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49 **ABSTRACT**

50 **Purpose:** To systematically review the physical, physiological,  
51 perceptual, and technical-tactical demands of official 3×3  
52 basketball games.

53 **Methods:** The Preferred Reporting Items for Systematic  
54 Reviews and Meta-Analyses (PRISMA) guidelines were  
55 followed. Three electronic databases (PubMed, Scopus, Web of  
56 Science) were systematically searched to identify studies  
57 assessing physical, physiological, perceptual and technical-  
58 tactical demands of 3×3 games. Data were also coded according  
59 to player's sex and tournament phases. Quality assessment of the  
60 included studies was performed using a modified Downs and  
61 Black checklist.

62 **Results:** Thirteen articles were finally included, with a mean  
63 quality of 8.6±1.1 out of 11. 3×3 basketball games have an  
64 intermittent profile (1:1 work rest ratio), with duration of ~15  
65 minutes, and are characterised by short (6-8 s) ball possessions,  
66 and considerable physical (17-33 accelerations, 24-44  
67 decelerations, 62-94 changes of directions, 17-24 jumps per  
68 game) and physiological (lactate: ~6.2 mmol·L<sup>-1</sup>) demands.  
69 Overall, the game performance profile is similar in males and  
70 females, with minor changes happening across tournament  
71 phases. Several key technical-tactical indicators were identified  
72 as discriminating winning and losing teams, such as better  
73 shooting and defensive efficiency, low number of turnovers, and  
74 implementing tactical actions involving more players, passing  
75 first, and ending possessions with shots from outside of the arch  
76 from the top of the key.

77 **Conclusions:** 3×3 basketball is an intermittent, physically  
78 demanding sport characterised by quick plays and specific  
79 tactical constraints. This review provides information which  
80 should be considered by performance staff to improve training  
81 prescription, game tactical plans, and for better player selection  
82 and talent identification.

83

84 **Keywords:** 3vs3; three-on-three basketball; team sport; external  
85 load; internal load; game-related statistics; performance analysis

86

87 **INTRODUCTION**

88 Basketball is one of the most popular sports worldwide,<sup>1</sup> played  
89 at the Olympic games since 1936. Alongside the classic 5×5  
90 basketball, amateur and even professional basketball players  
91 often play 3×3 basketball. This modified version is typically  
92 played outdoors on half-court, making it easier to organise and  
93 play for a wider range of players. The popularity, easiness of  
94 organization and accessibility of this modified format has  
95 received increasing interest in the recent years. Accordingly, in  
96 2011, the International Basketball Federation (FIBA) had  
97 organized the first 3×3 World Cup tournament, and in 2020 3×3  
98 basketball has been included as Olympic discipline at Tokyo  
99 2020.

100 The most prominent differences between 3×3 and 5×5 basketball  
101 are: i) each team consists of a maximum of 4 players (3 on the  
102 court and 1 substitute); ii) the game is played on 1 hoop and a  
103 reduced court size of 15 m in width and 11 m in length  
104 (approximately half size of the 5×5); iii) the FIBA regular  
105 playing time is 1 period of 10 minutes (4 x 10 minutes in 5×5)  
106 or first team to score 21 points; iv) a team in ball possession must  
107 attempt a shot within 12 seconds (24 seconds in 5×5); v) scoring  
108 system with 1 point awarded for a successful shot from inside  
109 the arc or a free throw, and 2 points for a successful shot from  
110 behind the arc (3 points in 5×5).<sup>2</sup> These rules make 3×3  
111 basketball a specific, distinctive sport. Previous basketball  
112 studies have demonstrated how manipulating the number of  
113 players<sup>3,4</sup>, court size<sup>3,4</sup> and rules<sup>5,6</sup> of basketball game-based  
114 drills directly influence the demands imposed on players. For  
115 instance, greater court areas per player typically determine  
116 higher physical, physiological and perceptual demands;<sup>7</sup>  
117 furthermore, reducing ball possession duration has been shown  
118 to increase the intensity in basketball game-based drills.<sup>8-10</sup>  
119 Therefore, it is highly possible that 3×3 games have distinct  
120 characteristics from the classic 5×5 basketball. In fact, a direct  
121 comparison performed by Willberg and colleagues<sup>11</sup> showed  
122 that, in male games, 3×3 basketball elicits higher physical and  
123 perceptual intensities than 5×5. Additionally, 3×3 international  
124 tournaments are typically held on a short time window of 3-5  
125 days with teams playing multiple games per day (up to 18 games  
126 in 5 days),<sup>12</sup> which might influence the games' physical,  
127 physiological, perceptual, and technical-tactical demands, as  
128 well as the players' wellness and readiness to perform across the  
129 tournament.

130 Together with the increasing interest by official federations and  
131 fans, also sport scientist have dedicated studies to describe the  
132 characteristics and demands of 3×3 basketball.<sup>13,14</sup> The increase  
133 of interest in this sport is, possibly, promoted by its inclusion in

134 the Olympics, a fact that has fostered attention from sport  
135 science research in other sports,<sup>15</sup> considering the importance of  
136 optimally preparing athletes for such important sport events, as  
137 well as other international competitions such as continental and  
138 World cups. While 3×3 basketball is still a new discipline, it  
139 could be of great help for practitioners and stakeholders to have  
140 access to a comprehensive source of information, such as a  
141 systematic review, providing specific information on the  
142 physical, physiological, perceptual and technical-tactical  
143 demands of official games. Such information would favour the  
144 optimization of training design based on systematic evidence,,  
145 improvement of game tactical strategies based on key  
146 performance indicators, and improved athlete's selection  
147 procedures taking into account the specific demands of the game.  
148 Altogether, these would lead to beneficial increases in the 3×3  
149 performance level. In addition, a synthesis of current evidence is  
150 needed to identify gaps and clarify scientific knowledge on 3×3  
151 which should be examined. Therefore, the aim of this systematic  
152 review is to describe the physical, physiological, perceptual, and  
153 technical-tactical demands of official 3×3 basketball games.

