Quantifying Elite Athlete Performance based on Munster Rugby GPS Data

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Motivation for Quantitative Analysis in Professional Sports Training

The use of Global Positioning Systems (GPS) are rapidly emerging in professional sports [1-3] to facilitate the analysis of athlete performance in competitive matches and training sessions. As athletes respond differently to training techniques due to varying styles, demands and biological factors, this drives the requirement for individualised and position specific training programmes thereby maximising gains, in contrast to the "one for all" model traditionally employed. Recent research has utilised GPS to assess the demands of competitive games, measure exertion and plan recovery strategies [4,5] while others have combined GPS and biochemical markers like creatine kinase (an energy carrier) [6].

The presented research analyses the performance of the Munster Rugby Team from 22 Catapult MinimaxS4 GPS units that gather approximately 350 parameters of data overall and which is split into minute blocks during training sessions and matches. The presented analysis is based on data across 28 games (resulting in 88,364 data points) by examining 4 key performance parameters.:

1) Odometer (Distance)   2) HI (High Impact) Acceleration   3) High Speed Running (HSR)   4) Number of Tackles

Odometer and HSR (>4.4m/s) are represented in metres. HI Acceleration is a combination of both acceleration and deceleration events (achieved by reaching $\pm$ 5m/s^2). The values represent summed occurrences of HI Acceleration events.

Fig 1: Munster Players wearing GPS

Fig 2: GPS MinimaxS4 Units

Position-Specific Requirements

Odometer	Lock	Hook	B'Row	Centre	Back 3	Half	No. 10
Mean	57.85	53.10	58.53	64.47	69.87	66.44	61.32
Median	53	50	56	62	67	60	56
95% Confidence	53	48	54	60	66	58	54
Interval	57	52	57	63	69	63	59
Std. Deviation	38.69	40.15	36.74	36.88	39.29	48.44	41.65
Minimum	1	1	1	1	1	1	1
Maximum	251	409	314	244	281	424	232

Table 1: Odometer – Specific positions (metres/min).

Table 1 shows the **mean and median distance travelled in metres per minute per position**. This indicates the requirements of a position. Confidence intervals are based on the median as the data is not normally distributed.

Forward Requirements

Season mean and median odometer results for overall forwards and specific forward positions are now shown

Graphs **3(A-D)** depict the median odometer (metres/min) values of the forwards, with the data divided into minute blocks. The minutes intervals are the mean for the games throughout the season.

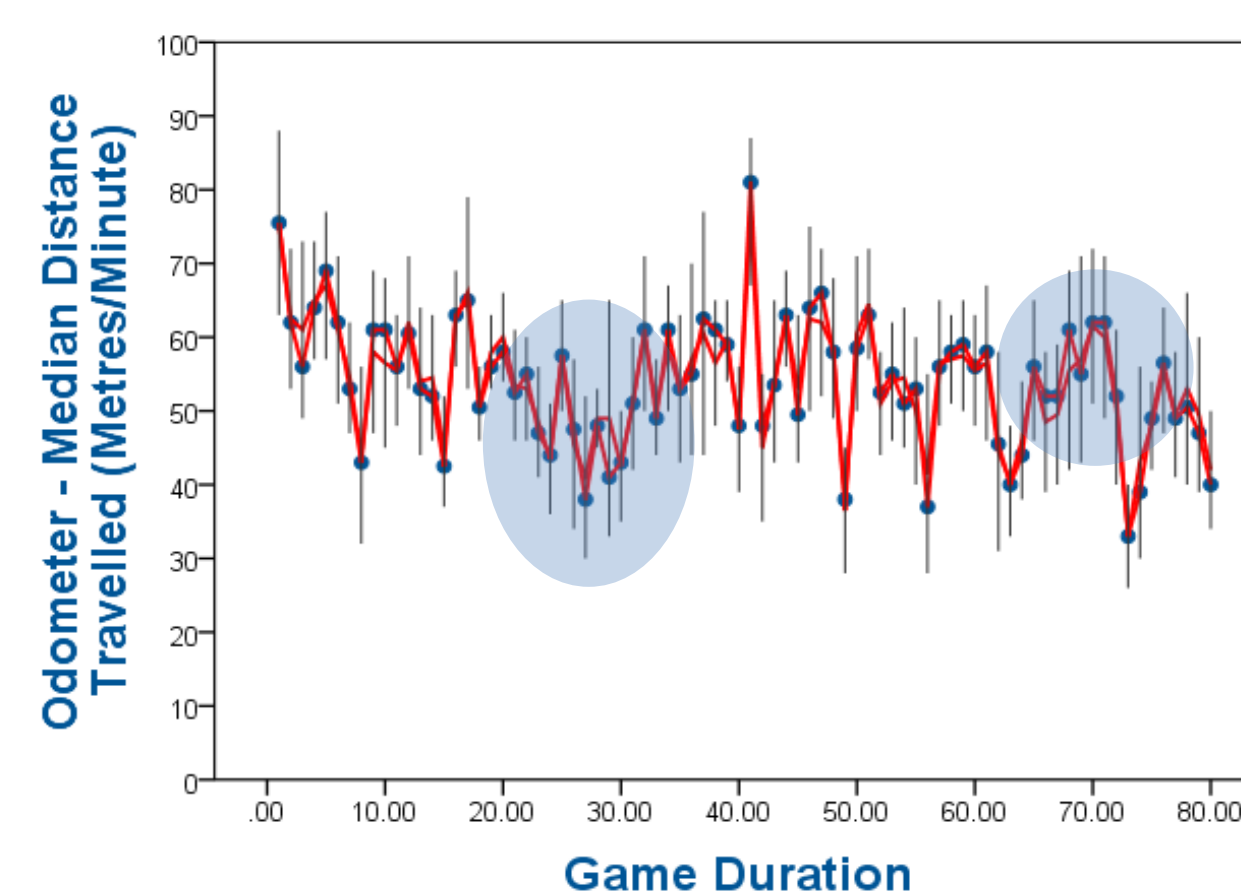Figure **3(A)** is the median for the overall forwards while Figures **3(B-D)** are specific forward positions

