The physical profile of adult male basketball players: differences between competitive levels and playing positions

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Abstract

This study examined the physical differences in adult male basketball players of different competitive level and playing position using a large cohort. In the middle of the regular season, 129 players from four different Divisions completed a Yo-YoIR1 and, after 3-to-8 days, they performed a 6-min continuous running test (Mognoni's test), a counter-movement jump (CMJ) test and a 5-min High-intensity Intermittent running test (HIT). Magnitude-based inferences revealed that differences in HIT were very likely moderate between Division I and II and likely small between Division II and III. The differences in absolute peak power and force produced during CMJs between Division I and II and between Division II and III were possibly small. Differences in Yo-YoIR1 and Mognoni's test were very likely-to-almost certain moderate/large between Division III and VI. We observed possibly-to-likely small differences in HIT and Mognoni's test between guards and forwards and almost certainly moderate differences in absolute peak power and force during CMJs between guards and centres. The ability to sustain high-intensity intermittent efforts (i.e. HIT) and strength/power characteristics~~, along with stature and body mass, ~~can differentiate between ~~playing position and~~competitive level, while~~ in basketball.~~ strength/power characteristics discriminate guards from forwards/centres. These findings inform practitioners on the development of identification programs and training activities in basketball.

Introduction

Basketball is an intermittent team sport characterized by frequent high-intensity periods of play, often requiring frequent changes of direction, a variety of specific technical skills and well-developed jumping ability (Stojanovic et al., 2018; Ziv & Lidor, 2010). Accordingly, the ability to produce strength, power and speed are important physical performance characteristics for basketball players (Ziv & Lidor, 2009). Due to these demands, both aerobic and anaerobic mechanisms are heavily activated to provide energy during basketball (Ziv & Lidor, 2009).

Whilst the anthropometric and physiological characteristics of basketball players have previously been described (Drinkwater, Pyne, & McKenna, 2008), only few studies compared the characteristics of male adult players competing at different playing levels (Delextrat & Cohen, 2008; Ferioli, Bosio, Bilsborough, et al., 2018; Ferioli, Bosio, La Torre, et al., 2018; Koklu, Alemdaroglu, Kocak, Erol, & Findikoglu, 2011; Metaxas, Koutlianos, Sendelides, & Mandroukas, 2009; Sallet, Perrier, Ferret, Vitelli, & Baverel, 2005; Vaquera, Santos, Gerardo, Morante, & Garcia-Tormo, 2015). Whilst anthropometric characteristics are considered advantageous for professional basketball players (Drinkwater, et al., 2008), it has been shown that stature and body mass fail to discriminate between top and moderate-level professional players (Delextrat & Cohen, 2008; Koklu, et al., 2011; Metaxas, et al., 2009; Sallet, et al., 2005; Vaquera, et al., 2015). Similarly, although the aerobic metabolism is heavily taxed during games (Ziv & Lidor, 2009), aerobic fitness level is a poor discriminant characteristic between adult male professional and semi-professional players (Ferioli, Bosio, La Torre, et al., 2018; Koklu, et al., 2011; Sallet, et al., 2005).

The ability to sustain high-intensity intermittent efforts and to produce greater leg strength/power are generally considered important physical characteristics for high level basketball players (Ziv & Lidor, 2009). Indeed, both a better Yo-Yo Intermittent Recovery test (Yo-YoIR1) performance (Ben Abdelkrim, Chaouachi, Chamari, Chtara, & Castagna, 2010; Vernillo, Silvestri, & La Torre, 2012) and lower physiological responses to high-intensity exercise (Ferioli, Bosio, La Torre, et al., 2018) have been reported in higher level basketball players. However, studies comparing strength characteristics and vertical jump ability in basketball players of different competitive level have shown conflicting results (Ben Abdelkrim, et al., 2010; Ferioli, Bosio, Bilsborough, et al., 2018; Koklu, et al., 2011; Metaxas, et al., 2009).

Some limitations should be acknowledged when interpreting the results of previous research on the topic. Only few studies have assessed the anthropometric and physiological characteristics among a large cohort (i.e. sample size >100) of adult players (Boone & Bourgois, 2013; Vaquera, et al., 2015), during the competitive phase of the season (Ben Abdelkrim, et al., 2010; Cormery, Marcil, & Bouvard, 2008; Delextrat & Cohen, 2008; Manzi et al., 2010; Vaquera, et al., 2015) and/or involving athletes from various (i.e. more than two) divisions (Metaxas, et al., 2009; Vaquera, et al., 2015). Thus, to overcome these limitations, a study that assess the qualities during the competition phase using a large cohort of adult male basketball players from various playing levels is still required. This information is needed to develop more appropriate training programs.

Similarly, coaches should consider the different anthropometric and physical profile of players according to their playing position when developing training programs. Forwards are generally shorter and lighter compared to centres, but taller and heavier compared to guards (Ziv & Lidor, 2009), whilst aerobic fitness is generally higher in guards compared to the other playing positions when assessed in the field (i.e. Yo-YoIR1 and multistage 20 m shuttle run test) (Ben Abdelkrim, et al., 2010; Ostojic, Mazic, & Dikic, 2006) and the laboratory (i.e. incremental running or cycling exercise) (Boone & Bourgois, 2013; Cormery, et al., 2008). Guards also have higher vertical jump compared to centres, who are characterized by higher level of muscle strength and power (Ben Abdelkrim, et al., 2010; Boone & Bourgois, 2013; Ostojic, et al., 2006). Most of the studies investigating the characteristics of players according to their playing position tested a limited number of players (n<60) (Ben Abdelkrim, et al., 2010; Koklu, et al., 2011; Pojskic, Separovic, Uzicanin, Muratovic, & Mackovic, 2015; Sallet, et al., 2005) or were conducted during the preseason phase of training (Boone & Bourgois, 2013; Cormery, et al., 2008; Ostojic, et al., 2006). Only a limited number of studies assessed these qualities including a great cohort of players (Boone & Bourgois, 2013; Vaquera, et al., 2015) or were conducted during the regular season (Ben Abdelkrim, et al., 2010; Cormery, et al., 2008; Vaquera, et al., 2015). Considering these limits and the importance to develop specific training programs tailored for the playing position, the findings of previous studies should be further confirmed.