154

## 155 **METHODS**

### 156 **Study design and search strategy**

157 A systematic review was conducted in accordance with the  
158 Preferred Reporting Items for Systematic Reviews and Meta-  
159 Analyses statement guidelines (PRISMA 2020).<sup>16</sup> Searches were  
160 performed on September 30, 2022 on Scopus, PubMed, and Web  
161 of Science using the following search terms: Basketball AND  
162 (3×3 OR 3x3 OR "3 x 3" OR 3-x-3 OR 3vs3 OR "3 vs 3" OR  
163 3on3 OR "3 on 3" OR 3-on-3 OR "3 \* 3" OR "3 x 3" OR 3<sub>x</sub>3 OR  
164 "3<sup>x</sup>3" OR "3<sub>x</sub>3" OR "3 × 3" OR "three x three" OR "three-x-  
165 three" OR "three vs three" OR three-vs-three OR "three by three"  
166 OR "three-by-three"). Additionally, websites of relevant journals  
167 and organizations (i.e. basketball federations) were screened to  
168 find relevant scientific articles. Only articles published starting  
169 from January 2010 were considered.

170

### 171 **Selection criteria**

172 After database screening, duplicates were removed using  
173 EndNote (Clarivate Analytics, Philadelphia, USA). Therefore  
174 studies were carefully examined by screening the title, abstract  
175 and full text. Studies were considered for inclusion if they: (1)  
176 were written in English, Spanish or Italian; (2) included male or  
177 female players of >16 years of age; (3) included data of 3×3  
178 basketball games following the official FIBA 3×3 basketball  
179 rules;<sup>2</sup> (4) measured at least one indicator of physical,  
180 physiological, perceptual, technical or tactical demands. The  
181 reference lists of included studies were also screened to search

182 for potentially relevant articles. Case studies, reviews,  
183 conference communications, opinion articles, presentations,  
184 theses, book chapters or posters were excluded from the analysis.  
185 For the purpose of this systematic review, physical demands  
186 were intended as any relevant measure obtained by: i) video-  
187 based time-motion analysis (TMA); or ii) microtechnology,  
188 accelerometry, global positioning systems (GPS) or local  
189 positioning systems (LPS). Physiological demands were  
190 considered as any heart rate (HR) and derived calculations (e.g.  
191 mean HR, peak HR, HR percentages and zones) as well as blood  
192 lactate or other biochemical internal response parameters.<sup>17-19</sup>  
193 Perceptual demands referred to ratings of perceived exertion  
194 (RPE) and derived calculations (session RPE, sRPE).<sup>17-19</sup>  
195 Technical-tactical demands were intended as relevant notational  
196 analysis variables used in basketball, such as shooting statistics  
197 (i.e., field goals, free throws, percentages and efficiency  
198 indicators), passes and assists, rebounds, turnovers, as well as  
199 tactical indicators such as count, frequency, types and  
200 effectiveness of ball possessions and tactical actions (i.e. ball-  
201 screens, number of players involved and court location of  
202 plays).<sup>20</sup> Variables were coded according to players' sex (male  
203 or female) and, when applicable, competition phase  
204 (qualification rounds or final rounds, including quarter finals,  
205 semi-finals and final games) and winning and losing teams (key  
206 performance indicators, KPI).

207

### 208 **Data extraction and analysis**

209 Studies were independently coded by 2 researchers (PS and DF)  
210 to obtain the sample characteristics (N, age, playing level, 3×3  
211 tournament information) and the outcome variables (game  
212 demands), following the above-mentioned criteria. In case of  
213 results' lack of clarity of the included studies, attempts were  
214 made to retrieve the data directly from the study's corresponding  
215 authors. If sufficient information could not be obtained, the data  
216 were not included in the results. Coding was cross-checked  
217 between authors to assert the quality and accuracy of the data  
218 extraction, and disagreements were settled by discussion, and a  
219 third author (DC) was in order to achieve consensus. Data are  
220 presented as mean and standard deviation (SD) or, estimated  
221 marginal means (EMM) with 95% confidence interval (CI).  
222 When available, effect sizes (ES) were extracted as reported in  
223 individual studies.

224

### 225 **Assessment of methodological quality**

226 Quality assessment was independently performed by 2 authors  
227 (PS, DF) by using a modified version of the Downs and Black  
228 checklist for the assessment of the methodological quality of  
229 randomized and non-randomized studies. This scale is composed  
230 of 27 total items, of which 11 were selected (Table 1) for their  
231 relevance to our study aim, as previously done in systematic

232 reviews in applied sport science.<sup>7,21</sup> Each item was scored as “1”  
233 (yes) or “0” (no/unable to determine), with the scores for each of  
234 the 11 items finally summed to provide the article quality score.  
235 Disagreements on the quality assessments were discussed, and a  
236 third author (DC) was consulted if consensus could not be  
237 reached.

238

239

\*\*\*Insert Table 1 around here\*\*\*

240

## 241 **RESULTS**

242 Figure 1 presents results of the systematic search process. The  
243 searches on the three databases provided a total of 2436 studies.  
244 After removal of 82 duplicates, 2354 titles and abstract were  
245 read. From these, 13 full-texts remained and were screened.  
246 Additionally, one further relevant article was retrieved by  
247 searching websites, organisations, and references of screened  
248 articles.<sup>16</sup> Following the inclusion criteria, 13 articles out of the  
249 14 pre-screened were finally included in the review (Figure  
250 1).<sup>11,13,29–31,14,22–28</sup>

251 Table 2 presents the results of the quality assessment. The  
252 methodological quality and bias score of the 13 included studies  
253 was 8.6±1.1 out of 11 (range: 7-10). No study was excluded  
254 based on the quality assessment or bias.

