

1 **Manuscript title:** Influence of opponent ranking on the physical demands encountered during  
2 Ultimate Frisbee match-play

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32 **Influence of opponent ranking on the physical demands encountered during Ultimate**  
33 **Frisbee match-play**

34

35 **Abstract**

36 There is a lack of evidence regarding the match demands encountered in elite Ultimate Frisbee  
37 (UF) overall and dependent upon opponent ranking. These data may be useful to elite UF  
38 coaches to implement optimal training loads and recovery strategies. Therefore, this study  
39 quantified the physical demands of elite UF match-play and analysed differences in demands  
40 according to opponent ranking. Twelve UF players from the same national team participated in  
41 the study. An observational design was used to compare the physical demands encountered by  
42 players between opponents carrying different rankings (1st, 3rd, 4th, and 5th) during four  
43 official matches in a 5-team competition. No significant differences ( $p > 0.05$ ) in sprinting and  
44 repeated-sprinting activity were evident across UF matches between opponents. In contrast, a  
45 higher (*moderate-large*) quantity and greater intensities of body impacts were observed in UF  
46 matches played against higher-ranked (1st) compared to lower-ranked teams (3rd, 4th, and 5th).  
47 Additionally, greater (*moderate-large*) PL and metabolic power were observed in matches  
48 played against higher-ranked (1st) compared to lower-ranked teams (3rd and 4th). These  
49 findings suggest coaches may need to reduce the training loads in the next days after the  
50 matches played against higher-ranked opponents compared to when facing lower-ranked  
51 opponents.

52

53 **Word Count:** 199

54

55 **Keywords:** external loads; sprints; impacts; metabolic power; Player Load.

56

57 **Introduction**

58 Ultimate Frisbee (UF) is considered an alternative, hybrid, non-contact sport as it contains rules,  
59 movements, and physical demands indicative of more common team sports such as rugby,  
60 basketball, netball, and football (Scanlan, Kean, Humphries, & Dalbo, 2015). The popularity  
61 and professionalism of UF has grown since its development in 1967 (Marfleet, 1991), with  
62 many competitions now held at regional, national, and international levels (Griggs, 2009). [This](#)  
63 [team sport](#) is played by millions of people in approximately 50 countries around the world  
64 (Scanlan et al., 2015). [Official matches are](#) administered on a soccer-sized pitch between two  
65 teams of seven players (Krustrup & Mohr, 2015) aiming to score goals by passing a flying disc  
66 (or Frisbee<sup>TM</sup>) and catching it in the attacking end-zone (Madueno, Kean, & Scanlan, 2017).  
67 Matches are completed when the first team reaches 15 goals with at least a two-goal advantage  
68 or when a pre-defined playing duration is met (i.e. 60 min) (WFDF, 2016). Therefore, the  
69 duration of UF matches can vary depending on the score ([e.g., from 53 min to 75 min](#)), which  
70 may dictate the physical demands encountered by players.

71 In team sports, when quantifying the physical demands encountered during match-play,  
72 high-intensity actions are particularly useful to measure given they can occur in critical match  
73 situations such as creating passing options to facilitate goal opportunity (Faude, Steffen,  
74 Kellmann, & Meyer, 2014). During a UF match, players undertake intermittent activity  
75 involving sprints, accelerations, decelerations, changes-of-direction, jumps, and lateral  
76 displacements (Krustrup & Mohr, 2015; Scanlan et al., 2015). In fact, collegiate, male UF  
77 players cover  $4.70 \pm 0.47$  km, including  $\sim 600$  m of high-intensity running ( $14\text{--}22 \text{ km}\cdot\text{h}^{-1}$ ) and  
78  $\sim 200$  m moving above  $22 \text{ km}\cdot\text{h}^{-1}$  during match-play (Krustrup & Mohr, 2015). Furthermore,  
79 recreational, male and female players undergo high physical loading across all movement  
80 planes covering  $\sim 3$  km during match-play estimated with accelerometry (Madueno et al.,  
81 2017). Although the physical demands regarding the distance covered at different speeds and

82 loading experienced by players has been examined during collegiate (Krustrup & Mohr, 2015)  
83 and recreational (Madueno et al., 2017) UF matches, reporting a wider range of variables in  
84 higher competitions, such as at the national level, is necessary to understand the precise physical  
85 demands imposed in elite UF players to maximise their on-field performance.

