

Using iMGs to Monitor Player Load in Rugby League

September 2025

Prof. Ben Jones & Dr. Cameron Owen

Similarities vs Differences



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Dr. Matt Cross



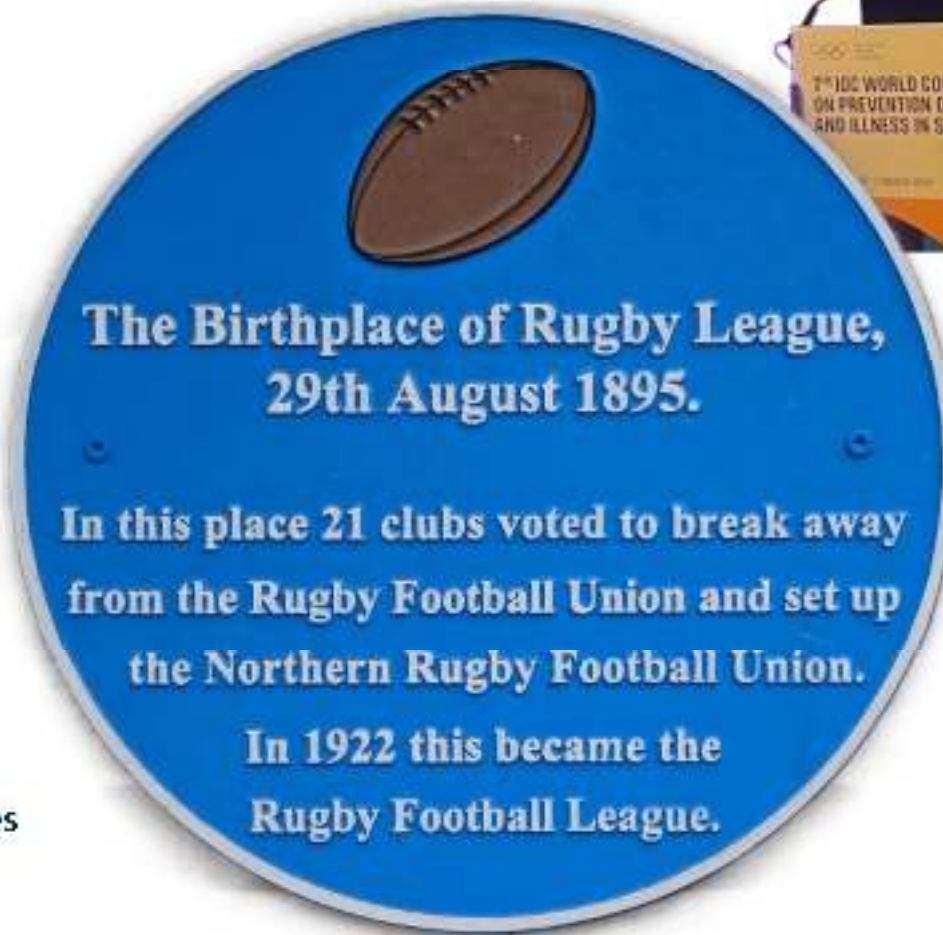
Prof. Simon Kemp



Prof. Keith Stokes



**PREM
RUGBY**



Prof. Ross Tucker



Prof. Éanna Falvey



WORLD
RUGBY



Dr. Lindsay Starling

Similarities vs Differences



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Journey

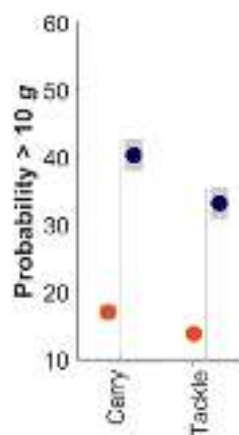
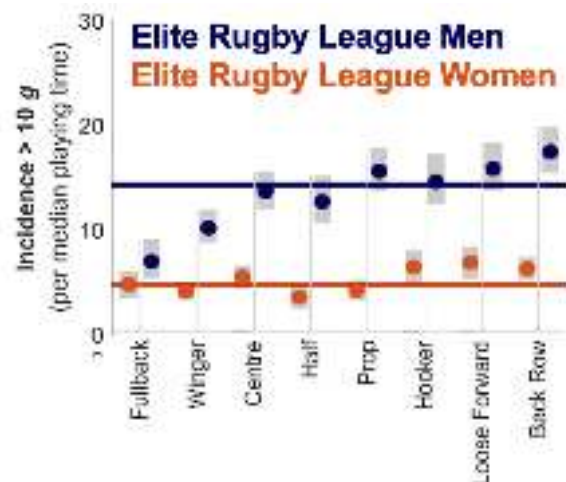