255 Tables 3, 4, 5 and 6 present detailed information from the  
256 included studies. Out of the 13 included studies, 9 studies  
257 monitored physical demands,<sup>11,13,14,23,25,27,29–31</sup> 5 studies  
258 monitored physiological demands,<sup>11,13,26,27,29</sup> 5 studies  
259 monitored the perceptual demands,<sup>11,13,26,27,31</sup> and 6 analysed the  
260 technical-tactical demands.<sup>11,14,22,24,26,28</sup>

261

262

\*\*\*Insert Figure 1 around here\*\*\*

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\*\*\*Insert Table 2 around here\*\*\*

264

\*\*\*Insert Table 3 around here\*\*\*

265

\*\*\*Insert Table 4 around here\*\*\*

266

\*\*\*Insert Table 5 around here\*\*\*

267

\*\*\*Insert Table 6 around here\*\*\*

268

### 269 ***Physical demands***

270 Table 3 presents the main results for physical demands  
271 monitored with TMA. The duration of a 3×3 basketball game is  
272 between 14.0 to 17.2 minutes,<sup>11,26</sup> with players spending 20-26%  
273 of the total game duration on the bench,<sup>11</sup> with a 3:1 court:bench  
274 ratio.<sup>26</sup> Looking specifically at active game phases (i.e. when the  
275 ball is in play), there is an approximate 1:1 ratio of live to  
276 stoppage time,<sup>14</sup> with one study showing higher live times (ES:  
277 *small*) in female World Cup games (EMM [95%CI]: 412 s [395–  
278 429]) compared to male ones (EMM [95%CI]: 388 s [370–

279 405]).<sup>23</sup> On average, each player is substituted  $2.6 \pm 1.4$  times per  
280 game in national tournaments.<sup>26</sup>  
281 The 3×3 male and female players spend 12% of the live time in  
282 possession of the ball.<sup>23</sup> Proportion of activity intensities of 3×3  
283 games encompass the ~15%, ~44%, ~17% and ~24% of the live  
284 game time spent recovering (REC) and performing low-  
285 intensity activity (LIA), moderate-intensity activity (MIA) and  
286 high-intensity activity (HIA), respectively.<sup>23</sup> Comparison of  
287 activity intensities between female and male World Cup games  
288 suggests similar activity proportions (in % of live time) for all  
289 type of activities.<sup>23</sup> Regarding competitions phases, in male  
290 tournaments HIA (in % of live time) were higher in group phases  
291 ( $24.4 \pm 4.4\%$ ) than final stages ( $22.0 \pm 4.9\%$ ) (ESs: *small*),<sup>28</sup> with  
292 also higher proportion of live time (%) spent in REC in final  
293 games ( $18.2 \pm 8.5\%$ ) compared to group games ( $14.59 \pm 5.97\%$ )  
294 (ESs: *small*).<sup>25</sup> Regarding female demands across the  
295 tournament, only LIA (in % of live time) were reported to be  
296 higher in group games (%:  $45.4 \pm 6.0\%$ ) compared to final games  
297 ( $43.6 \pm 5.4\%$ ) (ESs: *small*).<sup>23,25</sup> Regarding male tournaments,<sup>25</sup>  
298 lower durations (% of live time) performing high-intensity SM  
299 per minute and higher durations for jumps per minute were found  
300 in final phases (high-SM:  $5.6 \pm 1.4\%$ , jumps:  $4.1 \pm 1.2\%$ )  
301 compared to group (high-SM:  $6.6 \pm 1.2\%$ , jumps:  $3.6 \pm 1.1\%$ )  
302 (ESs: *small-moderate*). No differences in activity frequency or  
303 proportions were found between winning and losing teams in  
304 either male or female games.<sup>25</sup>  
305 Table 4 presents the physical demands monitored with  
306 microtechnology. Across tournament phases, there are small-to-  
307 moderate increases in total (m) and relative ( $\text{m} \cdot \text{min}^{-1}$ ) distances  
308 covered by male players, while no changes were found for  
309 female games.<sup>27</sup> Montgomery et al.<sup>27</sup> also found that PlayerLoad  
310 (PL, indicator of total physical load) and  $\text{PL} \cdot \text{min}^{-1}$  (indicator of  
311 intensity of physical load) are similar across games in male  
312 tournaments, while small decreases of PL were found in female  
313 games (lower in final games than groups; ES, *small*).  
314 Regarding jumps, male players typically perform 5.2–6.2 high-  
315 intensity jumps (>40 cm) per game, while 0.2–2.4 high-intensity  
316 jumps per game have been registered for female  
317 counterparts.<sup>11,13,27</sup> Stirn et al.<sup>30</sup> reported that, compared to  
318 females, male players perform more jumps per minute (M: 1.6;  
319 F: 1.1), jumps per game when taking a jump shot inside the paint  
320 (M,  $7.6 \pm 2.0$ ; F,  $4.8 \pm 1.6$ ) (ES: *large*), and jumps per game to  
321 block an opponent's shot (M,  $17.8 \pm 5.7$ ; F,  $10.4 \pm 4.7$ ) (ES: *very*  
322 *large*). No changes in jumps per game were registered across  
323 competition phases.<sup>11,27</sup>