86 In recent years, advances in match analysis technology have provided valid and reliable  
87 methods to assess activity profiles and mechanical load in team sport players during matches  
88 (Malone, Lovell, Varley, & Coutts, 2017). Although video based-tracking technology and local  
89 positioning systems (i.e. indoor global positioning systems (GPS)) are available to use, their  
90 high cost for installation and operation, as well as the potential time-consuming requirements  
91 for data acquisition and/or system setup make them practically challenging to use in quantifying  
92 the physical demands during match-play (Beato, Jamil, & Devereux, 2018; Fox, Scanlan &  
93 Stanton, 2017). Thus, the integration of accelerometers with GPS technology in micro-sensors  
94 have allowed the physical demands encountered in team sport match-play to be readily and  
95 comprehensively quantified using a suite of variables such as speed, acceleration, collisions,  
96 and repeated high-intensity efforts (Gabbett, Jenkins, & Abernethy, 2012). In this regard,  
97 technology quantifies the sum of the individual tri-axial accelerometer vectors registered during  
98 player movement to derive body impacts (Malone et al., 2017). In addition, other variables such  
99 as player load (PL), equivalent distance index (EDI), and metabolic power can be determined  
100 using micro-sensor technology (Dalen, Ingebritsen, Ettema, Hjelde, & Wisloff, 2016).  
101 Therefore, quantifying a wide range of variables indicative of the physical demands  
102 encountered during match-play may provide more detailed evidence for coaching staff to  
103 periodize the weekly microcycle and optimize player performance (Mujika, 2013). While  
104 monitoring players using micro-sensor technology permits quantification of player demands  
105 during matches, it is also essential to determine the impact of contextual factors on player  
106 demands.

107 In team sports, physical match demands may be influenced by various contextual factors  
108 such as match location (Lago-Peñas & Lago-Ballesteros, 2011), playing style (Castellano,  
109 Blanco-Villaseñor, & Álvarez, 2011), and opponent ranking (Castillo, Castagna, Cámaras,  
110 Iturriastillo, & Yanci, 2018). In UF, given the duration of matches, and thus opportunity to  
111 perform activity, can vary depending on the score-line, opponent ranking may exert a  
112 pronounced influence on the demands encountered by players. Indeed, research in other team  
113 sports, such as soccer (Hulka, Radim, Belka, & Háp, 2015) and rugby union (Murray & Varley,  
114 2015) have shown match-play against higher-ranked teams elicits higher ( $P < 0.05$ )  
115 physical demands than match-play against lower-ranked teams. Insight regarding the impact of  
116 opponent ranking on match demands in UF may be useful to implement optimal training loads  
117 and recovery strategies dependent on the team faced. Thus, the aim of this study was twofold:  
118 1) to describe the physical demands of elite UF match-play and 2) to compare the physical  
119 demands encountered during UF matches according to opponent ranking. It was hypothesized  
120 that matches played against higher-ranked teams would elicit higher physical demands.

121

## 122 **Material and methods**

### 123 *Participants*

124 Twelve male ( $n = 8$ ) and female ( $n = 4$ ) UF players (age =  $28.1 \pm 5.3$  years, height =  $173 \pm 7$   
125 cm, body mass =  $71.1 \pm 12$  kg, body mass index (BMI) =  $23.4 \pm 2.6 \text{ kg} \cdot \text{m}^{-2}$ , training experience  
126 =  $10.4 \pm 5.1$  years), from the same national team participated in the study. These players  
127 participated in at least 80% ( $50.2 \pm 11.1$  min) of total match time across all matches and were  
128 consequently selected for further analysis. All players trained at least three times a week and  
129 were competing in an official, national-level match every two weeks for two months.

130

131 The criteria for allocating opponent ranking was based on each team's final position in  
132 the competition (Castillo et al., 2018). The team in this study was ranked 2<sup>nd</sup> in the five-team  
133 competition, while the order of matches was as follows: match one = 5<sup>th</sup>-ranked team; match  
134 two = 4<sup>th</sup>-ranked team; match three = 3<sup>rd</sup>-ranked team; and match four = 1<sup>st</sup>-ranked team. All  
135 official matches were played at the same time (12:00 h) on the same UF pitch. All players  
136 participated voluntarily in the study and provided written consent prior to testing. The study  
137 was approved by a local ethics committee before commencement in accordance with the  
138 Declaration of Helsinki.