Accordingly, the aim of this study was to examine the physical differences in basketball players of different competitive level (from professional to amateur levels) and playing positions using a large cohort of players assessed during the competitive phase of the season.

Methods

Participants

Data were collected from 129 male basketball players competing in the Italian Serie A (Division I, n=39), Serie A2 (Division II, n=28), Serie B (Division III, n=34) and Serie D (Division VI, n=28) with the aim to assess athletes from heterogeneous playing standards (elite, professional, semi-professional and amateur levels). Players were selected from a total of 14 basketball teams (i.e. 3 or 4 teams for each division) during the competitive seasons 2014-15, 2015-16 and 2016-17. All the basketball players included in this study completed the standard training program of their respective team and were free of injury at least in the 6 months before the testing period. Playing positions (i.e. guards, forwards and centres) were equally represented in all Division groups to avoid potential bias effects of playing position on the outcomes variables. In Division I and II, athletes trained 6 to 10 times a week, while in Division III and VI teams performed 4 to 7 and 2 to 3 training sessions a week, respectively. On average, Division I, II and III performed two strength trainings in addition to a conditioning session per week. Division VI performed only technical/tactical trainings. Training sessions lasted 60-120 min, including warm-up and excluding cool down and/or stretching exercises. All the teams in the lower Divisions (i.e. Division II – VI) completed one game per week and the Division I teams played 1-2 games per week. Since the Division VI players were of amateur status and had low level of positional specialization, they were not included in the comparison between playing positions. After verbal and written explanation of the experimental design and potential risk and benefits of the study, written informed consent was signed by all players or their respective parents/guardians if underage. An Independent Institutional Review Board approved the study in accordance with the Helsinki Declaration.

Design and Methodology

This observational study was conducted in the middle of the competitive phase of the season (i.e. from December to March) and the players were assessed in the morning (from 9.30 am to 12.30 am) on two separate test days. On day 1 the athletes underwent

Yo-YoIR1, while on day 2 they performed a continuous running test (Mognoni's test), followed firstly by a counter-movement jump (CMJ) test and by a High-intensity Intermittent running test (HIT). The second test day was carried out between 3 to 8 days after the Yo-YoIR1. The Division I athletes did not carry out the Yo-YoIR1 due to restrictions made by technical coaches. To avoid potential confounding effects of prior exercise fatigue on the outcomes variables, no training sessions were performed the day preceding the assessments. No stretching exercises were allowed prior to the tests. All the players were familiar with the tests performed in the present study.

Yo-Yo Intermittent Recovery Test – level 1

The Yo-YoIR1 (Castagna, Impellizzeri, Rampinini, D'Ottavio, & Manzi, 2008; Krustrup et al., 2003) consisted of 20-m shuttle runs performed at increasing velocities (beginning speed of 10 $km \cdot h^{-1}$) with 10 s of active recovery (consisting of 2×5-m of jogging) between runs until exhaustion. The test concluded when participants failed to complete the distance in time twice (objective evaluation) or due to volitional fatigue (subjective evaluation). The total distance covered during Yo-YoIR1 was considered as the test "score" (Krustrup, et al., 2003). Heart rate was continuously monitored using Team^2 Pro System (Polar, Kempele, Finland) and all the athletes achieved at least the 90% of the predicted maximal heart rate, estimated as 220 – age (Fox III, Naughton, & Haskell, 1971).

Antropometrics

Before the commencement of physical test session, stature (stadiometer Wall Mounted, mod206 Seca, Birmingham UK), body mass (portable scale mod762 Seca, Birmingham

UK) and body fat (Harpenden skinfold caliper, Lanzoni srl, Bologna, Italy) percentage were determined. The estimation of the body density was determined through the equation eight as described by (Jackson & Pollock, 1978) using skin-fold (i.e. chest, abdomen and thigh) and circumference (i.e. forearm and waist) measures. The estimated body density was then transformed to body fat percentage using the Siri's equation (Siri, 1961).

Continuous Running Test (Mognoni's)

Mognoni's test (Sirtori, Lorenzelli, Peroni-Ranchet, Colombini, & Mognoni, 1993) consisted of a 6-min continuous run at a constant speed of 13.5 km·h^{-1} on a motorized treadmill (HP Cosmos, Nussdorf – Traunstein,Germany). Capillary blood lactate concentration ($MOG_{[La-]}$) was measured from the earlobe immediately after the completion of the test using a portable amperometric microvolume lactate analyser (Lactate Plus, Nova Biomedical, Waltham, MA, USA). Heart rate was continuously monitored using Team^2 Pro System (Polar, Kempele, Finland) and the mean heart rate (MOG_{HR}) of the last minute of running was considered for analysis. Athletes were instructed to abstain from any kind of warm-up prior to the test to avoid potential confounding effects on the physiological responses to the Mognoni's test. This test provides a simple method to assess aerobic fitness (Sirtori, et al., 1993), which is considered important for recovery during high-intensity intermittent exercise (Tomlin & Wenger, 2001).

Counter-Movement Jump Test

One minute before the CMJ test, athletes carried out two submaximal CMJs. The CMJ test was performed using a portable force platform (Quattro Jump, Kistler, Winterthur, Switzerland) 10 minutes after the Mognonj's test. Each athlete performed 5 bilateral single CMJs, separated by 30 s of passive rest, from a standing position with hands placed on the hips to minimize any influence of the arms. Players were instructed to perform a quick downward movement reaching about 90° knee flexion, promptly followed by a fast-upward movement with the aim to jump as high as possible. During the concentric phase of each CMJ, peak power output (PPO), peak force (PF) and jump height (CMJ_h) were measured. The average of the best three values was used for analysis.