324 3×3 players perform 17-33 accelerations (ACC), 24-44  
325 decelerations (DEC), 62-94 changes of directions (COD) and 17-  
326 24 jumps per game.<sup>11,13,27,31</sup> High-intensity accelerations (HI-  
327 ACC, >3.5 m·s<sup>2</sup>) per game ranged from 5.8 to 6.7 in males and  
328 from 3.8 to 5.5 for female games, while high-intensity  
329 decelerations (HI-DEC, >3.5 m·s<sup>2</sup>) were 5.1–5.8 in males and  
330 3.7–4.4 in females.<sup>11,27</sup> High-intensity changes-of-direction (HI-  
331 COD, >3.5 m·s<sup>2</sup>) per game were 13.8–15 and 6.7–10.9 for males  
332 and females, respectively.<sup>11,13,27</sup> Analyses performed across  
333 tournament phases show that HI-ACC and HI-DEC moderately  
334 increase along the tournament for female players, while no  
335 differences were detected for males.<sup>27</sup> Regarding HI-COD,  
336 Montgomery et al.<sup>27</sup> reported diverging changes across  
337 competition phases in males and females, with *small* increases  
338 for male games and *small* decreases in female games.

339

### 340 ***Physiological demands***

341 Table 5 presents results of the physiological demands. The mean  
342 heart rate (HR) is 160–182 beats per minute (bpm) for female  
343 players<sup>11,13,27,29</sup> and 149–164 bpm for male players,<sup>11,13,27</sup>  
344 respectively. Peak HR is 193–199 bpm and 198 bpm in  
345 female<sup>13,27,29</sup> and male<sup>13,27</sup> players, respectively. One study<sup>29</sup>  
346 reported relative HR values (in percentage of the peak HR),  
347 which was 90.8±3.8% (during live game time) in female players.  
348 Heart rate responses do not differ across sexes, as reported by  
349 the direct comparison performed by McGown et al.<sup>26</sup> The same  
350 authors registered higher peak HR in semi-finals compared to  
351 group games (ES: small),<sup>26</sup> while Montgomery et al. did not  
352 register any difference in HR indicators across tournament  
353 phases.<sup>27</sup>

354 Two studies collected blood lactate concentrations after 3×3  
355 games, with values of 6.1±2.2 and 6.3±2.4 mmol·L<sup>-1</sup> for female  
356 and male players, respectively.<sup>13,27</sup> No changes in blood lactate  
357 concentrations were registered across competition phases in  
358 either male or females.<sup>27</sup>

359

### 360 ***Perceptual demands***

361 Table 5 presents the results of the 5 studies monitoring  
362 perceptual demands. Three studies used the modified Borg  
363 Category Ratio 10 point scale,<sup>26,27</sup> while two studies did not  
364 specify the scale used.<sup>11,31</sup> Mean rating of perceived exertion  
365 (RPE) scores of 3×3 games were 5.4–7.3 arbitrary units (AU)  
366 and 5.7–6.3 AU in female and male players,  
367 respectively.<sup>11,13,26,27,31</sup> Regarding competition phases, three  
368 studies<sup>11,26,31</sup> found increases in RPE as the tournament  
369 progressed (groups games: 4.5–5.1; semifinals and finals: 7.2–



370 8.5; ES: large-very large<sup>26</sup>), while one study reported no  
371 differences.<sup>27</sup>

372

### 373 ***Technical-tactical demands***

374 The number of ball possessions played in each 3×3 game is  
375 between 30 and 40,<sup>14,28</sup> with 7.6±3.1 “check ball” (i.e. new  
376 possession start) situations per game.<sup>11</sup> The mean duration of a  
377 possession is 5.4–6.2 s.<sup>11,28</sup> Direct comparison between male and  
378 female games showed that more possessions are played female  
379 games (37±6) compared to males (34±5).<sup>24</sup> The same study  
380 reported no differences in ball possession count across  
381 competition phases.<sup>24</sup> Regarding possession efficiency, two  
382 studies reported that successful offensive possessions are  
383 relatively short (<8 s).<sup>11,28</sup>

384 The shooting profile of 3×3 games is characterised by  
385 approximately 28 field goal (FG) attempts per team per game.<sup>14</sup>  
386 Shots from inside the arch were the most frequent action in the  
387 study by McGown et al.;<sup>26</sup> furthermore, 1-point shot distribution  
388 is the highest (M: 54.6±9.7% F: 57.0±11.5%), while 2-point  
389 shots (from outside the arch) are less frequent (M: 37.4±10.1%,  
390 F: 31.9±12.0%).<sup>22</sup> Free throw shots are not frequent (1.3 per  
391 game per team)<sup>11</sup> and make part of the 8.1±2.9% and 11.4±3.3%  
392 of shots taken in male and female games, respectively.<sup>22</sup>

393 Shooting efficiency according to included studies is 39.0–50.3%  
394 for FG and 19.0–24.9% for 2-point shots.<sup>14,22</sup> Across the game  
395 duration, Willberg and colleagues<sup>11</sup> found that field goal %  
396 (FG%) was highest in the 05:00–06:59 min window (72.7%),  
397 and when possession duration was lower than 8 s. Ferioli et al.<sup>24</sup>  
398 compared shooting performances according to sex, and  
399 registered lower shooting value (S-VAL) (M: 10.5±4.99; F:  
400 8.19±3.82) (ES: *small*), less 2-point shots made (M: 3.53±2.3;  
401 F: 2.35±1.46; (ES: *moderate*), and less points (M: 17.18±4.18;  
402 F: 15.58±4.27) (ES: *small*) in female games, compared to male.  
403 In a 3×3 game, teams collect 12.3–15.4 total rebounds.<sup>14,24</sup>  
404 Specifically, Willberg et al.<sup>11</sup> reported that players collect 50.3%  
405 of the potential offensive rebounds available, and 81% of the  
406 potential defensive rebounds available. There are no differences  
407 in rebound indicators across tournament phases.<sup>11,14,24</sup> Two  
408 studies evaluated if rebound statistics discriminated between  
409 winning and losing teams, with contrasting findings (see Table  
410 6).