139

140 *Experimental design*

141 An observational design was used whereby four matches of an official UF competition were  
142 monitored. Each match consisted of two 30-min halves with a 5-min rest period between halves.  
143 Match rules state when the clock reaches full-time, play continues until one of the teams scores.  
144 The match was considered finished when a team scored 15 goals with a two-goal advantage  
145 (Krstrup & Mohr, 2015). The final durations were: 1<sup>st</sup> ranked team = 75 min, 3<sup>rd</sup> ranked team  
146 = 74 min, 4<sup>th</sup> ranked team = 53 min, and 5<sup>th</sup> ranked team = 71 min. The field was comprised of  
147 an outdoor, natural grass floor, spanning 100 m in length (including two 15-m end zones) and  
148 60 m in width. An official referee was present to tabulate the score and ensure match rules  
149 were followed. Prior to each match, players undertook a 20-min standardized warm-up  
150 consisting of slow jogging, strolling locomotion, dynamic stretching, UF-specific exercises  
151 (e.g., different passes in groups), and brief progressive sprints.

152

153 *Physical demands*

154 The physical demands of players were monitored using micro-sensor units containing a 10-Hz  
155 GPS (Wimu Pro<sup>TM</sup>, RealTrack Systems, Almería, Spain) (Bastida-Castillo, Gómez-Carmona,

156 De la Cruz-Sánchez, & Pino-Ortega, 2018). Micro-sensor units were affixed between the  
157 scapulae of each player in a fitted vest worn during the entirety of each match. The micro-sensor  
158 units were activated 15 min before the start of each match in accordance with manufacturer  
159 recommendations. Data were downloaded post-match to a computer and analysed using a  
160 customized software package (WIMU SPRO, version 1.0, Almería, Spain). The validity and  
161 reliability of the WIMU microsensor units for the measurement of sprints, body impacts, and  
162 load variables are supported elsewhere (Bastida-Castillo et al., 2018). A number of physical  
163 measures were recorded and taken as outcome variables across each match. Sprinting variables  
164 included the quantity of sprints ( $>22 \text{ km}\cdot\text{h}^{-1}$ ) performed, maximum velocity ( $\text{Vel}_{\max}$ ) reached,  
165 and the quantity of repeated-sprinting bouts (sprints completed within 30 s after finishing the  
166 previous sprint [ $\text{RSA}_{30}$ ] and sprints completed within 20 s after finishing the previous sprint  
167 [ $\text{RSA}_{20}$ ]). Body impacts were detected from accelerometer data provided in "g" force. An  
168 impact was identified by the system if the force applied was greater than 5g. The total impact  
169 count from collisions, intensity of each impact, and the time in the match where the impact  
170 occurred were recorded. A scaling system between 5-10+g for grading the impacts was used as  
171 follows: I5-6g: light impact (hard acceleration/deceleration/change-of-direction); I6-6.5g: light  
172 to moderate impact (player collision, contact with the ground); I6.5-7g: moderate to heavy  
173 impact; I7-8g: heavy impact; I8-10g: very heavy impact; and I10+g: severe impact/collision  
174 (Abade, Gonçalves, Leite, & Sampaio, 2014). Various loading variables were also taken [using](#)  
175 [the accelerometer](#), including PL, maximum EDI ( $\text{EDI}_{\max}$ ), mean EDI ( $\text{EDI}_{\text{mean}}$ ), and metabolic  
176 power. Player load was computed as the vector magnitude representing the sum of accelerations  
177 recorded in the anteroposterior, mediolateral, and vertical planes of movement, measured with  
178 100-Hz triaxial piezoelectric linear accelerometers in the micro-sensors (Dalen et al., 2016).  
179 Equivalent distance index represents the relation between the distance a player would have  
180 covered at a steady pace on grass using the same total energy spent over the match and the

181 actual distance covered during the match (Osgnach, Poser, Bernardini, Rinaldo, & di Prampero,  
182 2010). From these data, EDI<sub>max</sub> and EDI<sub>mean</sub> were determined for each match. Finally, metabolic  
183 power was derived using the mathematical model proposed by di Prampero et al. (2005) to  
184 estimate overall metabolic cost across each match (Gaudino, Alberti, & Iaia, 2014).