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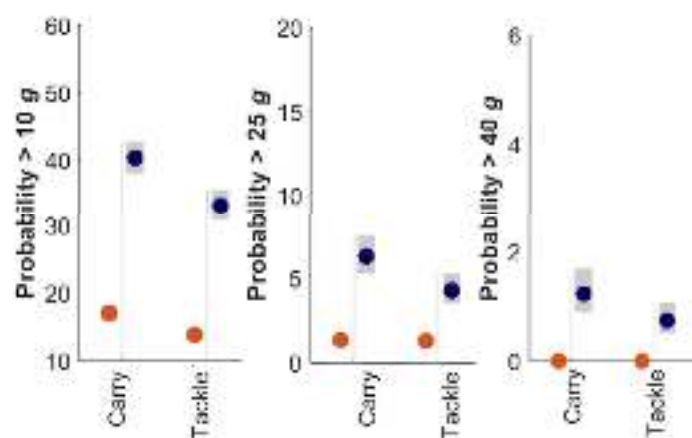
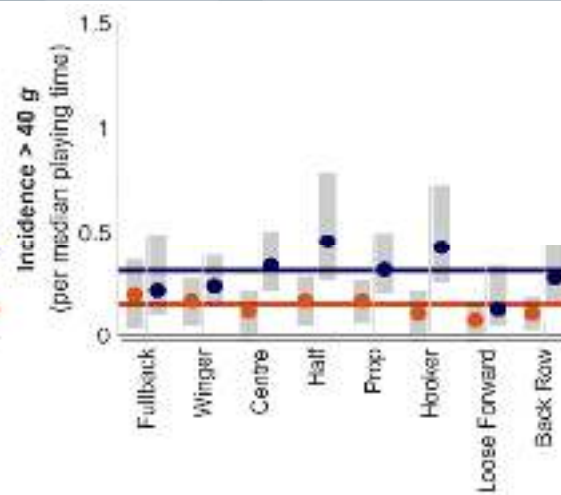
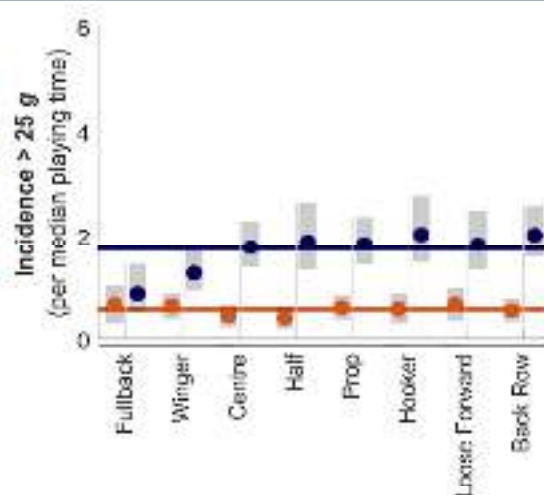
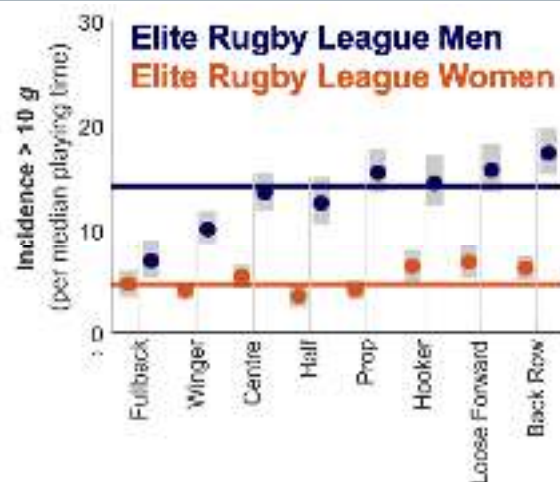


2021	Validity of iMGs
2022	2022: Yr 1/3 TaCKLE project (15-20% uptake)
2023	Yr 2/3 TaCKLE project (15-20% uptake)
2024	Yr 3/3 TaCKLE project (80% update), RFL implement 44 Brain Health Recommendations • Eg., Mandating iMGs (80% update) / FGE limits / Reduced tackle height (age-group & community)
2025	Yr 4/6 TaCKLE project; reconciling i) HAEs & FGEs and ii) HAEs & HIAs
2026	Yr 5/6 TaCKLE project; reducing i) HAEs and moving from FGEs and ii) using HAEs to identify HIAs