411 Only one study reported data of blocks in 3×3 games.<sup>24</sup> There is  
412 typically ~1 block per game, with no differences according to  
413 sex or game outcome. Across competition phases, more blocks  
414 were registered in group games (1.38±1.30) compared to final  
415 games (0.84±1.02) (ES: *small*).<sup>24</sup>

416 Studies evaluating turnovers and steals reported 3.9-6.6  
417 turnovers per game per team.<sup>14,24</sup> Ferioli et al.<sup>24</sup> found that male  
418 teams commit less turnovers (4.4±2.4) than female teams  
419 (6.2±2.8). Most turnovers happen in the final minutes of the  
420 game (11:00 – end), according to Willberg et al.<sup>11</sup>, while  
421 McGown et al.<sup>26</sup> registered less steals in final games compared  
422 to group games (ES: *small-moderate*). Importantly, two  
423 studies<sup>14,24</sup> agree that winning teams commit less turnovers than  
424 losing teams.

425 Current 3×3 literature assessed some tactical performance  
426 indicators. Ortega et al.<sup>28</sup> extensively analysed the efficacy of  
427 offensive actions (reported in proportion of total actions) during  
428 the 2017 3×3 World Cup. Live ball offensive possessions were  
429 implemented more frequently (72.4%) than “dead ball”  
430 situations (27.6%). Most frequently, offensive set plays involve  
431 2 (46.7%) or 3 players (35.6%), while one-player sets are the  
432 least implemented (17.8%). On-ball screens are scarcely  
433 implemented (15.5%).<sup>28</sup> Regarding passes, Willberg et al.<sup>11</sup>  
434 registered a mean of 1.35 passes per possession. Regarding  
435 assists, Ferioli et al.<sup>24</sup> registered 2.0–2.6 key assist per team per  
436 game, with no significant differences between sexes,  
437 competition phases and winning or losing teams. Furthermore,  
438 points per possession appear to be higher during final games  
439 (0.52±0.17) than group games (0.45±0.15) (ES: *small*).<sup>24</sup>

440 Table 6 presents the key technical-tactical indicators  
441 discriminating winning and losing teams in 3×3 basketball.  
442 Current literature identified several key technical-tactical  
443 indicators identified: shooting indicators (1- and 2-point shots,  
444 free throws made, shooting efficiency),<sup>14,24,28</sup> offensive and  
445 defensive ratings,<sup>14</sup> turnovers and steals.<sup>14,24</sup> Additionally,  
446 studies identified that shorter possession durations<sup>11,28</sup> and  
447 certain tactical plays (involving more players, passing first, and  
448 ending possessions with 2-point shots from the top of the key)  
449 are higher in winning teams.<sup>28</sup>

450

## 451 **DISCUSSION**

452 Understanding the physical, physiological, perceptual,  
453 and technical-tactical demands of 3×3 basketball is essential to  
454 develop appropriate training strategies, thus optimizing the  
455 players’ preparedness, and for talent identification purposes. The  
456 present systematic review aimed to summarize the scientific  
457 findings on 3×3 basketball and to identify existing gaps in the  
458 current knowledge about this novel discipline.

459

### 460 ***Physical demands***

461 To establish the 3×3 game profile, microsensors and  
462 time-motion analysis were the most applied techniques,  
463 suggesting that the use of microtechnology is already present in  
464 such a novel sport. The 3×3 game profile described by the  
465 reviewed studies showed that games last for 14-17 minutes,<sup>11,26</sup>  
466 a limited volume which allows performing multiple games on  
467 the same day. The live:stoppage time ratio is approximately  
468 1:1,<sup>14</sup> and players spend approximately 75% of the total game  
469 time on court.<sup>11,26</sup> 3×3 rules pose no limits on substitutions, with  
470 each player substituted ~2.5 times per game, which permit  
471 breaks to recover when needed. Overall, 3×3 games are  
472 characterized by an intermittent profile, encompassing the  
473 ~15%, ~44%, ~17% and ~24% of the live game time spent  
474 performing REC, LIA, MIA and HIA, respectively.<sup>23</sup> These data  
475 suggests that high-intensity requirements during live time are  
476 greater in 3×3 than 5×5 basketball (REC: ~36%; LIA: ~44%;  
477 MIA: ~10%; HIA: ~9%).<sup>32</sup>

478 Considering results of microtechnology (Table 4), the distance  
479 covered by 3×3 players is not particularly high (~44-64 m\*min<sup>-1</sup>),  
480 which may be expected given the reduced court dimensions  
481 with only one basket. On the contrary, 3×3 players perform 17-  
482 33 ACC, 24-44 DEC, 62-94 COD and 17-24 jumps per  
483 game.<sup>11,13,27,31</sup> Considering the short game duration (~16 minutes  
484 including stoppages), the games are characterized by an  
485 intermittent profile encompassing several high-intensity and  
486 physically-demanding actions per minute, thus underlining the  
487 importance of developing neuromuscular capacities related to  
488 expressing high levels of force over short time frames.<sup>33</sup>