185

186 *Statistical analyses*

187 All variables are reported as mean  $\pm$  standard deviation (SD). Normal distribution and  
188 homogeneity of variances was confirmed with the Kolmogorov-Smirnov and Levene tests. The  
189 repeated measures analysis of variance (ANOVA) with the Bonferroni post hoc test was used  
190 to compare the physical demands of players among each match. Effect sizes (ES) with  
191 uncertainty of the estimates shown as 90% confidence limits (CL) were used to quantify the  
192 magnitude of the difference between the four matches against varied opponents. Effect sizes  
193 were classified as *trivial* ( $<0.2$ ), *small* (0.2-0.59), *moderate* (0.6-1.19), *large* (1.2-1.99), *very*  
194 *large* (2.0-3.99), and *extremely large* ( $\geq 4.0$ ) (Hopkins, Marshall, Batterham, & Hanin, 2009).

195 Statistical analysis was performed using the Statistical Package for Social Sciences (version  
196 25.0 for Windows, SPSS Inc, Chicago, IL, USA). The level of significance was set at  $p < 0.05$ .

197

198 **Results**

199 Mean  $\pm$  SD sprinting variables against each opponent are shown in Table 1. No significant  
200 differences ( $p > 0.05$ , *trivial-small*) in sprinting variables were observed across UF matches  
201 against differently-ranked opponents.

202

203 **### Table 1 about here ###**

204

205 Mean  $\pm$  SD body impacts against each opponent are shown in Table 2. A higher quantity of  
206 total body impacts was registered against the 1<sup>st</sup>-ranked team compared to the 5<sup>th</sup>- ( $p < 0.01$ ,  
207 *moderate*), 4<sup>th</sup>- ( $p < 0.01$ , *large*), and 3<sup>rd</sup>-ranked teams ( $p < 0.01$ , *moderate*). In addition, higher  
208 total body impacts were encountered against the 5<sup>th</sup>-ranked team compared to the 4<sup>th</sup>-ranked  
209 team ( $p < 0.01$ , *moderate*) (Table 2). Body impacts at each intensity (e.g., I5-6g, I6-6.5, 6.5-7g,  
210 I7-8g, I8-10g and  $>I10+g$ ) were higher ( $p < 0.05$ , *moderate-large*) against the 1<sup>st</sup>-ranked team  
211 compared to all other opponents.

212

213 **### Table 2 about here ###**

214

215 Mean  $\pm$  SD loading variables against each opponent are shown in Table 3. PL against the 4<sup>th</sup>-  
216 ranked team was lower ( $p < 0.01$ , *large*) than against all other opponents. In addition, PL against  
217 the 1<sup>st</sup>-ranked team was higher ( $p < 0.01$ , *moderate*) than against the 3<sup>rd</sup>-ranked team. No  
218 significant differences ( $p > 0.05$ ) in EDI<sub>max</sub> and EDI<sub>mean</sub> were observed across UF matches  
219 against differently-ranked opponents. A lower metabolic power was evident against the 4<sup>th</sup>-  
220 ranked team ( $p < 0.01$ , *large*) compared to all other opponents. Additionally, metabolic power  
221 against the 1<sup>st</sup>-ranked team was higher ( $p < 0.05$ , *moderate*) than against the 3<sup>rd</sup>-ranked team.

222

223 **### Table 3 about here ###**

224

## 225 **Discussion and Implication**

226 The main aim of this study was [to quantify](#) and analyse the differences in physical demands  
227 registered during national-level UF matches according to opponent ranking. To our knowledge,  
228 this is the first study reporting the influence of opponent ranking on match demands in UF. Our

229 results indicate higher volumes and intensities of body impacts, PL, and metabolic power were  
230 encountered during matches played against higher-ranked teams than lower-ranked teams.