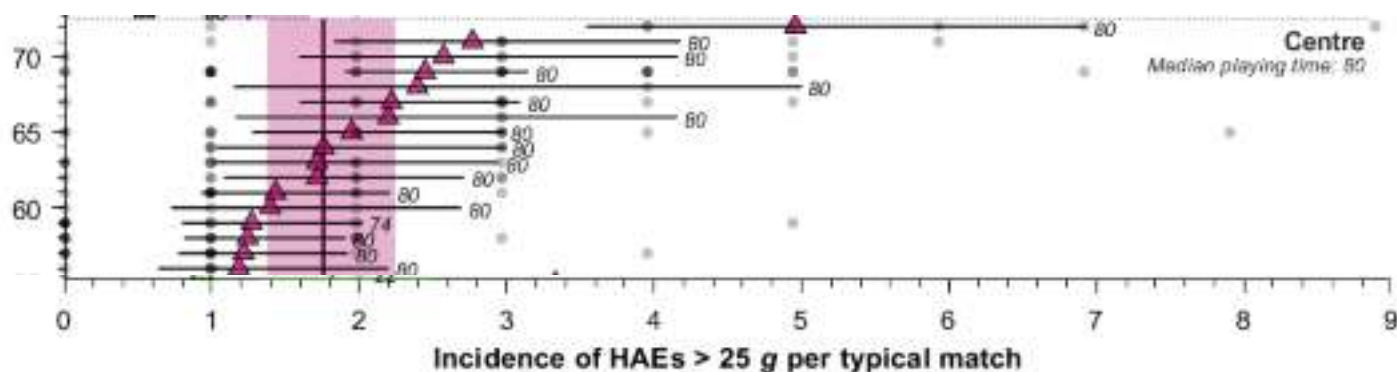
How many HAEs per time, how many per tackle?



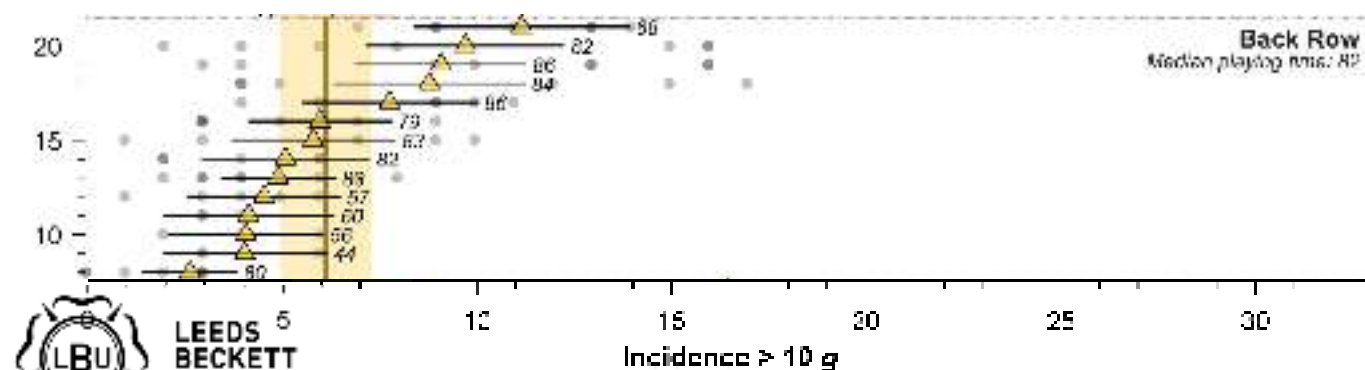
How many HAEs per time, how many per tackle?



How many HAEs per time, how many per tackle?

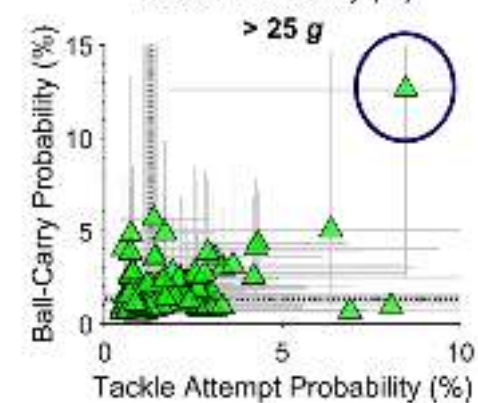


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LEAGUE**



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Women



Match exposure vs. HAE exposure



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[illegible]

Match exposure vs. HAE exposure



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Position	Age Group	FGE Groups Rank	Min (this season)	Tackles	Carries	Total Tackles and Carries	HAE percentiles (measured)	HAE percentiles (estimated)
Bob F	>22yrs							
Forward	>22yrs							
Forward	>22yrs							
Forward	>22yrs							
Forward	>22yrs							
Fred B	>22yrs							
Back	>22yrs							
Back	>22yrs							
Back	>22yrs							
Back	>22yrs							
Forward	19-22yrs							
Forward	19-22yrs							
Jeff F	19-22yrs							
Forward	19-22yrs							
Forward	19-22yrs							
Billy B	19-22yrs							
Back	19-22yrs							
Back	19-22yrs							
Back	19-22yrs							
Back	19-22yrs							