High-intensity Intermittent Test

The HIT protocol (Rampinini et al., 2010), comprising 10×10 s shuttle runs over a 25+25 m course with a 180° change of direction and 20 s of passive recovery between each bout, was performed 10 minutes after the end of the CMJ test. The players were required to run at 18 $km{\cdot}h^{-1}$, following a sequence of audio signals. Immediately after the HIT protocol, a 100 µL capillary blood sample was drawn from an earlobe into a heparinised capillary tube and analysed for blood hydrogen ion concentration ($HIT_{[H+]}$) and bicarbonate concentration ($HIT_{[HCO3-]}$) using a calibrated blood-gas analyser (GEM Premier 3000, Instrumentation Laboratory, Milan, Italy) with an Intelligent Quality Management System cartridge and for blood lactate concentration ($HIT_{[La-]}$) using a portable amperometric microvolume lactate analyser (Lactate Plus, Nova Biomedical, Waltham, MA, USA). Heart rate was continuously monitored using Team[2] Pro System (Polar, Kempele, Finland) and the mean heart rate of the test (HIT_{HR}) was considered for the statistical analysis.

Statistical analysis

The participants' descriptive results are reported as means ± standard deviations (SD). The magnitude-based inference approach was used to analyse the data according to Hopkins et al. (Hopkins, Marshall, Batterham, & Hanin, 2009). All data were first log-transformed to reduce bias arising from non-uniformity of effects or errors (Hopkins, et al., 2009). Practical significance of differences was also assessed by calculating the effect size (ES) and the signal to noise ratio (SNR). ES were considered as follow: ≤0.02, trivial; >0.2-0.6, small; >0.6-1.2, moderate; >1,2-2.0, large; >2.0-4.0, very large (Hopkins, et al., 2009). The SNR was calculated for each variable as the percentage mean difference of the results between two divisions/playing positions (signal) divided by the typical error of measurement (absolute reliability as the noise) (Amann, Hopkins, & Marcora, 2008). For this purpose, the typical error of measurement expressed as coefficient of variation (CV) was established (test-retest reliability). CVs were determined in our laboratory in 15 Division VI basketball players on 2 trials, resulting as follow: Body mass, 0.7%; Body fat percentage, 3.4%; $MOG_{[La-]}$, 8.0%; MOG_{HR}, 0.8%; $HIT_{[La-]}$, 12.4%; $HIT_{[H+]}$, 5.3%; $HIT_{[HCO3-]}$, 7.2%; HIT_{HR}, 2.3%; CMJ_{h}, 3.8%; absolute PPO, 2.5%; relative PPO, 2.9%; absolute and relative PF, 3.8%. The CV of the Yo-YoIR1 has been described previously (Krustrup, et al., 2003). Probabilities were also calculated to compare the true (unknown) differences and the smallest worthwhile changes (SWC). SWC was obtained multiplying the between-subject SD by 0.3. Quantitative chances of positive, trivial or negative differences between Division groups and playing positions were evaluated qualitatively according to established criteria: <1%, almost certainly not; 1-5%, very unlikely; 5-25%, unlikely; 25-75%, possible; 75-95%, likely; 95-99%, very likely; >99%, almost certain (Hopkins, et al., 2009). When the probability of having higher or lower values than the SWC was less than 5%, the true difference was assessed as unclear (Hopkins, et al., 2009). Customized spreadsheets and SPSS statistical software (version 24.0, IBM SPSS Statistics, Chicago, IL, USA) were utilised to perform data analysis.

Results

Competitive level of play

Anthropometric characteristics and data of physical tests according to competitive level of play are presented in Table 1, while standardized differences between groups are reported in Table 2.

Table 1 near here

***Table 2 near here ***

Differences in physiological responses to HIT (i.e. $HIT_{[La-]}$, $HIT_{[H+]}$, $HIT_{[HCO3-]}$) were very likely moderate between Division I and II and likely small between Division II and III. The PPO and the absolute PF produced during the CMJ test by Division II players were possibly lower compared to Division I athletes and possibly greater compared to Division III players. Very likely to almost certain differences were observed in several parameters of the tests between Division III and VI groups.

Playing position

Anthropometric characteristics and data of physical tests relative to playing position are presented in Table 3, while standardized differences between groups are reported in Table 4.

***Table 3 near here ***

***Table 4 near here ***

Forwards were shorter and lighter compared to centres, but taller and heavier compared to guards. Differences in physiological responses to HIT (i.e. $HIT_{[La-]}$, $HIT_{[H+]}$, $HIT_{[HCO3-]}$) and Mognoni's test (i.e. $MOG_{[La-]}$, and MOG_{HR}) were possibly-to-likely small between guards and forwards, while unclear to possibly small differences were found between forwards and centres. The absolute PPO and the absolute PF produced during the CMJ test by forwards were very likely greater compared to guards.

Discussion

The present study provides novel insights into the physical and physiological characteristics of a large cohort of adult male basketball players competing at different levels (from elite to amateur levels) during the competitive phase of the season. The main results showed that physiological responses to a submaximal high-intensity intermittent run (i.e. HIT) discriminated adult players between most of the different competitive levels. Professional (i.e. Division II) and semi-professional (i.e. Division III) athletes also performed better in Yo-YoIR1 and Mognoni's test compared to amateur players (i.e. Division VI), however these tests did not discriminate between Division II and III players.