231 This study is the first to quantify body impacts during UF matches, showing competition  
232 against higher-ranked teams promoted more frequent and intense impacts than when playing  
233 against lower-ranked teams. Quantification of body impacts in team sports may provide insight  
234 on the fatigue accumulated across competition in players (Arruda et al., 2015). In fact, studies  
235 have considered quantification of body impacts during match-play as a useful variable to  
236 quantify match and training loads in team sports (Gaudino et al., 2014), compared to other  
237 physical measures such as TD and high-running intensity (Abade et al., 2014; Arruda et al.,  
238 2015). Considering body impacts do not only refer to collisions, and include actions such as  
239 hard accelerations and decelerations, changes-of-direction, or contact with the ground (Moreira  
240 et al., 2016), it was unsurprising many impacts were detected in our study examining national-  
241 level UF players. Our data revealed similar external loads in terms of volume and intensity of  
242 body impacts as previous studies in rugby and soccer players (Arruda et al., 2015; McLellan,  
243 Lovell, & Gass, 2011). While a total of  $816 \pm 366$  body impacts were encountered by UF  
244 players,  $830 \pm 135$  and  $\sim 850$  body impacts were found in elite, adult rugby league (McLellan  
245 et al., 2011) and international, junior soccer players (Arruda et al., 2015), respectively during  
246 match-play. These data suggest the impact demands encountered during national-level UF are  
247 comparable to elite players in more traditional field-based team sports. Furthermore, a higher  
248 quantity and intensity of body impacts occurred as opponent ranking increased during UF  
249 match-play. These differences could be due an alteration of tactical behaviours when playing  
250 against higher-ranked teams, whereby more frequent high-intensity actions (i.e., accelerations,  
251 decelerations, jumps and changes-of-direction) are performed to evade or defend a higher level  
252 of opponent in offensive and defensive situations (Folgado, Goncalves, & Sampaio, 2018).

253           Further to impact data, PL and metabolic power exhibited significant differences in  
254           matches according to opponent ranking. In this regard, PL and metabolic power against the 4<sup>th</sup>-  
255           ranked team ( $p < 0.01$ , *large*) were lower compared to all other opponents. In addition, PL and  
256           metabolic power were *moderately* higher against the 1<sup>st</sup>-ranked team than the 3<sup>rd</sup>-ranked team.  
257           These load variables are indicative of the volume of activity performed, being determined by  
258           the product of movement intensity and duration. In line with previous studies reporting  
259           higher physical loading volumes when competing against higher opponents in soccer (Hulka et  
260           al., 2015) and rugby union (Murray & Varley, 2015), our findings may be due to the tactical  
261           strategies adopted when facing higher-ranked opponents. Specifically, better teams may  
262           manage the tempo of the match by retaining possession of the disc more effectively through  
263           passing and catching the disc, creating less unforced turnovers. Consequently, when defending  
264           in these situations, the analysed team implemented individual player-to-player marking on  
265           defence to increase pressure on the opposition across the pitch. In this sense, defensive  
266           formations involving individualized marking evoke higher work intensities than zone  
267           formations with less stringent defending (Ngo et al., 2012), which may underpin the greater PL  
268           and metabolic power we observed against the 1<sup>st</sup>-ranked team.

269           Sprinting actions play a key role during critical scoring periods in team sports,  
270           potentially impacting the outcome of matches and physical performance of players (Cochrane  
271           & Monaghan, 2018). Our results indicate no significant differences in sprinting activity ( $<22$   
272            $\text{km}\cdot\text{h}^{-1}$ ) were apparent during matches played against differently-ranked opponents in UF.  
273           These findings may be due to the same playing structure (i.e., two handlers and five cutters)  
274           being used by the team analysed in this study across all matches, promoting similar offensive  
275           tactical behaviours and therefore sprinting actions in creating space for passing and catching  
276           opportunities. These results concur with those reported by Varley et al. (2018) who observed  
277           consistent sprint performance across 3 successive, international soccer matches. However, the

278 lack of differences in sprinting demands we observed between opponents contrasts other  
279 research conducted in soccer and rugby union showing greater sprinting distances are  
280 encountered during matches played against higher-ranked teams than lower-ranked teams  
281 (Hulka et al., 2015; Murray & Varley, 2015). Differences in findings across studies might  
282 underline the variations in movement patterns across teams or competitions, as well as relate to  
283 the different requirements of soccer and rugby union compared to UF. More precisely, these  
284 ball sports may involve more sprinting work when facing better opponents given offensive  
285 positioning on the field is dictated by defensive structures (i.e. players can be ruled offside if  
286 not in correct positioning) possibly allowing more talented players to make breaks in the  
287 defensive line and rapidly move across the pitch, requiring defenders to sprint more readily to  
288 prevent scoring (Higham, Hopkins, Pyne, & Anson, 2014).