Match exposure vs. HAE exposure



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Position	Age Group	FGE Groups Rank	Min (this season)	Tackles	Carries	Total Tackles and Carries	HAE percentiles (measured)	HAE percentiles (estimated)
Bob F	>22yrs	1						
Forward	>22yrs	2						
Forward	>22yrs	3						
Forward	>22yrs	4						
Forward	>22yrs	5						
Fred B	>22yrs	1						
Back	>22yrs	2						
Back	>22yrs	3						
Back	>22yrs	4						
Back	>22yrs	5						
Forward	19-22yrs	1						
Forward	19-22yrs	2						
Jeff F	19-22yrs	3						
Forward	19-22yrs	4						
Forward	19-22yrs	5						
Billy B	19-22yrs	1						
Back	19-22yrs	2						
Back	19-22yrs	3						
Back	19-22yrs	4						
Back	19-22yrs	5						

Match exposure vs. HAE exposure



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Position	Age Group	FGE Groups Rank	Min (this season)	Tackles	Carries	Total Tackles and Carries	HAE percentiles (measured)	HAE percentiles (estimated)
Bob F	>22yrs	1	1273	521	138	659		
Forward	>22yrs	2	991	550	130	680		
Forward	>22yrs	3	1149	623	125	748		
Forward	>22yrs	4	1015	508	122	631		
Forward	>22yrs	5	1090	882	108	890		
Fred B	>22yrs	1	1200	272	42	314		
Back	>22yrs	2	1185	252	189	451		
Back	>22yrs	3	966	207	116	323		
Back	>22yrs	4	1040	157	105	266		
Back	>22yrs	5	1120	54	246	300		
Forward	19-22yrs	1	1108	352	163	520		
Forward	19-22yrs	2	963	448	64	542		
Jeff F	19-22yrs	3	685	382	105	558		
Forward	19-22yrs	4	759	281	113	394		
Forward	19-22yrs	5	375	204	19	223		
Billy B	19-22yrs	1	1200	60	256	314		
Back	19-22yrs	2	865	222	143	365		
Back	19-22yrs	3	1054	69	139	208		
Back	19-22yrs	4	795	109	107	216		
Back	19-22yrs	5	728	55	147	202		

Match exposure vs. HAE exposure



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Position	Age Group	FGE Groups Rank	Min (this season)	Tackles	Carries	Total Tackles and Carries	HAE percentiles (measured)	HAE percentiles (estimated)
Bob F	>22yrs	1	1273	821	138	609	95	96
Forward	>22yrs	2	991	560	130	680	99	98
Forward	>22yrs	3	1149	623	125	748	0	90
Forward	>22yrs	4	1015	508	122	631	92	89
Forward	>22yrs	5	1090	882	108	800	98	99
Fred B	>22yrs	1	1200	272	42	314	36	34
Back	>22yrs	2	1185	282	189	451	76	84
Back	>22yrs	3	966	207	116	323	0	58
Back	>22yrs	4	1040	157	105	266	67	61
Back	>22yrs	5	1120	54	246	300	87	82
Forward	19-22yrs	1	1108	352	163	520	91	89
Forward	19-22yrs	2	963	448	84	542	0	95
Jeff F	19-22yrs	3	688	382	108	558	99	100
Forward	19-22yrs	4	759	281	113	394	88	85
Forward	19-22yrs	5	375	204	19	223	50	46
Billy B	19-22yrs	1	1200	60	256	314	80	90
Back	19-22yrs	2	868	222	143	365	66	61
Back	19-22yrs	3	1054	69	139	208	86	82
Back	19-22yrs	4	795	109	107	216	55	51
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Match exposure vs. HAE exposure