Fig 3 (A)

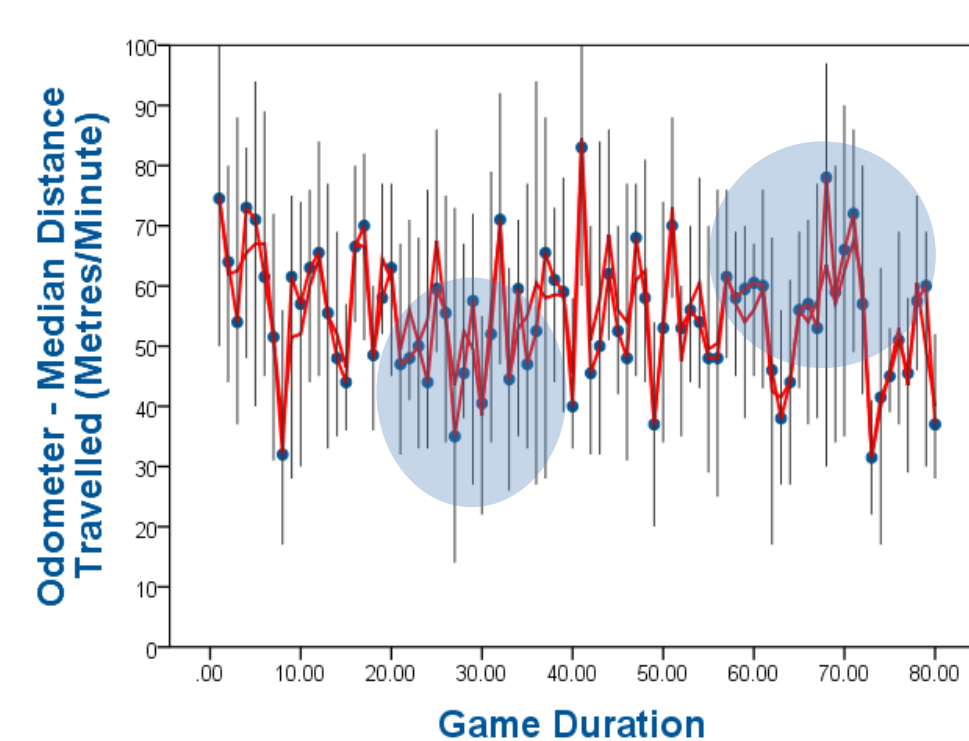**B) Lock   C) Hook   D) Back-Row**