289 While this study provides novel insight regarding the impact of opponent ranking on  
290 match demands in national-level UF players, it is not exempt from limitations. [The main](#)  
291 [limitation was the unequal duration of the matches \(53 to 75 min\), which should be considered](#)  
292 [when interpreting the provided data given variables were not reported relative to time.](#) In  
293 addition, opponent ranking was identified according to the final position at the end of the  
294 competition ([Castillo et al. 2018](#)). We are aware the ranking of teams may change from match  
295 to match in a competition format, depending on the win/loss record of the team. However, final  
296 placing in the competition is likely to reflect the longitudinal performance of each team across  
297 the entire competition and thus was used to establish criteria to adjudge team ranking in our  
298 study. In addition, only four UF matches were examined in the present study. While  
299 examination of a wider number of matches would have been ideal, the included matches  
300 allowed for an effective comparison between all teams in the competition holding different  
301 rankings. Furthermore, only one contextual factor (opponent rank) was considered in this study.  
302 Other contextual factors (e.g., match location, playing style) ([Castellano et al., 2011](#)) may have

303 affected the physical demands encountered by players and should be considered in future  
304 investigations. Finally, we included a range of variables to comprehensively quantify match  
305 demands in elite UF. Given the practical advantage in reducing the volume of data needed for  
306 interpretation of match demands, future work is encouraged applying appropriate analyses (e.g.  
307 principal component analysis) to identify variables that provide unique insight (Weaving, Jones,  
308 Till, Abt, & Beggs, 2017).

309

## 310 **Conclusions**

311 The current results first emphasize the high physical demands required of players during UF  
312 match-play at the national level. Specifically, players undergo extensive intermittent and high-  
313 intensity activity involving sprints and repeated-sprinting bouts, with high volumes and  
314 intensities of body impacts and loading. Second, the novel analysis of match demands  
315 considering the ranking of the opposing team showed coaching staff may need to prepare and  
316 manage players differently dependent upon the quality of the opposition faced. Specifically,  
317 matches played against higher-ranked teams may imposed greater volumes and intensities of  
318 body impacts, PL, and metabolic power than matches played against lower-ranked teams.  
319 Consequently, UF coaching staff may reduce the training loads in the next days after the  
320 matches played against higher-ranked opponents compared to when facing lower-ranked  
321 opponents. Third, greater precision in the planning of player training loads and recovery  
322 considering opponent ranking may allow coaches to optimize player performance and minimize  
323 overuse injury risk across the season.

324

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327

328 **Disclosure statement**

329 No potential conflict of interest was reported by the authors.

330

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427

428 **Table 1.** Mean  $\pm$  standard deviation sprinting variables during Ultimate Frisbee matches played  
 429 against differently-ranked opponents.  
 430

| Variable                                 | Opponent (ranking) |                 |                 |                 | Total           | Statistical differences                |
|--|--------------------|-----------------|-----------------|-----------------|-----------------|--|
|  | 1 <sup>st</sup>    | 3 <sup>rd</sup> | 4 <sup>th</sup> | 5 <sup>th</sup> |                 |  |
| Sprints (bouts)                          | 9.3 $\pm$ 8.4      | 6.8 $\pm$ 5.6   | 9.8 $\pm$ 5.4   | 8.3 $\pm$ 6.5   | 8.5 $\pm$ 6.4   | No significant differences (p > 0.05). |
| Vel <sub>max</sub> (km·h <sup>-1</sup> ) | 25.4 $\pm$ 4.1     | 25.9 $\pm$ 3.4  | 27.3 $\pm$ 3.8  | 25.5 $\pm$ 3.0  | 26.0 $\pm$ 3.5  | No significant differences (p > 0.05). |
| RSA <sub>30</sub> (bouts)                | 2.10 $\pm$ 2.33    | 1.20 $\pm$ 1.40 | 2.00 $\pm$ 1.66 | 2.22 $\pm$ 2.73 | 1.87 $\pm$ 2.04 | No significant differences (p > 0.05). |
| RSA <sub>20</sub> (bouts)                | 0.80 $\pm$ 1.40    | 0.80 $\pm$ 0.92 | 1.11 $\pm$ 1.05 | 0.78 $\pm$ 0.97 | 0.87 $\pm$ 1.07 | No significant differences (p > 0.05). |