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Forward	>22yrs	2	991	560	130	680	99	98		Forward	>22yrs	5	1090	892	108	800	98	99
Forward	>22yrs	3	1149	623	125	748	0	90		Forward	>22yrs	2	991	550	130	680	99	98
Forward	>22yrs	4	1015	509	122	631	92	89		Bob F	>22yrs	1	1273	521	138	659	95	96
Forward	>22yrs	5	1090	892	108	800	98	99		Forward	19-22yrs	2	963	448	84	542	0	95
Fred B	>22yrs	1	1200	272	42	314	36	34		Forward	>22yrs	3	1149	623	125	748	0	90
Back	>22yrs	2	1188	252	199	451	76	84		Billy B	19-22yrs	1	1200	60	254	314	80	90
Back	>22yrs	3	966	207	116	323	0	58		Forward	>22yrs	4	1015	509	122	631	92	89
Back	>22yrs	4	1040	157	109	266	67	61		Forward	19-22yrs	1	1108	357	183	520	91	89
Back	>22yrs	5	1120	54	246	300	87	82		Forward	19-22yrs	4	769	201	113	394	88	85
Forward	19-22yrs	1	1108	357	183	520	91	89		Back	>22yrs	2	1188	252	199	451	76	84
Forward	19-22yrs	2	963	448	84	542	0	95		Back	>22yrs	5	1120	54	246	300	87	82
Jeff F	19-22yrs	3	666	392	156	558	99	100		Back	19-22yrs	3	1054	69	139	208	86	82
Forward	19-22yrs	4	759	281	113	394	88	85		Back	>22yrs	4	1040	157	109	266	67	61
Forward	19-22yrs	5	379	204	19	223	50	46		Back	19-22yrs	2	606	222	143	365	66	61
Billy B	19-22yrs	1	1200	60	254	314	80	90		Back	>22yrs	3	966	207	116	323	0	58
Back	19-22yrs	2	896	222	143	365	66	61		Back	19-22yrs	5	728	55	147	202	54	55
Back	19-22yrs	3	1054	69	139	208	86	82		Back	19-22yrs	4	795	109	107	216	55	51
Back	19-22yrs	4	795	109	107	216	55	51		Forward	19-22yrs	5	379	204	19	223	50	46
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Practical Feedback to Clubs



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Super League Head Acceleration Event (HAE) Report: Leeds
Start of 2025 season to 11 July 2025

Minutes Played	Tackle Attempts	Catches Made	Successful Kicks	Estimated HAEs (Percentage)
813	413	150	580	438 (97%)
714	452	158	586	358 (97%)
825	448	150	580	358 (97%)
703	477	73	587	321 (96%)
738	714	136	577	300 (96%)
878	259	132	582	300 (96%)
808	743	88	531	301 (96%)
757	458	122	586	287 (96%)
815	418	157	57	280 (97%)
754	778	211	541	261 (97%)
801	258	148	277	217 (94%)
718	33	333	0	180 (96%)
737	243	24	0	188 (96%)
700	84	285	0	184 (96%)
700	18	273	0	171 (95%)
657	243	138	30	128 (91%)
652	243	28	180	128 (91%)
263	110	27	0	81 (96%)
413	208	115	18	74 (96%)
268	108	24	0	75 (96%)
257	0	45	0	60 (96%)
70	0	3	15	70 (96%)

**Estimated
HAEs
(Percentile)**

468 (97%)



>40 g



25 - 40 g



10 - 25 g



**Estimated HAEs
from matches with
missing data**

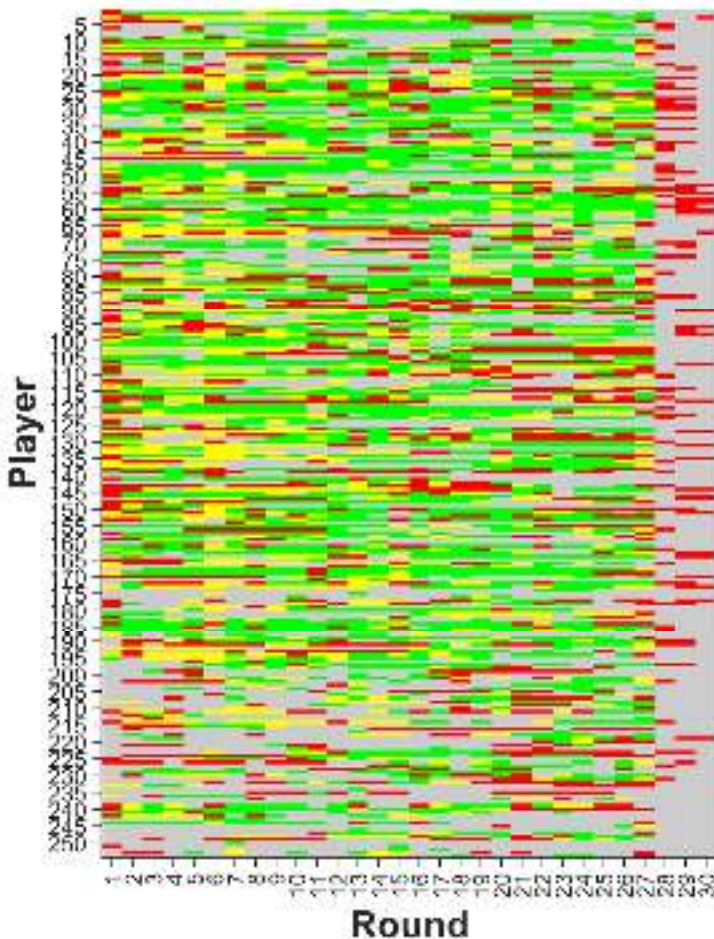
 >40 g
  25 - 40 g
  10 - 25 g
  Estimated HAEs from matches with missing data