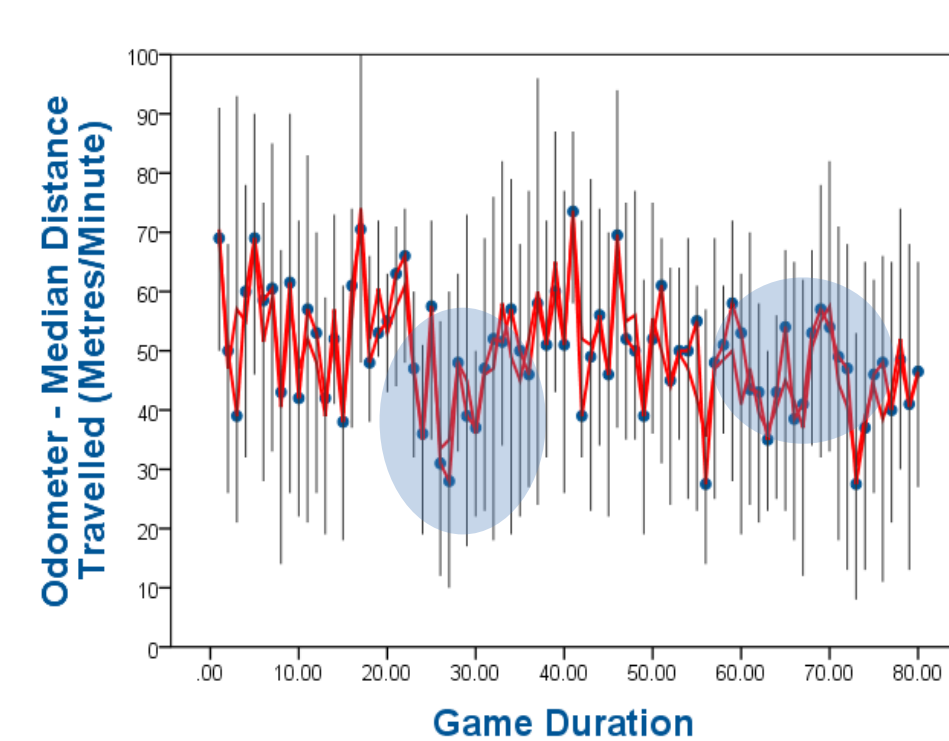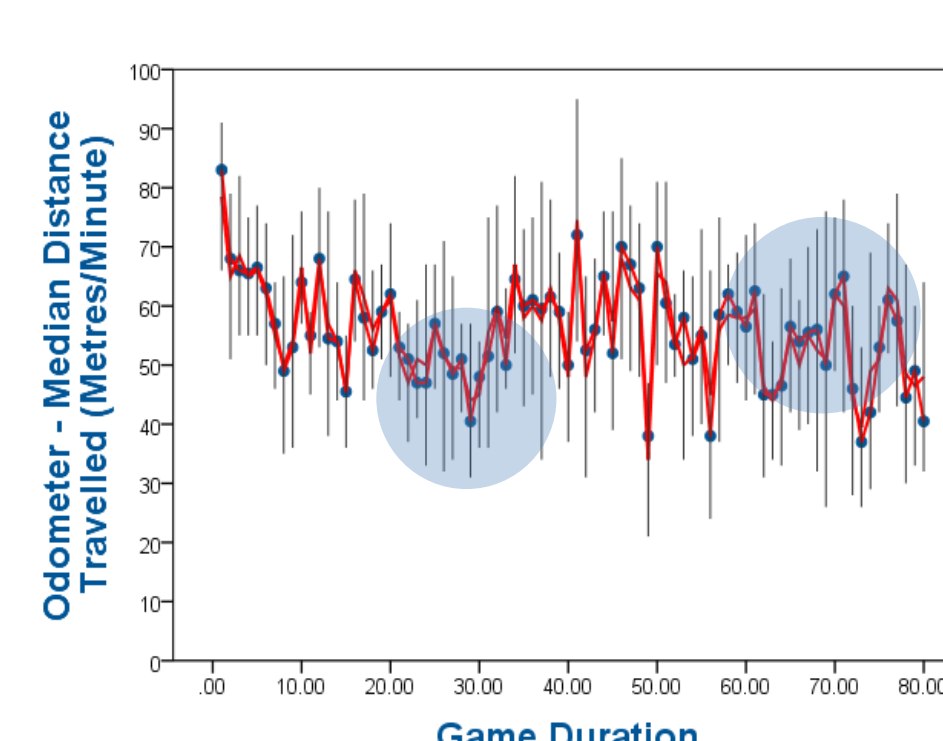
Fig 3 (B)   Fig 3 (C)   Fig 3 (D)

