Comparing Head Acceleration Events in Elite Men's and Women's Rugby Union Tackle Events Using Instrumented Mouthguards and Video Analysis

James Woodward, James Tooby, Gregory Tierney

I. INTRODUCTION

The tackle event has been well established in research as the contact event most likely to lead to any form of rugby injury, with over 50% of all concussions occurring in the tackle [1-2]. Strategies aiming to reduce the incidence of concussion in the sport should therefore investigate ways to reduce the magnitude of head accelerations that occur during the tackle [3]. Head Acceleration Events (HAE) occur as a result of direct head loading or indirect head loading in rugby [4] and can result in concussive and sub-concussive events [5]. HAEs are a growing concern in Rugby Union (RU), due to fears of repeated exposure to head accelerations and the risk of neurodegenerative disease development, however, further research is required [5]. Sex-specific characteristics of HAEs in RU have yet to be investigated, however, the majority of all research into RU has been conducted in men's rugby [6]. HAEs can be recorded with instrumented mouthguards (iMGs) [3-4]. This study used a combination of iMGs and video analysis to identify differences in HAEs between different stages of the tackle event for elite men's and women's RU.

II. METHODS

A total of 83 players (64 male, 19 female) from elite RU teams in five of the major European RU competitions (Gallagher Premiership, Top 14, United Rugby Championship, Allianz Premiership 15s, and Women's Autumn Internationals) were instrumented with Prevent Biometrics iMGs across 23 total matches. iMGs events were recorded using a peak head centre of gravity linear acceleration (PLA) threshold of 5 g, capturing a 50 ms window, 10 ms pre- and 40 ms post-threshold. All true positive events were time synchronized to broadcast quality footage and analysed using an adapted video analysis framework [7]. Preliminary qualitative video analysis identified the tackle-and-carry event to be the most frequently occurring contact event in men's and women's players, accounting for 29.0% and 23.1% of all contact events, respectively. For each tackle event, qualitative video analysis was conducted to identify the HAE stage within the tackle, coded as either an Initial Collision, Secondary Contact, Ground Impact or Breakdown (Table I).

	HEAD ACCELERATION EVENT STAGES OF THE TACKLE
HAE Stage	Definition
Initial Collision	HAE occurs from the initial impact to the instrumented player,
	e.g., the instrumented player is the carrier, any initial contact to the iMG
	player from a tackle would count as initial collision, any after that would
	be secondary. In rucks, initial collisions are only given when HAE is the
	result of an instrumented player joining the ruck.
Secondary Contact	HAE occurs from secondary contact after the occurrence of the initial
	collision to the instrumented player.
Ground Impact	HAE occurs as a result of the instrumented player falling to the ground.
Breakdown	HAE occurs after the instrumented player has fallen to the ground, e.g.,
	impacts during the ruck when the instrumented player is a ball carrier or a
	tackler and not actively rucking.

TABLE I

J. Woodward (e-mail: woodward-j2@ulster.ac.uk) is a PhD Researcher in mechanics of head injuries in Rugby Union at Ulster University. J. Tooby is a PhD Researcher in mechanics of head injuries in rugby codes at Leeds Beckett University. Dr G. Tierney is a Lecturer in Sport and Exercise Biomechanics at Ulster University.



III. INITIAL FINDINGS

Fig. 1. Median peak linear acceleration values of tackle impacts by HAE stage. Blue plots show female impacts (n=258) (initial collision 43.4%, secondary contact 18.6%, ground impact 24.8% and breakdown 13.2%), and red plots show male impacts (n=1140) (initial collision 48.2%, secondary contact 20.2%, ground impact 17.1% and breakdown 14.5%). Dots show outliers within 40 g. Outliers above 40 g are not displayed.

In total, 1,398 HAEs occurred at the tackle event. Similar peak linear accelerations can be observed across all HAE stages of the tackle (Fig. 1). Male athletes appear to experience greater median and upper quartile PLA (g) in all HAE stages, except for the breakdown. Female athletes experience a greater proportion of HAEs in the ground impact stage (24.8%) compared to male athletes (17.1%).

IV. DISCUSSION

The preliminary results of this study suggest that the majority of HAEs occur in the initial contact stage of the tackle in both men's and women's RU, therefore this should remain a focus for future research. Given that a quarter of all HAEs in the tackle occurred at the ground impact stage in female rugby players, future research should be conducted into the risk factors at this HAE stage. More studies into the women's side of the game should be conducted, with a focus on larger female cohorts, as over 70% of participants in this study were male. Ongoing data collection aims to reach a 50% ratio. In conclusion, the results provide initial guidance on the areas of the tackle that need to be further investigated for the development of HAE mitigation strategies in RU.

V. REFERENCES

[1] Tucker, R., et al., Br J Sport Med, 2017.

[2] Cross, M., et al., Br J Sport Med, 2016.

[3] Tierney, G., et al., BMJ Open SEM, 2021.

[4] Tooby, J., et al., Sensors, 2022.

[5] Tierney, G., Sports Biomech, 2021.

[6] Heyward, O., et al., BMJ Open SEM, 2021.

[7] Hendricks, S., et al., Br J Sport Med, 2020.