The present results confirm that stature and body mass are fundamental prerequisites for higher level (i.e. Division I, II and III) basketball players (Drinkwater, et al., 2008). Indeed, the Division VI athletes were the shortest and lightest group assessed in the present study. Division I and II players had similar stature, body mass and body fat percentage, confirming previous findings observed among Division I and II players competing in the French (Sallet, et al., 2005), Greek (Metaxas, et al., 2009), Spanish (Vaquera, et al., 2015) and Turkish (Koklu, et al., 2011) leagues.

In the present study, the aerobic fitness of basketball players was evaluated using a submaximal continuous running test (Mognoni's test). Unclear-to-possibly small differences were observed in the physiological responses ($MOG_{[La-]}$ and MOG_{HR}) to the Mognoni's test between Division I, II and III players, but the Division III athletes performed better than their Division VI counterparts. These findings partially confirm previous studies (Ferioli, Bosio, La Torre, et al., 2018; Koklu, et al., 2011), which reported aerobic fitness characteristics did not discriminate between adult basketball players of different competitive levels (i.e. from elite to semi-professional).

The distances covered during the Yo-YoIR1 by Division II and III players were slightly higher than performances reported in Italian Division I players (1945±144 m) (Manzi, et al., 2010), but lower compared to Tunisian National players (2619±731 m) (Ben Abdelkrim, et al., 2010). ~~Different body mass of the various cohorts of players might explain these contrasting findings.~~ Whilst previous research has shown the Yo-YoIR1 differentiates between playing levels (e.g. elite vs subelite) in young basketball players (Vernillo, et al., 2012), the present study showed similar results between Division II and III athletes. Notably however, these professional and semi-professional players had greater Yo-YoIR1 than their amateur counterparts (Division VI) (Table 1). These findings agree with a recent research that showed no differences in Yo-YoIR1 in a small cohort of professional and semi-professional male adult basketball players assessed before and after the preparation period (Ferioli, Bosio, La Torre, et al., 2018). Collectively, these findings suggest that Division II and III basketball players should have well-developed fitness capacities to cope with maximal high-intensity intermittent running. In contrast however, the ability to perform maximal high-intensity intermittent exercise did not discriminate between playing levels amongst the high-level basketball players (i.e. Division II and III). It is unfortunate that the Division I players in the present study were not able to perform the Yo-YoIR1 which limits the generalisability of our findings. Future studies should further confirm the use of Yo-YoIR1 as a valid tool to differentiate the competitive level among elite and professional adult players in basketball.

In the present study, the physiological responses to HIT were influenced by the competitive level of the players. Indeed, differences in $HIT_{[La-]}$, $HIT_{[H+]}$ and $HIT_{[HCO3-]}$ between Division I and II and between Division III and VI were likely-to-almost certain moderate/large. These results highlight the ability of top professional players (i.e. Division I) to better cope with the physiological demands of a high-intensity intermittent exercise (Ferioli, Bosio, La Torre, et al., 2018). The lower $HIT_{[La-]}$ of players competing at higher level suggests that these players have a lower anaerobic contribution to standardized high-intensity intermittent running protocol. Furthermore, the lower $HIT_{[H+]}$ and higher $HIT_{[HCO3-]}$ measured in higher competitive level players suggest a greater buffering capacity compared to lower competitive level counterparts. Taken collectively, the present results show that the physiological responses to a submaximal high-intensity intermittent exercise could be a more sensitive differentiator between the competitive level of adult basketball players than maximal intermittent running tests (such as Yo-YoIR1). Indeed, likely small differences in the physiological responses to HIT were found between Division II and Division III players, despite similar Yo-YoIR1 performance. Unfortunately, this reasoning cannot be inferred to Division I players, because they did not perform the Yo-YoIR1. From a practical point of view, this observation confirms the difficulties using maximal tests with elite athletes. The submaximal nature of HIT may represent an advantage for the systematic evaluation of elite players.

The CMJ_h measured in the present study are slightly lower to those previously reported in professional players (52.0±7.5 cm) (Shalfawi, Sabbah, Kailani, Tonnessen, & Enoksen, 2011) and in elite players competing in Tunisian national team (49.7±5.8 cm) (Ben Abdelkrim, et al., 2010). Although relative strength/power parameters might enable players to move more efficiently around the basketball court, we found unclear-to-possibly small differences in CMJ_h and PPO and PF normalized by body mass between Division I, II and III players. Notably, these jump measures were greater in Division VI players compared to their Division III counterparts. For these reasons, we recommend that CMJ_h and PPO and PF normalized by body mass should not be considered as major factors of success in basketball. Furthermore, possibly small differences in the absolute PF and PPO produced during the CMJ were observed between Division I and II and between Division II and III, suggesting a low sensitivity~~sensibility~~ of absolute values of both PPO and PF measures for differentiating players of the closest divisions. However, when comparing Division I with Division III and Division II with Division VI (comparisons not presented in the results section) we found likely-to-very likely moderate differences in both absolute values of PPO and PF in favour of higher level competitive players. Thus, we recommend that greater focus be placed on developing absolute PPO and PF in talented basketball players, as these qualities might be advantageous to compete at higher level.

Many studies (Ben Abdelkrim, et al., 2010; Boone & Bourgois, 2013; Cormery, et al., 2008; Delextrat & Cohen, 2008; Ostojic, et al., 2006; Sallet, et al., 2005) have described the position-specific anthropometric and physiological profile of young and adult male basketball players. However, the present study provides novel insight into the physical profile of a large cohort of adult male basketball players ~~(i.e. 101)~~ assessed in the middle of the regular season. In agreement with others (Ben Abdelkrim, et al., 2010; Boone & Bourgois, 2013; Cormery, et al., 2008; Delextrat & Cohen, 2008; Ostojic, et al., 2006; Sallet, et al., 2005), we observed almost certain moderate-to-very large differences in stature and body mass when comparing forwards with guards and centres. Small differences were observed in aerobic fitness between the playing positions, except for a very likely moderate difference between guards and centres in the Mognoni's test. The differences in $HIT_{[HCO3-]}$ and Yo-YoIR1, indices of the ability to sustain high-intensity intermittent exercise, were likely-to-very likely moderate when comparing guards with centres, but unclear-to-likely small between forwards and centres. In line with previous findings (Ben Abdelkrim, et al., 2010; Cormery, et al., 2008; Ostojic, et al., 2006; Sallet, et al., 2005), these results may be explained by the higher physiological load at which guards are subjected during games and training (Ben Abdelkrim, El Fazaa, & El Ati, 2007). Confirming previous findings (Ben Abdelkrim, et al., 2010; Boone & Bourgois, 2013; Ziv & Lidor, 2009), the differences between guards and centres in vertical jumping performance were likely small for CMJ_h, but almost certain moderate for absolute values of PPO and PF. Taken together, the present findings show that basketball players of different playing positions are characterized by a different physical and physiological profile. These differences are likely a consequence of the specific physical demands of basketball practice.