489 The physical demands of male and female games seem to be  
490 similar. The only observed differences regard jumps and  
491 CODs,<sup>11,13,27,30</sup> which appear to be higher in males (jumps, M:  
492 21.8 – 23.5; F: 16.6 – 19.5) (CODs, M: 94.4; F: 62.3) (HI-CODs,  
493 M: 15; F: 10.9). Regarding competition phases, findings by one  
494 study<sup>25</sup> show a decrease in HIA and increase in REC in final  
495 games compared to group stages in males, while no differences  
496 were found in females. These results might indicate that male  
497 players could accumulate more fatigue across 3×3 tournaments,  
498 while female players maintain their physical performances.  
499 However, the observed changes were small, and might have also  
500 been influenced by tactical aspects (e.g., offensive and defensive  
501 actions and types)<sup>8,9,34</sup> and game-related contextual factors (e.g.,  
502 score line)<sup>35</sup>, which have been previously shown to influence  
503 physical performances in 5×5 basketball games. Additionally,  
504 microtechnology results provide in-deep data which  
505 practitioners might consider alongside tournament phases.  
506 Specifically, small reductions in PL and HI-COD were found

507 across female tournaments (lower in final games) by two  
508 studies,<sup>13,27</sup> which might suggest a reduced volume of physical  
509 work and certain demanding actions, while on the other hand,  
510 HI-ACC and HI-DEC increased. Differently, an increase in  
511 covered distances and HI-COD was found in final games,  
512 compared to group stages, in males.<sup>13,27</sup> Altogether, current data  
513 do not indicate clear physical performance changes across  
514 tournament phases. Future 3×3 studies should monitor specific  
515 fatigue indicators (e.g. impairment in neuromuscular properties  
516 and perceptual responses) alongside game physical  
517 performances across tournaments to detect possible relationships  
518 between changes in match physical activities and indicators of  
519 fatigue, and, if needed, to consequently plan appropriate  
520 recovery interventions.

521 Only one study evaluated if physical performances discriminated  
522 winning and losing teams, and found no differences.<sup>25</sup> This is not  
523 surprising, considering that performance in team sports elicits  
524 from the complex and non-linear interaction between physical,  
525 technical-tactical, psychological and contextual factors. Seen the  
526 limited amount of data, we recommend future studies to further  
527 investigate physical indicators alongside technical-tactical and  
528 contextual factors to better understand what plays a key role for  
529 success in 3×3 basketball.

530 To provide a comparison with 5×5 basketball, the 3×3 game  
531 appears more intense. Specifically, players spend less time in  
532 REC (15%) (5×5: ~33%), more time in HIA (24%) (5×5: :  
533 ~9%)<sup>32</sup> and perform more COD (3.9-5.9), ACC (n= 1.1-2.1) and  
534 DEC (n= 1.5-2.8) per minute<sup>11,13,27</sup> than in 5×5 basketball (5×5,  
535 per minute: COD: 3.6-4.5; ACC: 0.6-0.8 ; DEC: 1.1-1.7).<sup>36,37</sup> To  
536 obtain further relevant evidence, a direct comparison of the  
537 physiological demands of the two games, possibly  
538 encompassing evaluation of energetic and metabolic systems, is  
539 needed.

540

#### 541 ***Physiological demands***

542 All the studies investigating physiological demands of 3×3  
543 basketball reported raw HR data, with only one<sup>29</sup> paper  
544 reporting HR in % of the peak HR, which was 91% (during live  
545 time). This is a lack of current literature, which should be  
546 implemented to make it possible to produce practical suggestions  
547 for metabolic conditioning. Based on the limited evidences  
548 available, HR responses do not appear to substantially differ  
549 between sexes or tournament phases.<sup>26,27</sup>

550 The metabolic intensity of 3×3 basketball, quantified via blood  
551 lactate concentration, was reported only in two studies, with  
552 values of ~6.2 mmol·L<sup>-1</sup>.<sup>13,27</sup> These results further emphasize

553 the considerable high-intensity efforts of this sport, seen the  
554 reliance on anaerobic energetic systems. Therefore, considering  
555 the reduced game duration (~16 minutes), the anaerobic  
556 contribution is crucial and, in line with this, also buffer capacity  
557 should be trained. However, aerobic capacities should be also  
558 developed to allow players' recovery in between high-intensity  
559 efforts.<sup>38</sup>

560 No study evaluated whether physiological responses differ  
561 between winning and losing teams. In comparison with 5×5  
562 basketball, unfortunately it is not possible to provide an in-deep  
563 analysis as %HR data was reported just in one study.<sup>29</sup>  
564 According to available data, 3×3 basketball seems to elicit  
565 similar cardiovascular demands to 5×5 (relative HR: 81-95%).<sup>19</sup>  
566 3×3 games. The metabolic intensity of a 3×3 game seems to be  
567 similar (~6.2 mmol·L<sup>-1</sup>) to that of 5×5 basketball (3.9–6.8  
568 mmol·L<sup>-1</sup>).<sup>19</sup> However, the comparison of blood lactate data may  
569 be misleading considering the time frame at which they have  
570 been collected across the studies on the topic. Nevertheless,  
571 considering that 3×3 tournaments schedule feature  
572 approximately 3 games per team per day, with up to 18 games  
573 over 5 days of tournament,<sup>12</sup> specific recovery strategies are  
574 needed - seen the high physiological demands - to allow players  
575 to maintain their performances across the tournament duration.

576

### 577 *Perceptual demands*

578 RPE responses of 3×3 basketball players were 5.4-6.3,<sup>11,13,26,27</sup>  
579 which correspond to slightly more than “intense/hard” (= 5) on  
580 the RPE CR-10 scale. While no differences appear to exist  
581 between perceptual demands in male and female players, final  
582 tournament games were reported to elicit significantly higher  
583 RPE responses than group stage games in three studies.<sup>11,26,31</sup>

584 These results might be explained by several facts. The higher  
585 quality of teams competing in the final stages, with possibly the  
586 most skilled and physically prepared players, and the higher  
587 importance of the games together can lead to higher physical and  
588 mental demands, which might ultimately determine higher  
589 RPE.<sup>39</sup> Additionally, fatigue might accumulate across  
590 tournaments, which could also determine higher RPE scores.

