)			Successful Tackles (n = 86)		
	PLA	PRV	PRA	PLA	PRV	PRA
Intercept	17.81	15.49	1181	17.1	10.5	1129
Athletic Stance	-	-1.32	-	-	-	-
Head Up	-	-0.81	-	-	-	-
Balanced Posture	-	-	-	0.75	-	-
Head Does Not Cross Body	-1.14	-0.38	-	-	-	-
Keeps Head Up	-	-	-	-	-	-
First Contact Not with Head	-0.52	-0.25	-	-	-	-
Head Remains Up	-	-	-	-1.58	-	-
Drives Upwards	-	-0.06	-	-	-	-
Squeezes Around Hips and Thighs	-0.77	-0.27	-	-1.56	-	-
Drives to Ground	-	-	-	-0.34	-	-

**Conclusions:**

Higher tackle form score was associated with lower biomechanics on average. Tackles where tacklers lowered their head or allowed their head to cross the body of the ball carrier led to higher magnitude HAEs. The results of this study aid in the understanding of the association between tackle form and head impact exposure in youth football.

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