431 Abbreviations: CL: confidence limits; RSA<sub>20</sub>: number of repeated sprints completed within 20 s of the  
 432 previous sprint; RSA<sub>30</sub>: number of repeated sprints completed within 30 s of the previous sprint.  
 433

434  
435 **Table 2.** Mean  $\pm$  standard deviation body impacts during Ultimate Frisbee matches played  
436 against differently-ranked opponents.

| Variable | Opponent (ranking) |                 |                 |                 | Total         | Statistical differences<br>(Effect size; $\pm 90\%$ CL)  |
|----------|--------------------|-----------------|-----------------|-----------------|---------------|--|
|          | 1 <sup>st</sup>    | 3 <sup>rd</sup> | 4 <sup>th</sup> | 5 <sup>th</sup> |               |  |
| Impacts  | 1017 $\pm$ 456     | 764 $\pm$ 289   | 605 $\pm$ 246   | 863 $\pm$ 352   | 816 $\pm$ 366 | Large: 1 <sup>st</sup> vs.4 <sup>th**</sup> (1.95; $\pm 0.85$ )<br>Moderate: 4 <sup>th</sup> vs.5 <sup>th**</sup> (-0.71; $\pm 0.32$ );<br>1 <sup>st</sup> vs.5 <sup>th**</sup> (0.74; $\pm 0.75$ ); 3 <sup>rd</sup> vs.4 <sup>th**</sup> (0.89; $\pm 0.40$ ); 1 <sup>st</sup> vs.3 <sup>rd**</sup> (0.80; $\pm 0.44$ )      |
| I5-6g    | 459 $\pm$ 202      | 357 $\pm$ 134   | 251 $\pm$ 84    | 420 $\pm$ 118   | 374 $\pm$ 158 | Large: 4 <sup>th</sup> vs.5 <sup>th**</sup> (-1.31; $\pm 0.40$ );<br>3 <sup>rd</sup> vs.4 <sup>th**</sup> (1.28; $\pm 0.75$ );<br>1 <sup>st</sup> vs.4 <sup>th**</sup> (2.47; $\pm 1.23$ )<br>Moderate: 1 <sup>st</sup> vs.5 <sup>th*</sup> (0.69; $\pm 1.05$ );<br>1 <sup>st</sup> vs.3 <sup>rd**</sup> (0.70; $\pm 0.45$ ) |
| I6-6.5g  | 152 $\pm$ 70.09    | 115 $\pm$ 40    | 93 $\pm$ 39     | 178 $\pm$ 109   | 124 $\pm$ 57  | Large: 1 <sup>st</sup> vs.4 <sup>th**</sup> (1.76; $\pm 0.84$ )<br>Moderate: 4 <sup>th</sup> vs.5 <sup>th**</sup> (-0.66; $\pm 0.54$ );<br>3 <sup>rd</sup> vs.4 <sup>th**</sup> (0.72; $\pm 0.37$ );<br>1 <sup>st</sup> vs.3 <sup>rd**</sup> (0.84; $\pm 0.48$ )   |
| I6.5-7g  | 116 $\pm$ 56       | 90 $\pm$ 35     | 69 $\pm$ 38     | 94 $\pm$ 49     | 93 $\pm$ 46   | Large: 1 <sup>st</sup> vs.4 <sup>th**</sup> (1.53; $\pm 0.72$ )<br>Moderate: 1 <sup>st</sup> vs.5 <sup>th*</sup> (0.77; $\pm 0.79$ );<br>3 <sup>rd</sup> vs.4 <sup>th**</sup> (0.83; $\pm 0.29$ ); 1 <sup>st</sup> vs.3 <sup>rd*</sup> (0.94; $\pm 0.48$ )   |
| I7-8g    | 143 $\pm$ 77       | 107 $\pm$ 49    | 96 $\pm$ 56     | 115 $\pm$ 75    | 116 $\pm$ 65  | Large: 1 <sup>st</sup> vs.4 <sup>th**</sup> (1.24; $\pm 0.56$ )<br>Moderate: 1 <sup>st</sup> vs.5 <sup>th*</sup> (0.68; $\pm 0.57$ );<br>1 <sup>st</sup> vs.3 <sup>rd**</sup> (0.67; $\pm 0.43$ )  |
| I8-10g   | 109 $\pm$ 71       | 74 $\pm$ 49     | 73 $\pm$ 42     | 79 $\pm$ 63     | 84 $\pm$ 57   | Large: 1 <sup>st</sup> vs.4 <sup>th**</sup> (1.27; $\pm 0.68$ )<br>Moderate: 1 <sup>st</sup> vs.5 <sup>th*</sup> (0.61; $\pm 0.45$ );<br>1 <sup>st</sup> vs.3 <sup>rd*</sup> (0.65; $\pm 0.37$ )   |
| I10+g    | 39 $\pm$ 35        | 21 $\pm$ 19     | 23 $\pm$ 19     | 19 $\pm$ 23     | 26 $\pm$ 26   | Large: 1 <sup>st</sup> vs.4 <sup>th**</sup> (1.19; $\pm 0.61$ )<br>Moderate: 1 <sup>st</sup> vs.5 <sup>th*</sup> (0.64; $\pm 0.44$ );<br>1 <sup>st</sup> vs.3 <sup>rd**</sup> (0.81; $\pm 0.54$ )  |