The main limitation of this study is that basketball players were selected from just one national competition. Therefore, normative data might not be extended reliably to overall high-level basketball players. Moreover, only a limited number of anthropometric and physiological capacities could be assessed, to develop a more holistic understanding of these capacities in basketball, we suggest that future studies utilize a wider range of test parameters. Furthermore, due to the difficulties in assessing elite and professional players, the evaluations have been performed during a 4-month period in the middle of each season for 3 years. To overcome potential bias effect of time on the outcome variable, we assessed a similar number of athletes from each Division within each month.

Conclusions

The physiological test carried out in the present study can be used to assess the fitness status of player; the results should be used to develop individualized training programs based on the weaknesses of players according to their competitive level and playing position. Strength and conditioning coaches should focus to enhance the ability to sustain intermittent efforts at higher intensities and to improve strength/power characteristics of the athletes, while technical coaches should use basketball-specific exercises to enhance these characteristics (e.g. small side-games). Furthermore, the present findings highlight the anthropometric characteristics that are generally required to compete at high level (i.e. Division I and II) and provide insight into the talent identification and into the determination of the athlete's playing position in basketball.

References

Amann, M., Hopkins, W. G., & Marcora, S. M. (2008). Similar sensitivity of time to exhaustion and time-trial time to changes in endurance. *Medicine and Science in Sports and Exercise, 40*(3), 574-578.

Ben Abdelkrim, N., Chaouachi, A., Chamari, K., Chtara, M., & Castagna, C. (2010). Positional role and competitive-level differences in elite-level men's basketball players. *Journal of Strength and Conditioning Research, 24*(5), 1346-1355.

Ben Abdelkrim, N., El Fazaa, S., & El Ati, J. (2007). Time-motion analysis and physiological data of elite under-19-year-old basketball players during competition. *British Journal of Sports Medicine, 41*(2), 69-75; discussion 75.

Boone, J., & Bourgois, J. (2013). Morphological and physiological profile of elite basketball players in Belgian. *International Journal of Sports Physiology and Performance, 8*(6), 630-638.

Castagna, C., Impellizzeri, F. M., Rampinini, E., D'Ottavio, S., & Manzi, V. (2008). The Yo-Yo intermittent recovery test in basketball players. *Journal of Science and Medicine in Sport, 11*(2), 202-208.

Cormery, B., Marcil, M., & Bouvard, M. (2008). Rule change incidence on physiological characteristics of elite basketball players: a 10-year-period investigation. *British Journal of Sports Medicine, 42*(1), 25-30.

Delextrat, A., & Cohen, D. (2008). Physiological testing of basketball players: toward a standard evaluation of anaerobic fitness. *Journal of Strength and Conditioning Research, 22*(4), 1066-1072.

Drinkwater, E. J., Pyne, D. B., & McKenna, M. J. (2008). Design and interpretation of anthropometric and fitness testing of basketball players. *Sports Medicine, 38*(7), 565-578.

Ferioli, D., Bosio, A., Bilsborough, J. C., La Torre, A., Tornaghi, M., & Rampinini, E. (2018). The Preparation Period in Basketball: Training Load and Neuromuscular Adaptations. *International Journal of Sports Physiology and Performance*, p *In press*.

Ferioli, D., Bosio, A., La Torre, A., Carlomagno, D., Connolly, D. R., & Rampinini, E. (2018). Different training loads partially influence physiological responses to preparation period in basketball. *Journal of Strength and Conditioning Research, 32*(3), 790-797.

Fox III, S. M., Naughton, J. P., & Haskell, W. L. (1971). Physical activity and the prevention of coronary heart disease. *Annals of clinical research, 3*(6), 404-432.

Hopkins, W. G., Marshall, S. W., Batterham, A. M., & Hanin, J. (2009). Progressive statistics for studies in sports medicine and exercise science. *Medicine and Science in Sports and Exercise, 41*(1), 3-13.

Jackson, A.S., & Pollock, M.L. (1978). Generalized equation for predicting body density of men. *British Journal of Sports Medicine, 40*(3), 497-504.

Koklu, Y., Alemdaroglu, U., Kocak, F. U., Erol, A. E., & Findikoglu, G. (2011). Comparison of chosen physical fitness characteristics of Turkish professional basketball players by division and playing position. *Journal of Human Kinetics, 30*, 99-106.

Krustrup, P., Mohr, M., Amstrup, T., Rysgaard, T., Johansen, J., Steensberg, A., . . . Bangsbo, J. (2003). The Yo-Yo Intermittent Recovery Test: physiological response, reliability, and validity. *Medicine and Science in Sports and Exercise, 35*(4), 697-705.

Manzi, V., D'Ottavio, S., Impellizzeri, F. M., Chaouachi, A., Chamari, K., & Castagna, C. (2010). Profile of weekly training load in elite male professional basketball players. *Journal of Strength and Conditioning Research, 24*(5), 1399-1406.