What does mandated iMG data look like



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- 254 players wore an iMG for at least one match
- These players collectively participated in 4,356 player matches
- iMG data were recorded in 72.52% of these matches
- Of these player matches, 31.41% were deemed invalid due following sanity checks using proximity sensor data to:
 - Ensure that the iMG was worn throughout the entire match
 - Ensure proper fit of the iMG

Super League 2024



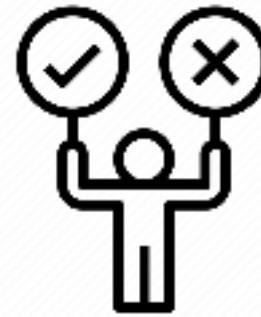
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**Device
faults**



**Improper
charging**



**Player
Choice**



**Data
Corruption**

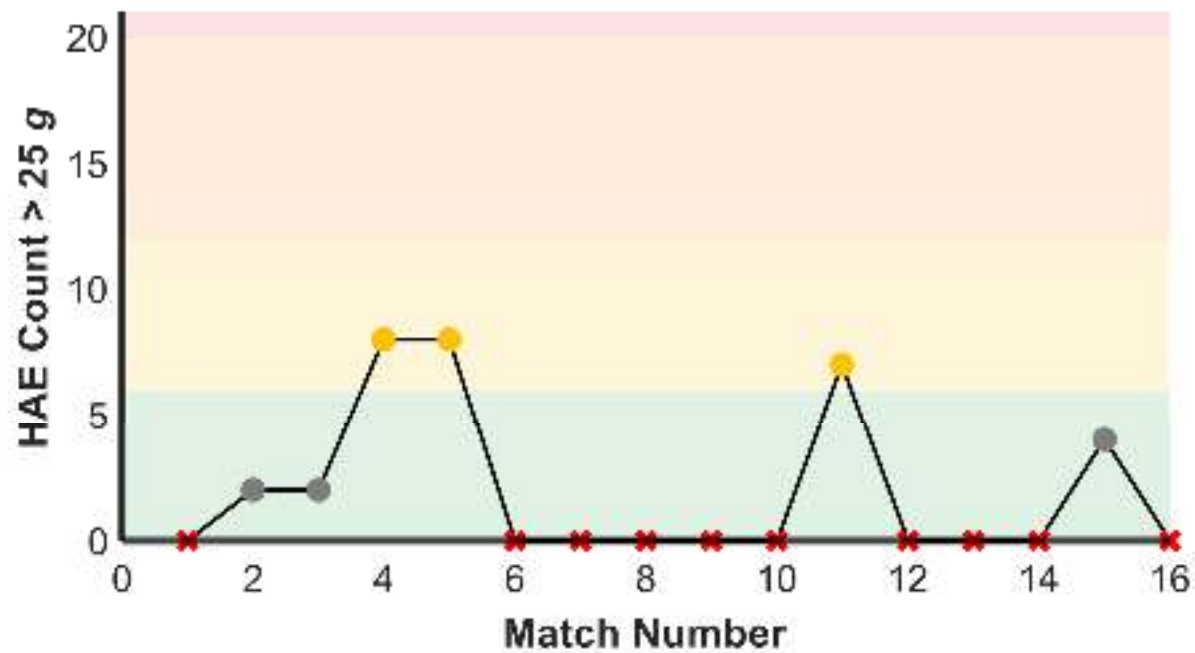
The problem



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X No iMG data despite playing



Solution: Predictive modelling



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$$\text{HAE count} \sim \text{minutes} + \text{tackles} + \text{carries} + (1|\text{match}) \\ + (1|\text{position}) + (1|\text{player})$$

Per player match:

- n minutes
- n tackles
- n carries
- Match
- Position
- Player identifier



Generalised linear
mixed model (GLMM)

HAE Count (> 10 g)

HAE Count (> 25 g)

HAE Count (> 40 g)