591 No study has evaluated whether RPE differ between winning and  
592 losing teams. In comparison with 5×5 basketball (RPE: 6.0-  
593 7.3),<sup>36,37</sup> perceptual demands of a single 3×3 game appear similar  
594 or slightly lower (RPE: 5.4-6.3); however, considering the  
595 multiple games played per day, 3×3 players might have to face  
596 considerable psychophysiological demands across tournaments.

597

### 598 *Technical-tactical demands*

599 3×3 basketball is a team sport characterized by an high frequency  
600 of technical-tactical actions, with approximately 8 ball  
601 possessions played each minute of live time.<sup>11,14,28</sup> Considering  
602 this, tactical abilities appear essential seen the quick evolution of  
603 the game.

604 The shooting profile features a high distribution of 1-point shots  
605 (i.e., from inside the arc) (~55%) followed by 2-point shots (i.e.,  
606 from outside the arc) (~35%),<sup>22</sup> while free throws are not very  
607 frequent (<2 per team per game).<sup>11,26</sup> One study<sup>24</sup> comparing  
608 shooting performances of male and female players at the FIBA  
609 2019 3×3 World Cup found, overall, better shooting in males  
610 (higher S-VAL, more 2-point shots made), which could be  
611 considered when designing female training plans. Regarding  
612 tournament phases, the same study<sup>24</sup> found how shooting  
613 performances did not change across phases, suggesting that  
614 shooting efficiency is maintained despite the congested game  
615 schedule. Furthermore, more points per possessions were scored  
616 in final phases compared to group,<sup>24</sup> which might indicate how  
617 teams with better offenses reach the final stages of tournaments.  
618 While these data provide solid evidences as they were retrieved  
619 from a numerous sample (96 players monitored across 24  
620 games),<sup>24</sup> it should be considered that they belong to the same  
621 international tournament. Therefore, further studies are needed  
622 on this topic, with a more in-depth analysis required on the type  
623 of shots used (e.g., lay-up, jump shot, hook). Several shooting  
624 statistics (Table 6) were identified as KPI by reviewed studies,  
625 and therefore should be well considered by 3×3 practitioners.

626 In comparison with 5×5, the shooting distribution of shots from  
627 inside and outside the arch is similar. However, efficiency from  
628 outside the arch (3×3: 19-25%) is lower than in 5×5 basketball,  
629 (~35-40%).<sup>40</sup> Because ball possessions develop quickly and  
630 considering the 12 s shot clock, players have less time to take a  
631 shot, and the possibility to create clear offensive advantages (i.e.  
632 having a shot with little to no opposition) is limited over this  
633 short time available. Additionally, the speed of the game could  
634 be responsible for poorer shooting efficiency when considering  
635 the speed-accuracy trade-off in motor skills, including basketball  
636 shooting.<sup>41</sup>

637 Regarding rebounds, in one study<sup>11</sup> 3×3 teams collected ~80%  
638 of the available defensive and ~50% of offensive rebounds.  
639 Regarding sex and tournament phases, no differences were  
640 identified for any rebound indicator.<sup>11,14,24,26</sup> Similarly, evidence  
641 is inconclusive on whether rebound differentiate successful and  
642 unsuccessful performances, with two studies reporting  
643 contrasting findings.<sup>14,24</sup>

644 In comparison, 5×5 basketball teams collect less of the offensive  
645 rebounds available (best NBA teams for this statistics, 2021-  
646 2022 season: offensive: 34%)<sup>42</sup> than 3×3 teams (~50%).<sup>11</sup>  
647 Importantly, rebounds have been widely confirmed as a KPI in  
648 5×5 basketball, while evidence in 3×3 is unclear. These  
649 differences could be related to the constraint of playing only on  
650 one basket in 3×3, and therefore, court dimensions, player  
651 placement and tactical strategies might significantly differ  
652 compared to playing with two baskets in 5×5. For instance, the  
653 distance to cover in between offensive and defensive game  
654 phases in 3×3 basketball is very much reduced and facilitates  
655 offensive players in trying to catch offensive rebounds,  
656 compared to doing it in 5×5 basketball, which might  
657 disadvantage the team in the defensive transition.

658 Turnovers appear to increase in the final phases (> 11<sup>th</sup> minute)  
659 of 3×3 games,<sup>11</sup> with potential influences of fatigue and the  
660 psychological pressure of the decisive game moments. One  
661 study<sup>24</sup> reported more turnovers committed by female players  
662 compared to males, which should be considered by coaches,  
663 while no differences were found across tournament phases.<sup>24</sup>  
664 Importantly, two studies<sup>14,24</sup> reported that turnovers and  
665 recovered balls are a KPI in 3×3. Therefore, 3×3 coaches should  
666 implement training strategies aimed at enhancing the quality of  
667 offense to reduce turnovers, and to improve defensive strategies  
668 in all its features (e.g., defensive type, pressure on the ball,  
669 players' positions on the court) to recover more balls. Similarly,  
670 turnovers and recovered balls also differentiate winning and  
671 losing teams in 5×5 basketball.<sup>43,44</sup>

672 The current 3×3 basketball literature offers only limited insights  
673 into tactical analysis of this novel discipline. A detailed study by  
674 Ortega and colleagues<sup>28</sup> reported 3×3 game being characterised  
675 by few stops of the ball-play (27.6% “dead ball” situations,  
676 72.4% live ball). Only 15% of offensive set-plays are invested in  
677 isolation play (1 player only involved). On-ball screens are also  
678 not frequent (17%), much less than 5×5 basketball (35-40% of  
679 tactical actions),<sup>45,46</sup> in which these actions are frequently  
680 implemented to obtain advantages in offensive settings. Further  
681 studies should investigate the efficiency of on-ball screens in  
682 3×3 basketball, to provide more valuable information to  
683 practitioners.