Metaxas, T. I., Koutlianos, N., Sendelides, T., & Mandroukas, A. (2009). Preseason physiological profile of soccer and basketball players in different divisions. *Journal of Strength and Conditioning Research, 23*(6), 1704-1713.

Ostojic, S. M., Mazic, S., & Dikic, N. (2006). Profiling in basketball: physical and physiological characteristics of elite players. *Journal of Strength and Conditioning Research, 20*(4), 740-744.

Pojskic, H., Separovic, V., Uzicanin, E., Muratovic, M., & Mackovic, S. (2015). Positional role differences in the aerobic and anaerobic power of elite basketball players. *Journal of Human Kinetics, 49*, 219-227.

Rampinini, E., Sassi, A., Azzalin, A., Castagna, C., Menaspa, P., Carlomagno, D., & Impellizzeri, F. M. (2010). Physiological determinants of Yo-Yo intermittent recovery tests in male soccer players. *European Journal of Applied Physiology, 108*(2), 401-409.

Sallet, P., Perrier, D., Ferret, J. M., Vitelli, V., & Baverel, G. (2005). Physiological differences in professional basketball players as a function of playing position and level of play. *The Journal of Sports Medicine and Physical Fitness, 45*(3), 291-294.

Shalfawi, S. A., Sabbah, A., Kailani, G., Tonnessen, E., & Enoksen, E. (2011). The relationship between running speed and measures of vertical jump in professional basketball players: a field-test approach. *Journal of Strength and Conditioning Research, 25*(11), 3088-3092.

Siri, W. E. (1961). *Techniques of measuring body composition* Washington DC: National Academy of Science.

Sirtori, M. D., Lorenzelli, F., Peroni-Ranchet, F., Colombini, A., & Mognoni, P. (1993). A single blood lactate measure of OBLA running velocity in soccer players. *Medicina dello Sport*(43), 281 – 286.

Stojanovic, E., Stojiljkovic, N., Scanlan, A. T., Dalbo, V. J., Berkelmans, D. M., & Milanovic, Z. (2018). The activity demands and physiological responses encountered during basketball match-play: a systematic review. *Sports Medicine, 48*(1), 111-135.

Tomlin, D. L., & Wenger, H. A. (2001). The relationship between aerobic fitness and recovery from high intensity intermittent exercise. *Sports Medicine, 31*(1), 1-11.

Vaquera, A., Santos, S., Gerardo, V. J., Morante, J. C., & Garcia-Tormo, V. (2015). Anthropometric Characteristics of Spanish Professional Basketball Players. *Journal of Human Kinetics, 46*, 99-106.

Vernillo, G., Silvestri, A., & La Torre, A. (2012). The yo-yo intermittent recovery test in junior basketball players according to performance level and age group. *Journal of Strength and Conditioning Research, 26*(9), 2490-2494.

Ziv, G., & Lidor, R. (2009). Physical attributes, physiological characteristics, on-court performances and nutritional strategies of female and male basketball players. *Sports Medicine, 39*(7), 547-568.

Ziv, G., & Lidor, R. (2010). Vertical jump in female and male basketball players--a review of observational and experimental studies. *Journal of Science and Medicine in Sport, 13*(3), 332-339.

Table 1. Anthropometric characteristics and physical tests results relative to competitive levels of play.

	DIVISION I	DIVISION II	DIVISION III	DIVISION VI
	Anthropometric Characteristics			
	n=39 (17-14-8)	*n=28 (13-9-6)*	*n=34 (15-12-7)*	*n=28 (13-10-5)*
Age (years)	26.5 ± 5.0	24.1 ± 4.1	24.4 ± 5.8	21.7 ± 5.3
Stature (cm)	198 ± 9	197 ± 8	193 ± 8	187 ± 8
Body mass (kg)	96.0 ± 11.1	92.7 ± 11.6	90.5 ± 12.8	80.0 ± 10.2
Body fat (%)	11.2 ± 3.1	11.4 ± 3.6	11.5 ± 3.9	11.5 ± 4.3
	Mognoni's Test			
	n=34 (16-11-7)	*n=25 (11-8-6)*	*n=34 (15-12-7)*	*n=28 (13-10-5)*
$MOG_{[La-]}$ ($mmol·L^{-1}$)	3.7 ± 1.1	3.8 ± 1.2	4.0 ± 1.9	5.8 ± 2.3
MOG_{HR} (bpm)	160 ± 9	161 ± 8	164 ± 11	174 ± 12
	High-intensity Intermittent Test			
	n=31 (14-10-7)	*n=27 (13-8-6)*	*n=34 (15-12-7)*	*n=28 (13-10-5)*
$HIT_{[La-]}$ ($mmol·L^{-1}$)	4.0 ± 1.6	5.0 ± 1.5	6.5 ± 2.6	9.9 ± 3.1
$HIT_{[H+]}$ ($mmol·L^{-1}$)	44.3 ± 4.4	47.0 ± 3.3	51.6 ± 8.9	57.7 ± 7.9
$HIT_{[HCO3-]}$ ($mmol·L^{-1}$)	22.3 ± 2.3	20.4 ± 2.0	18.9 ± 3.2	15.4 ± 2.7
HIT_{HR} (bpm)	151 ± 9	156 ± 10	159 ± 11	168 ± 12
	Yo-Yo Intermittent Recovery Test – level 1			
	-	*n=29 (13-10-6)*	*n=30 (14-10-6)*	*n=28 (13-10-5)*
Distance (m)	-	2135 ± 356	2265 ± 578	1671 ± 370
	Counter-Movement Jump test			
	n=36 (16-12-8)	*n=25 (11-8-6)*	*n=34 (15-12-7)*	*n=28 (13-10-5)*
CMJ_h (cm)	47.8 ± 5.7	49.2 ± 4.9	48.0 ± 6.1	51.8 ± 4.1
PPO ($W·kg^{-1}$)	57.2 ± 5.9	55.8 ± 5.8	54.1 ± 6.5	60.7 ± 5.3
PF ($N·kg^{-1}$)	27.0 ± 2.6	26.5 ± 3.5	26.0 ± 2.5	28.2 ± 3.4
PPO (W)	5468 ± 820	5177 ± 629	4865 ± 723	4800 ± 536
PF (N)	2573 ± 325	2459 ± 317	2345 ± 316	2231 ± 323

Abbreviations: CMJ_h, Counter-movement jump height; MOG, Mognoni's test; HIT, High-intensity Intermittent Test; HR, heart rate; n, sample size (Guards, Forwards, Centres); PPO, peak power output; PF, peak force; [H+], blood hydrogen ion concentration; [HCO3-], blood bicarbonates concentration; [La-], blood lactate concentration.