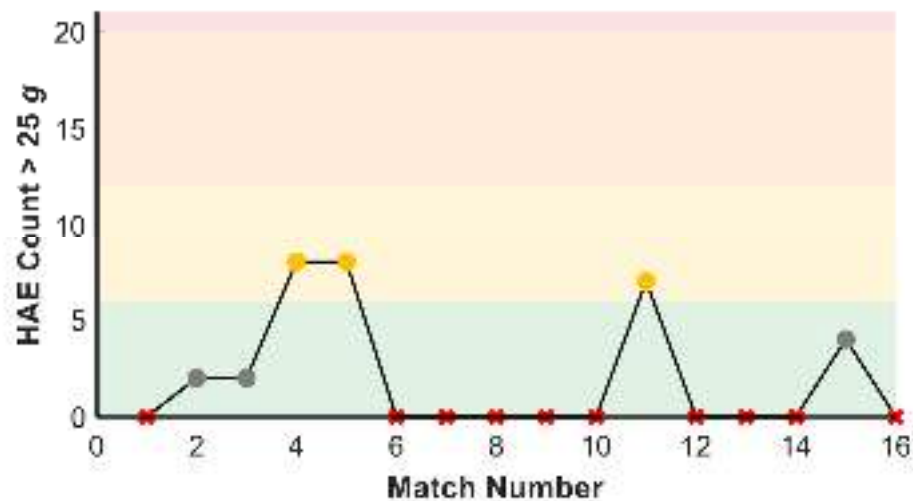
Implementation of imputation



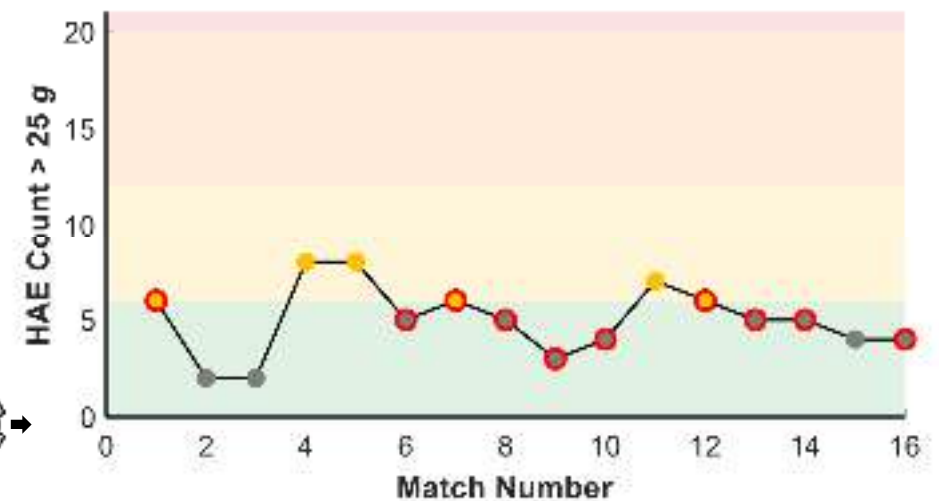
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✗ No iMG data despite playing



Imputed HAE counts



The challenge with WSL



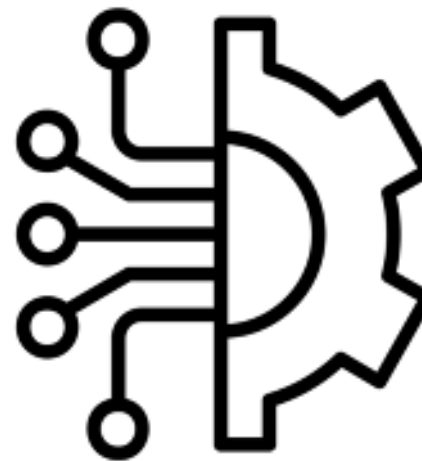
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$$\text{HAE count} \sim \text{minutes} + \text{tackles} + \text{carries} + (1|\text{match}) \\ + (1|\text{position}) + (1|\text{player})$$

Per player match:

- n minutes
- ~~n tackles~~
- ~~n carries~~
- Match
- Team
- Player identifier



Generalised linear
mixed model (GLMM)

HAE Count (> 10 g)

HAE Count (> 25 g)

HAE Count (> 40 g)

WSL: Measured percentile



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Position	Age Group	HAE percentiles (measured)	HAE percentiles (estimated)
Jeff F	19-22yrs	99	100
Forward	>22yrs	98	99
Forward	>22yrs	99	98
Bob F	>22yrs	95	96
Forward	19-22yrs	0	95
Forward	>22yrs	0	90
Billy B	19-22yrs	80	90
Forward	>22yrs	92	89
Forward	19-22yrs	91	89
Forward	19-22yrs	88	85
Back	>22yrs	76	84
Back	>22yrs	87	82
Back	19-22yrs	86	82
Back	>22yrs	67	61
Back	19-22yrs	66	61
Back	>22yrs	0	58
Back	19-22yrs	54	55
Back	19-22yrs	55	51
Forward	19-22yrs	50	46
Fred B	>22yrs	36	34

- All data is accessible and can be analysed.
- Identifies players with the highest recorded exposure that may be at risk.
- Misses' exposure when device not worn
- Players who never wear a device are neglected/players with good compliance get over exposed