684 Some tactical actions discriminated winning and losing teams  
685 according to the reviewed 3×3 studies. Specifically, starting  
686 offensive possessions with a pass rather than a dribble,<sup>28</sup>  
687 implementing less isolations and preferring plays involving  
688 more players,<sup>28</sup> using off-ball screens,<sup>28</sup> ending the possession  
689 with a 2-point shot from the center of the court, rather than

690 ending the possession near the basket.<sup>28</sup> Additionally, according  
691 to Conte et al.,<sup>14</sup> team offensive and defensive ratings  
692 discriminate winning and losing 3×3 teams.

693

#### 694 **FUTURE RESEARCH DIRECTIONS**

695 Firstly, considering the distinctive physical and physiological  
696 demands of 3×3 basketball, we recommend future studies to  
697 assess the physical profile<sup>47,48</sup> of 3×3 players to identify strength  
698 and weaknesses of the population, with respect to the game  
699 profile and for better player selection and talent identification.  
700 Secondly, there is a paucity of studies performing tactical  
701 analyses of 3×3 basketball games, which is essential to better  
702 understand key aspects (e.g., line ups, tactical actions) of this  
703 novel sport. Lastly, the specific schedule of 3×3 tournaments,  
704 typically developed over 4-5 days and featuring multiple games  
705 per day, call for the monitoring of physical and mental fatigue  
706 and players' wellbeing across games and competition days. This  
707 information could help performance staffs to identify ideal  
708 recovery strategies (e.g., sport massage, stretching, relaxation  
709 techniques, sleep hygiene, nutritional strategies).

710

#### 711 **PRACTICAL APPLICATIONS**

712 We recommend 3×3 basketball coaches to consider our findings  
713 to optimize training prescriptions. The peculiarities of 3×3 and  
714 its differences with 5×5 basketball should be considered to select  
715 players that fit this discipline best, and to optimally train them.  
716 We recommend this with a certain decision considering that  
717 most 3×3 teams are composed selecting 5×5 basketball players  
718 which are then involved in 3×3, with often limited preparation  
719 periods.

720 Practitioners should consider the intermittent activity profile  
721 (REC: ~15%; LIA: ~44%; MIA: ~17%; HIA: ~24%) and  
722 average intensities (PL·min<sup>-1</sup>: ~8 AU; %HR<sub>max</sub>: ~90%; RPE: ~7  
723 AU) of competition when developing game-based conditioning  
724 drills. Furthermore, seen the abundance of neuromuscular  
725 actions (e.g., jumps, COD, ACC, DEC) required, neuromuscular  
726 training appears essential to develop physical capacities of 3×3  
727 players. However, no investigation has yet examined any  
728 specific neuromuscular training programs for 3×3.

729 Lastly, we identified some technical-tactical KPI of 3×3  
730 basketball which can help coaches to prepare competition plans  
731 and increase their teams' chances of success. According to  
732 findings of this review, technical-tactical training plans should  
733 aim at increasing shooting efficiency, reducing turnovers,  
734 improving team defensive performance and prepare fast tactical  
735 plays which involve multiple players.

736

#### 737 **CONCLUSIONS**

738 3×3 basketball is a short duration, intermittent team sport with  
739 high neuromuscular and physiological demands. The game is



740 characterised by short ball possessions (6-8 s) in which quick,  
741 powerful, and tactically brilliant players and teams are favoured.  
742 Performance profiles in male and female games are substantially  
743 similar, with minor differences identified in jumps, COD and  
744 shooting efficiency (higher in males). Across 3×3 tournaments,  
745 concurrent reductions in HIA and increase in REC activity of  
746 players suggest that fatigue might accumulate in final stages;  
747 however, contrasting findings were reported for other physical  
748 indicators (e.g. HI-ACC and HI-DEC). Additionally, RPE  
749 in final games is typically higher, which indicates higher  
750 psychophysiological demands perceived by players after more  
751 important games. According to the key technical-tactical  
752 performance indicators found, 3×3 coaches should consider  
753 improving their teams' shooting and defensive efficiency,  
754 limiting turnovers and favour certain tactical actions (involving  
755 more players, passing first, not ending the possession near the  
756 basket) to increase their team's chances of success.

757

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## 973 FIGURES AND TABLES

974

### 975 **Figure 1. Flowchart of the study screening and selection** 976 **processes**

977 \*separate file\*

978

979 **Table 1. Modified Black and Downs checklist used to assess**  
980 **methodological quality of included studies**  
981 **\*separate file\***  
982

983 **Table 2. Results of the methodological quality assessment of**  
984 **included studies**  
985 **\*separate file\***  
986

987 **Table 3. Findings of studies monitoring physical demands**  
988 **with video-based time-motion analysis**  
989 \*separate file\*  
990



991 **Table 4. Findings of studies monitoring physical demands**  
992 **with microtechnology**  
993 **\*separate file\***  
994

995 **Table 5. Findings of studies monitoring physiological and**  
996 **perceptual demands**  
997 **\*separate file\***  
998

999 **Table 6. Key technical-tactical indicators discriminating**  
1000 **winning and losing teams in 3×3 official basketball**  
1001 **competitions**  
1002 **\*separate file\***  
1003