Table 3. Anthropometric characteristics and physical tests results relative to playing positions.

	GUARDS		**FORWARDS**		**CENTRES**	
			Anthropometric Characteristics			
	n=45 (17-13-15)		*n=35 (14-9-12)*		*n=21 (8-6-7)*	
Age (years)	24.6	± 4.7	25.4	± 5.3	25.7	± 5.7
Stature (cm)	189	± 6	200	± 4	206	± 6
Body mass (kg)	83.6	± 8.3	97.5	± 6.0	106.8	± 8.2
Body fat (%)	9.5	± 2.6	12.3	± 3.4	13.7	± 3.4
			Mognoni's Test			
	n=42 (16-13-13)		*n=31 (11-8-12)*		*n=20 (7-6-7)*	
$MOG_{[La-]}$ ($mmol \cdot L^{-1}$)	3.5	± 1.3	3.9	± 1.4	4.6	± 1.6
MOG_{HR} (bpm)	160	± 9	164	± 8	163	± 12
			High-intensity Intermittent Test			
	n=42 (14-13-15)		*n=30 (10-8-12)*		*n=20 (7-6-7)*	
$HIT_{[La-]}$ ($mmol \cdot L^{-1}$)	4.7	± 2.1	5.6	± 2.3	5.9	± 2.4
$HIT_{[H+]}$ ($mmol \cdot L^{-1}$)	45.7	± 4.3	50.2	± 8.3	48.9	± 8.2
$HIT_{[HCO3-]}$ ($mmol \cdot L^{-1}$)	21.4	± 2.9	20.1	± 2.8	19.3	± 3.1
HIT_{HR} (bpm)	154	± 11	157	± 8	156	± 12
			Yo-Yo Intermittent Recovery Test – level 1			
	n=27 (0-14-13)		*n=20 (0-10-10)*		*n=12 (0-6-6)*	
Distance (m)	2447	± 427	2078	± 350	1853	± 524
			Counter-Movement Jump test			
	n=42 (16-11-15)		*n=32 (12-8-12)*		*n=21 (8-6-7)*	
CMJ_h (cm)	49.2	± 4.9	48.6	± 6.0	45.8	± 6.0
PPO ($W \cdot kg^{-1}$)	57.2	± 5.5	56.0	± 6.2	52.2	± 6.5
PF ($N \cdot kg^{-1}$)	27.6	± 2.8	26.3	± 2.4	24.8	± 2.6
PPO (W)	4785	± 678	5436	± 738	5560	± 682
PF (N)	2304	± 333	2547	± 262	2645	± 287

Abbreviations: CMJh, Counter-movement jump height; MOG, Mognoni's test; HIT, High-intensity Intermittent Test; HR, heart rate; n, sample size (Division I, Division II, Division III); PPO, peak power output; PF, peak force; [H+], blood hydrogen ion concentration; [HCO3-], blood bicarbonates concentration; [La-], blood lactate concentration.

Table 2

Table 2. Comparison between competitive levels of play.