WSL: Position estimation



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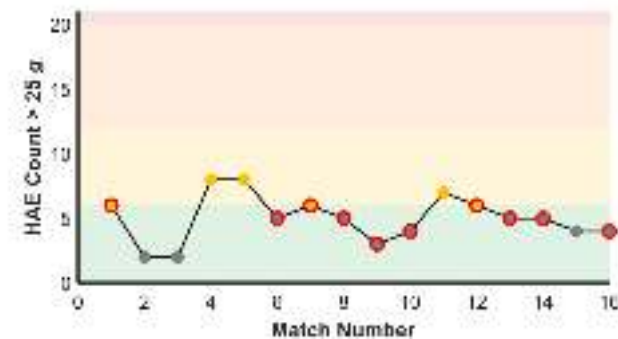


Per player match:

- n minutes
- Team
- Position



Generalised linear
mixed model (GLMM)



$$HAE\ count \sim minutes + (1|match) + (1|position)$$

- Allows for the inclusion of players that choose not to wear an iMG with an estimate based on match and position average.
- Fails to capture the individual differences observed within position.

WSL: Position estimation



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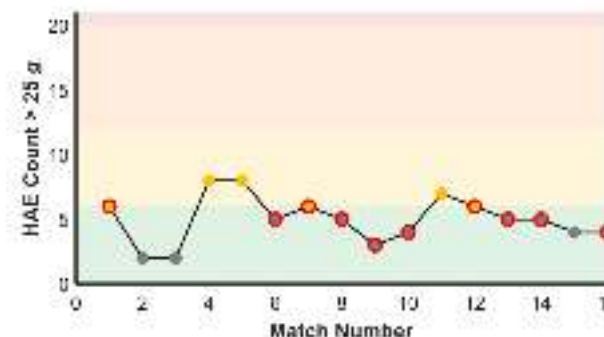


Per player match:

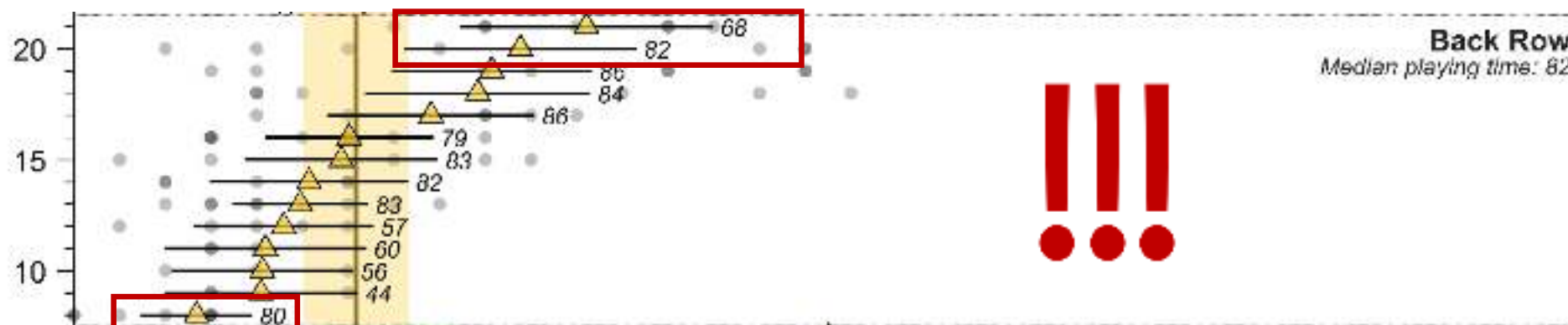
- n minutes
- Team
- Position



Generalised linear
mixed model (GLMM)



$$HAE\ count \sim minutes + (1|match) + (1|position)$$



WSL: Individual estimation



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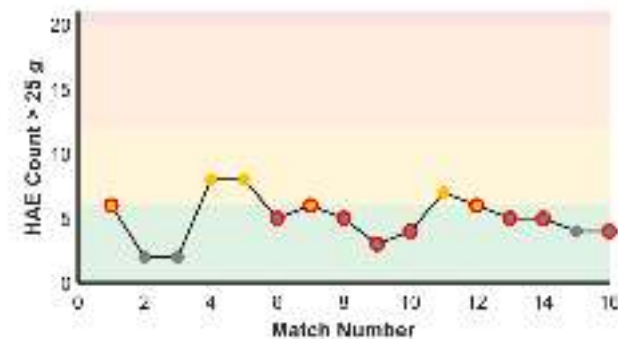


Per player match:

- *n* minutes
- Team
- Position
- **Player**



Generalised linear
mixed model (GLMM)



$$HAE\ count \sim minutes + (1|team) + (1|player) + (1|position)$$

- Provides an individualised estimate for that player in the event of a broken device.
- Cannot be used for players that have not worn the device for at least a few matches.

Summary



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- Pragmatic approaches can be used to measure and manage player exposure to head acceleration events.
- Individualised estimations of head acceleration event exposure can be obtained using robust statistical analysis when missing data are present.
- Players should be encouraged to wear mouthguard to support player management.