- A decline in performance is noted at the midpoint of the 1st half of the game. At specific positions (micro level), the decrease occurs for each position.
- A peak is observed at the midpoint of the 2nd half and is greatest in the lock position. This peak does not occur however in the hook position. This is an expected result as hook players are often replaced after 60 minutes.
- This highlights the fitness of the locks to perform greatest at crucial periods of the game

Player Profile: Peter O'Mahony
2012/2013 - Season Statistics

Date of Birth:	17th September 1989
Birthplace:	Cork, Ireland
Height:	1.91m
Weight:	108kg
Position:	Back Row (Forward)
Munster Caps:	46
Ireland Caps:	16

Fig 4: Player Profile: Graphs **4(A-D)** represent Peter O Mahony's statistics for the season (median) for each minute of game.
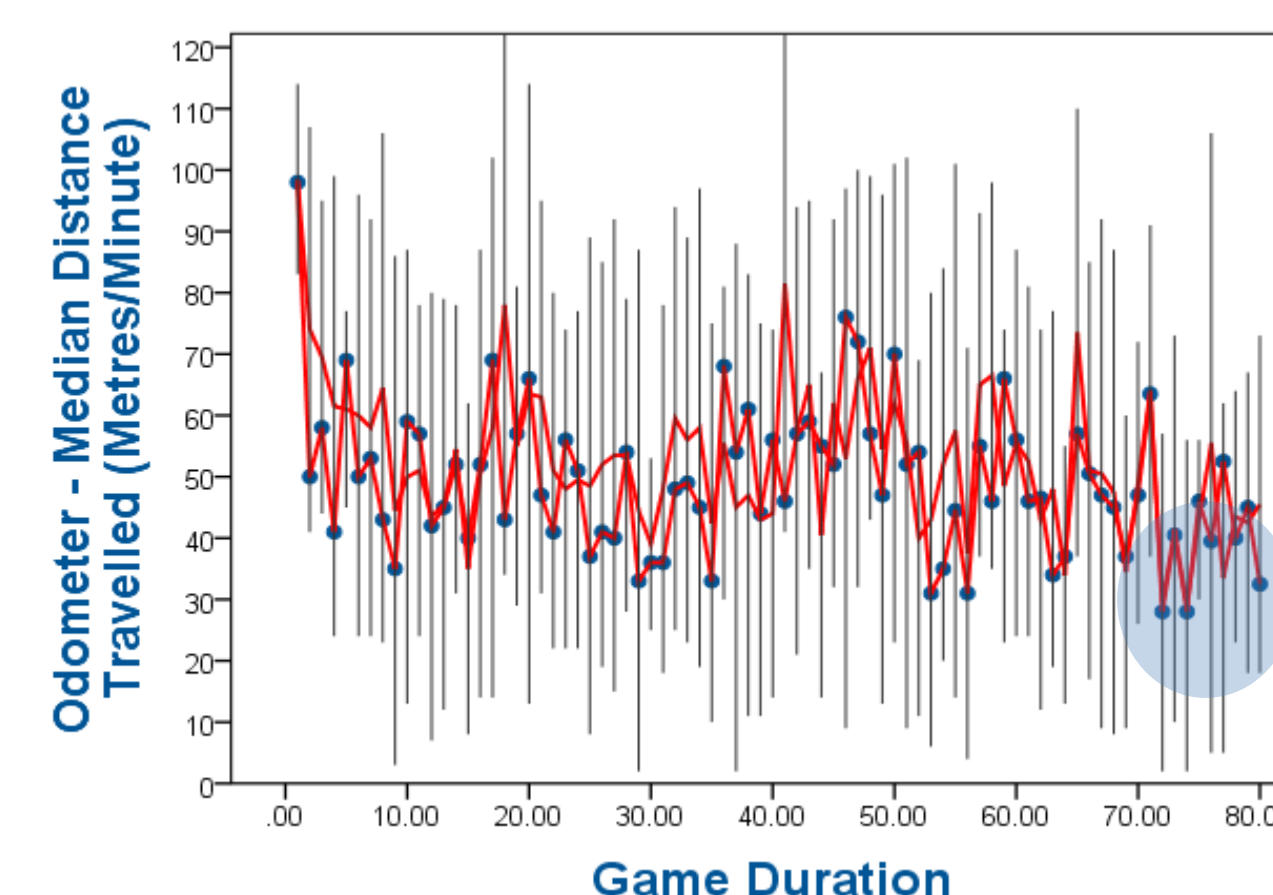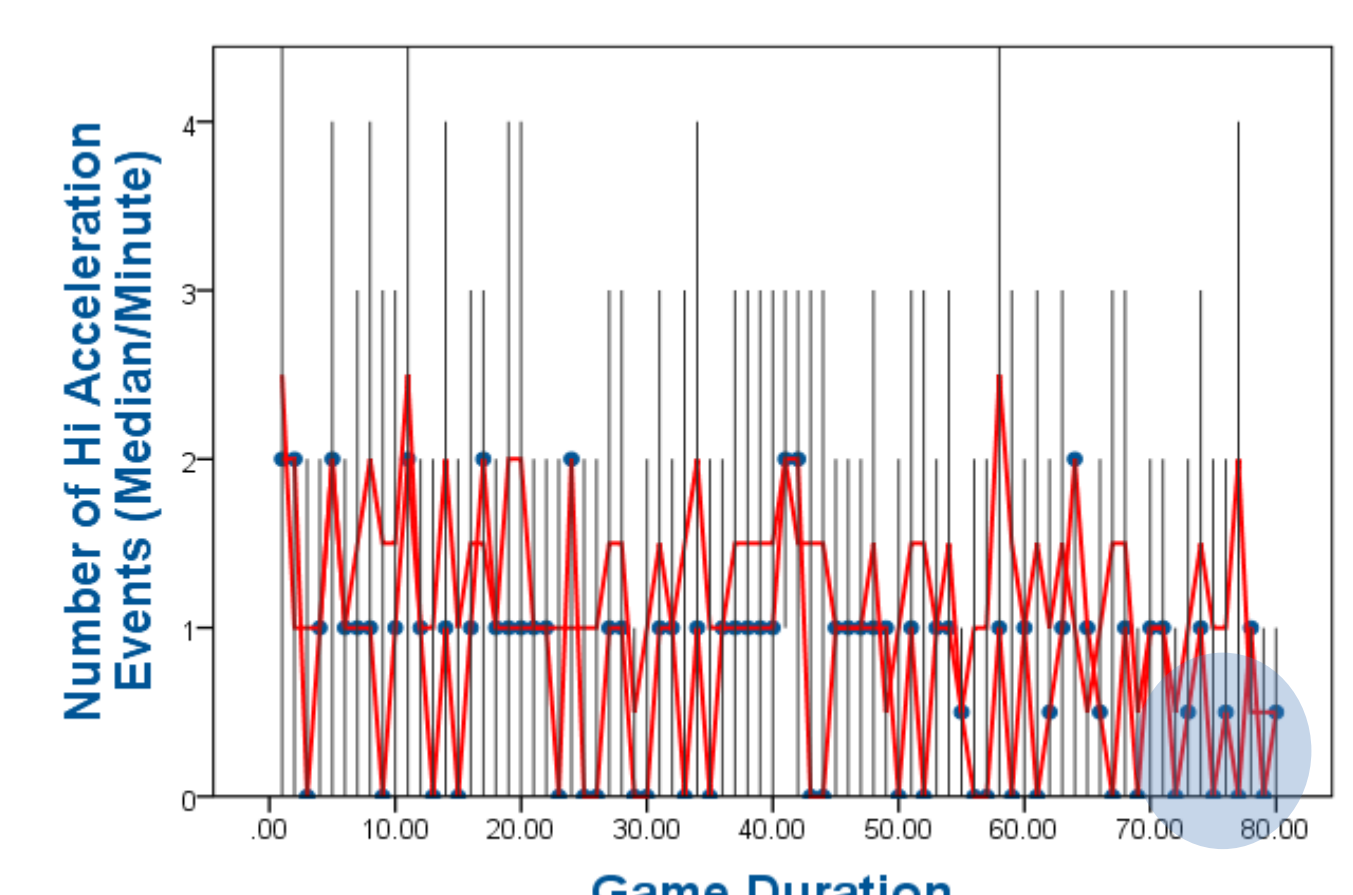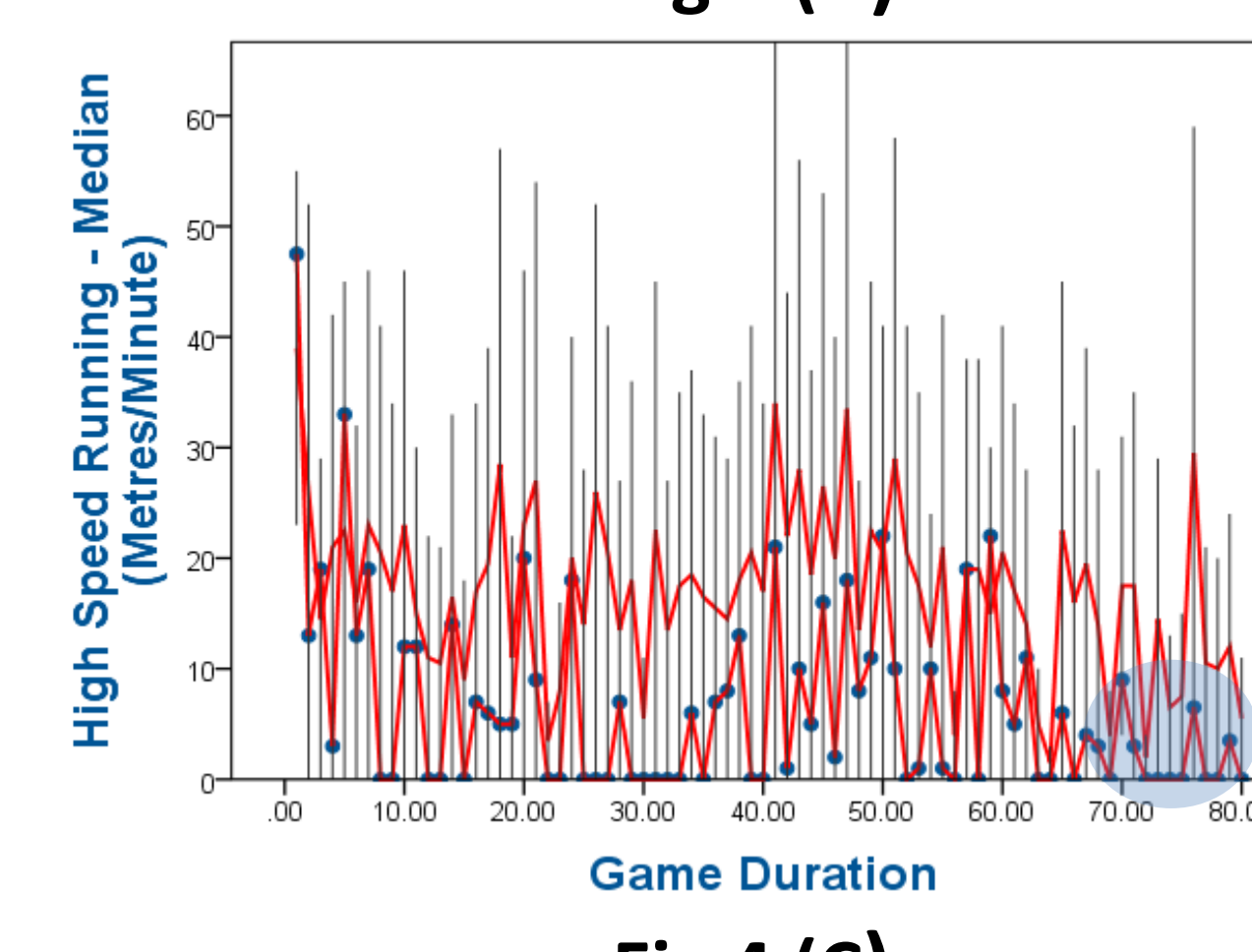
Fig 4 (A)   Fig 4 (B)
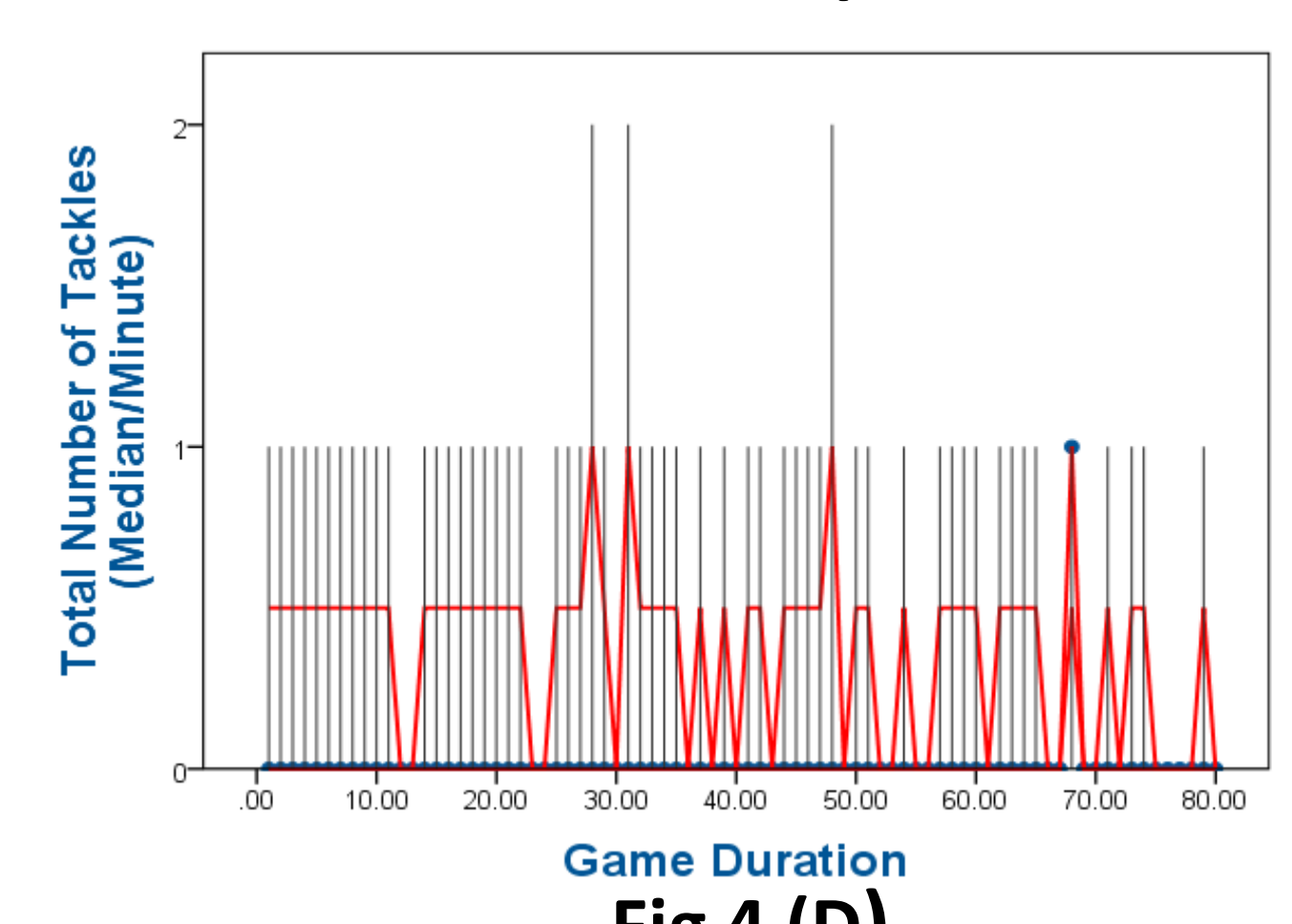
Fig 4 (C)   Fig 4 (D)

- The odometer results are analysed in conjunction with Fig 3(D) as the player is in the Back Row. The data points are consistently scattered around 50m. This is below the 56m median shown in Table 1 and Fig 3(B) i.e. indicating decreased player movement.
- It can be noted that tackles are consistent throughout showing determination and awareness.
- The odometer, HI acceleration and HSR results are consistent until the final 10 minutes of the second half where they decrease may be due to fatigue.

Future Analysis

- Identify "worst case scenario" to be used to design circuits and monitor player improvements. Highlight differences between perceived "easier" and "hard" games
- Training session classification e.g. power, agility, conditioning etc.
- GPS for Recovery analysis, injury rehabilitation strategies and nutritional interventions
- Analysis of subjective (RPE) and objective data (GPS) along with coaches ratings to optimise dose of training required for optimal performance

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Acknowledgments