437 Note: \* Significant level was set at  $p<0.05$  \*\* Significant level was set at  $p<0.01$ . Abbreviations: CL:  
438 confidence limits; I5-6g: light impact; I6-6.5g: light to moderate impact; I6.5-7g: moderate to heavy  
439 impact; I7-8g: heavy impact; I8-10g: very heavy impact, and; I10+g: severe impact.

440

441      **Table 3.** Mean  $\pm$  standard deviation player load and metabolic power variables during  
 442      Ultimate Frisbee matches played against differently-ranked opponents.  
 443

| Variable            | Opponent (ranking)  |                     |                     |                     | Total               | Statistical differences<br>(Effect size; $\pm 90\%$ CL)   |
|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---|
|                     | 1 <sup>st</sup>     | 3 <sup>rd</sup>     | 4 <sup>th</sup>     | 5 <sup>th</sup>     |                     |   |
| PL (AU)             | 65.6 $\pm$<br>22.3  | 53.9 $\pm$<br>11.6  | 37.6 $\pm$<br>6.6   | 64.7 $\pm$<br>6.6   | 55.7 $\pm$<br>17.3  | Large: 4 <sup>th</sup> vs.5 <sup>th</sup> ** (-3.54;<br>$\pm 0.67$ ); 3 <sup>rd</sup> vs.4 <sup>th</sup> ** (2.69;<br>$\pm 0.74$ ); 1 <sup>st</sup> vs.4 <sup>th</sup> ** (4.45;<br>$\pm 1.65$ );<br>Moderate: 1 <sup>st</sup> vs.3 <sup>rd</sup> ** (0.92;<br>$\pm 0.65$ ) |
| EDI <sub>max</sub>  | 1.23 $\pm$<br>0.23  | 1.19 $\pm$<br>0.18  | 1.30 $\pm$<br>0.24  | 1.38 $\pm$<br>0.33  | 1.27 $\pm$<br>0.25  | No significant differences.   |
| EDI <sub>mean</sub> | 0.93 $\pm$<br>0.05  | 0.94 $\pm$<br>0.04  | 0.93 $\pm$<br>0.03  | 0.94 $\pm$<br>0.04  | 0.93 $\pm$<br>0.04  | No significant differences.   |
| Metabolic power (W) | 18857 $\pm$<br>5004 | 16258 $\pm$<br>2547 | 11455 $\pm$<br>1257 | 19463 $\pm$<br>2389 | 16564 $\pm$<br>4368 | Large: 4 <sup>th</sup> vs.5 <sup>th</sup> ** (-2.77;<br>$\pm 0.72$ ); 3 <sup>rd</sup> vs.4 <sup>th</sup> ** (4.12;<br>$\pm 1.02$ ); 1 <sup>st</sup> vs.4 <sup>th</sup> ** (6.28;<br>$\pm 2.05$ )<br>Moderate: 1 <sup>st</sup> vs.3 <sup>rd</sup> * (0.93;<br>$\pm 0.76$ )   |

444      Note: \* Significant level was set at  $p<0.05$  \*\* Significant level was set at  $p<0.01$ . Abbreviations: CL:  
 445      90% confidence limits; PL: player load; AU: arbitrary units; EDI<sub>max</sub>: maximum equivalent distance  
 446      index; EDI<sub>mean</sub>: mean equivalent distance index.

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