COMPARISON OF EXTERNAL LOAD VARIABILITY IN INJURED AND UNINJURED YOUTH ELITE FOOTBALL MALE ATHLETES: A CROSS-SECTIONAL STUDY

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INTRODUCTION

- Football's high-intensity nature increases the risk of injuries, especially non-contact soft tissue injuries to the lower limbs, with physical, financial, and psychological impacts on players [1-2].
- External load monitoring has gained relevance due to its accessibility and objectivity, helping to optimize training–recovery ratios and improve performance [3].
- GPS-based metrics—such as total distance (TD), high-speed running (HSR), sprint distance, and acceleration/deceleration (ACC/DCC)—are widely used [4–5], though current evidence linking them to injury risk is limited [6].
- Traditional external load measures often fail to capture the dynamic distribution of workload across days and weeks. Nonlinear analysis methods can reveal hidden fluctuations [7-8], providing deeper insights into load–recovery cycles.

AIMS

- This study aimed to investigate the external load temporal dynamics between non-injured and injured football athletes, ten sessions before the injury event. Although this study is mostly exploratory, we anticipated that injured athletes would exhibit greater randomness in their patterns.

MATERIALS & METHODS

- **Participants**: 38 elite male youth football players (ages 13–24) from a top Portuguese academy (U14–B Team).
- **Study Design**: Retrospective cross-sectional study. One full season. *Inclusion Criteria*: age 13-24; football elite players; male; injuries to lower limbs. *Exclusion Criteria*: contact injuries; reinjuries; Currently injured or in a recovery process.
- **Data Collection & Management**: Medical staff collected Injury data daily following the FIFA consensus [9]. External load data collected daily by GPS units (STATSports APEX, 10 & 18 Hz) placed between the scapulae. Processed with STATSports Sonra software [10].
- **Data Analysis:** Data cropped and merged (10-day sessions) and processed in MATLAB (R2008b), variables compared between injured and non-injured athletes. Detrended Fluctuation Analysis (DFA) computed fractal scaling exponent α for velocity time series [11].
- **Statistical Analysis:** Descriptive stats (mean ± SD); Shapiro-Wilk for normality; Levene's test for homogeneity; Independent t-tests (Jamovi v1.6); Significance: p < .05.

Figure 1. *GPS (Apex unit models) and harness.*

RESULTS & CONCLUSIONS

- The results from linear GPS variables, mean and standard deviation between the two groups weren't statistically significant. On the other hand, the values from non-linear metrics, such as Detrended Fluctuations Analysis, showed that the alpha from the injured players was significantly lower (0.84±0.03) compared to non-injured players (0.86±0.03, $p<0.05$). We have observed greater randomness in the temporal structure of injured athletes. This study concluded that integrating these metrics may make GPS technology an even more effective tool for injury prevention and possible daily monitoring. Future studies should validate these findings in larger cohorts, consider other sports contexts, and explore combinations of nonlinear dynamics with subjective and physiological fatigue indicators to build a more holistic model of injury risk.

Table 1. Results from the External Load Variables.

Variables	Injured	Noninjured	95% CI	*p*	Effect size
TD (m)	45806±10636	46258±12775	−0.119 to 0.906	0.906	−0.0385
HSR (m)	2307±1097	2499±1049	−0.553 to 0.584	0.584	−0.1793
Sprint (m)	481±373	575±371	−0.781 to 0.440	0.440	−0.2536
V80 (m)	223±263	239±167	−0.230 to 0.821	0.820	−0.0745
AD2 (m)	8497±2039	8678±2818	−0.228 to 0.821	0.821	−0.0739
AD3 (m)	812±160	852±311	−0.506 to 0.616	0.616	−0.1641
Alpha	0.84±0.03	0.86±0.03	−2.144 to 0.039	0.039*	−0.6955

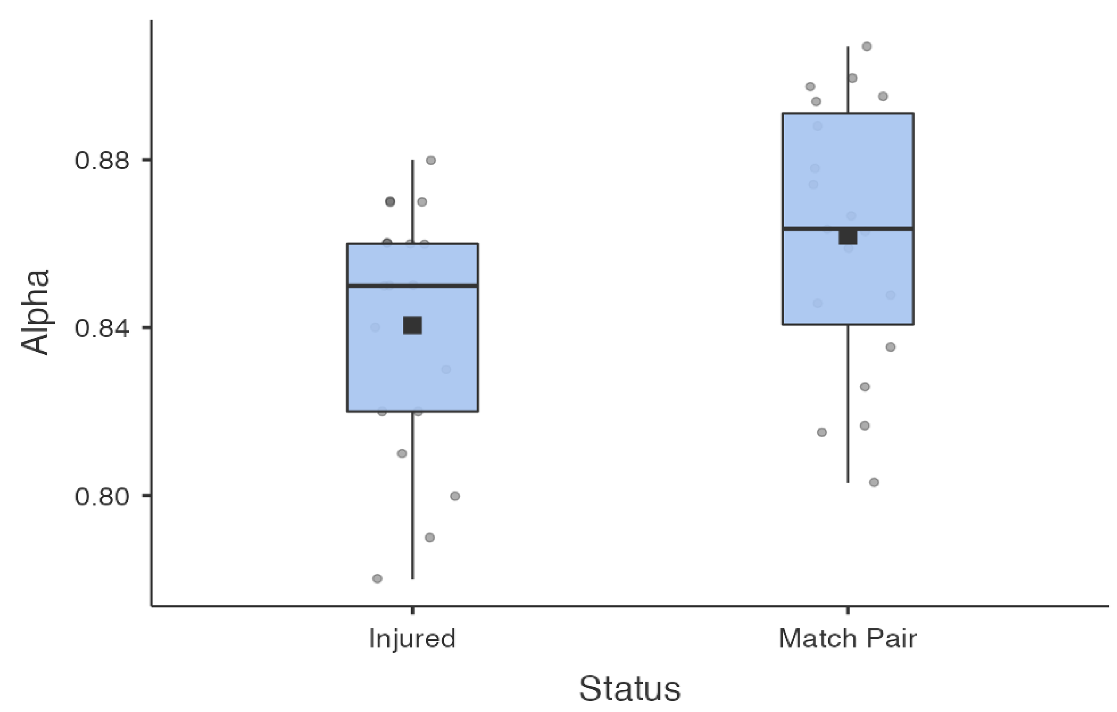

Figure 2. Box plot of the mean values differences between the groups on DFA alpha (α).

REFERENCES

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