		Mean difference (90% CL) *		MBI (%)	Rating	ES (90% CL)		SNR (90% CL)	
				DIVISION I VS DIVISION II					
Anthropometric	Stature (cm)	0.6	±1.8	25/71/4	Possibly trivial	0.16	±0.45	-	
	Body mass (kg)	3.6	±5.3	50/49/1	Possibly small	0.27	±0.40	5.21	±7.48
	Body fat (%)	-0.3	±1.4	7/73/19	Unclear	-0.07	±0.38	-0.07	±0.38
Mognoni's Test	MOG$_{[La-]}$ (mmol·L^{-1})	-3.2	±12.9	7/67/25	Unclear	-0.10	±0.42	-0.40	±1.67
	MOG$_{HR}$ (bpm)	-0.9	±2.3	4/65/31	Possibly trivial	-0.17	±0.46	-1.18	±3.23
HIT	HIT$_{[La-]}$ (mmol·L^{-1})	-22.9	±12.1	0/5/95	Very likely moderate	-0.66	±0.44	-1.84	±1.22
	HIT$_{[H+]}$ (mmol·L^{-1})	-6.3	±3.5	0/5/95	Very likely moderate	-0.83	±0.51	-1.18	±0.74
	HIT$_{[HCO3-]}$ (mmol·L^{-1})	9.4	±5.1	98/2/0	Very likely moderate	0.92	±0.47	1.31	±0.68
	HIT$_{HR}$ (bpm)	-3.1	±2.7	0/23/77	Likely small	-0.47	±0.42	-1.36	±1.19
Yo-YoIR1 Test	Distance (m)	-		-	-	-		-	
CMJ test	CMJ$_h$ (cm)	-3.2	±4.6	1/49/49	Possibly small	-0.29	±0.45	-0.84	±1.34
	PPO (W·kg^{-1})	2.5	±4.6	41/57/2	Possibly small	0.23	±0.43	0.86	±1.57
	PF (N·kg^{-1})	1.9	±5.1	33/63/4	Possibly trivial	0.12	±0.39	0.51	±1.54
	PPO (W)	5.2	±6.4	60/39/1	Possibly small	0.45	±0.48	2.10	±2.35
	PF (N)	4.7	±5.9	59/40/1	Possibly small	0.35	±0.43	1.22	±1.49
				DIVISION II VS DIVISION III					
Anthropometric	Stature (cm)	2.1	±1.7	89/20/0	Likely small	0.50	±0.41	-	
	Body mass (kg)	2.6	±5.9	35/62/3	Possibly trivial	0.17	±0.40	3.79	±8.97
	Body fat (%)	-0.1	±1.6	11/75/14	Unclear	-0.02	±0.39	-0.02	±0.40
Mognoni's Test	MOG$_{[La-]}$ (mmol·L^{-1})	0.9	±16.4	14/77/10	Unclear	-0.10	±0.34	0.11	±0.42
	MOG$_{HR}$ (bpm)	-1.8	±2.5	1/49/49	Possibly small	-0.27	±0.37	-2.24	±3.17
HIT	HIT$_{[La-]}$ (mmol·L^{-1})	-18.4	±13.3	0/17/83	Likely small	-0.53	±0.33	-1.48	±0.98
	HIT$_{[H+]}$ (mmol·L^{-1})	-7.6	±4.9	0/14/86	Likely small	-0.49	±0.31	-1.42	±1.02
	HIT$_{[HCO3-]}$ (mmol·L^{-1})	8.6	±6.6	86/14/0	Likely small	0.43	±0.35	1.19	±1.04
	HIT$_{HR}$ (bpm)	-2.0	±2.8	1/48/51	Possibly small	-0.29	±0.41	-0.87	±1.23
Yo-YoIR1 Test	Distance (m)	-3.7	±9.7	5/62/33	Possibly small	-0.22	±0.35	-0.76	±1.22
CMJ test	CMJ$_h$ (cm)	2.9	±5.1	42/56/2	Possibly trivial	0.20	±0.38	0.76	±1.54
	PPO (W·kg^{-1})	3.3	±5.1	49/50/1	Possibly small	0.25	±0.41	1.15	±1.91
	PF (N·kg^{-1})	1.6	±5.1	29/66/6	Unclear	0.20	±0.54	0.42	±1.08
	PPO (W)	6.8	±6.4	75/25/0	Possibly small	0.42	±0.40	2.72	±2.63
	PF (N)	5.0	±6.1	60/39/1	Possibly small	0.35	±0.43	1.30	±1.59
				DIVISION III VS DIVISION VI					
Anthropometric	Stature (cm)	3.2	±1.9	95/5/0	Likely moderate	0.71	±0.41	-	
	Body mass (kg)	13.67	±6.6	99/1/0	Very likely moderate	1.04	±0.46	19.69	±8.94
	Body fat (%)	0.0	±1.8	12/75/13	Unclear	0.00	±0.40	-0.00	±0.51
Mognoni's Test	MOG$_{[La-]}$ (mmol·L^{-1})	-32.5	±11.9	0/1/99	Very likely moderate	-0.74	±0.38	-4.05	±2.05
	MOG$_{HR}$ (bpm)	-5.5	±2.8	0/3/97	Very likely moderate	-0.76	±0.39	-7.04	±3.61
HIT	HIT$_{[La-]}$ (mmol·L^{-1})	-37.0	±10.7	0/0/100	Almost certain moderate	-1.08	±0.39	-2.98	±1.06
	HIT$_{[H+]}$ (mmol·L^{-1})	-10.9	±5.7	0/4/96	Very likely moderate	-0.74	±0.44	-2.05	±1.24
	HIT$_{[HCO3-]}$ (mmol·L^{-1})	23.0	±9.5	100/0/0	Almost certain large	1.29	±0.46	3.21	±1.17
	HIT$_{HR}$ (bpm)	-5.0	±2.9	0/5/95	Likely moderate	-0.69	±0.40	-2.21	±1.27
Yo-YoIR1 Test	Distance (m)	33.9	±14.7	100/0/0	Almost certain large	1.56	±0.56	6.92	±2.51
CMJ test	CMJ$_h$ (cm)	-7.7	±4.1	0/4/96	Very likely moderate	-0.90	±0.52	-2.04	±1.23
	PPO (W·kg^{-1})	-11.2	±4.1	0/0/100	Almost certain large	1.22	±0.46	-3.90	±1.51
	PF (N·kg^{-1})	-7.4	±4.3	0/6/94	Likely moderate	-0.61	±0.37	-1.94	±1.14
	PPO (W)	0.9	±5.6	18/74/8	Unclear	0.12	±0.49	0.36	±1.52
	PF (N)	5.3	±6.4	61/39/1	Possibly small	0.34	±0.41	1.37	±1.64

Abbreviations: *, in percentage; CL, confidence limits; CMJh, Counter-movement jump height; ES, effect size; MBI (%), percent of chances of positive/trivial/negative effects; MOG, Mognoni's test; HIT, High-intensity Intermittent Test; HR, heart rate; PPO, peak power output; PF, peak force; SNR, Signal to noise ratio; [H+], blood hydrogen ion concentration; [HCO3-], blood bicarbonates concentration; [La-], blood lactate concentration.

Table 4

Table 4. Comparison between playing positions.

		Mean difference (90% CL) *		MBI (%)	Rating	ES (90% CL)		SNR (90% CL)	
				GUARDS VS FORWARDS					
Anthropometric	Stature (cm)	-5.5	±0.9	0/0/100	Almost certain very large	-2.60	±0.45	-	
	Body mass (kg)	-14.6	±2.6	0/0/100	Almost certain very large	-2.28	±0.43	-20.98	±4.18
	Body fat (%)	-2.8	±1.2	0/1/99	Very likely moderate	-0.81	±0.33	-0.81	±0.32
Mognoni's Test	$MOG_{[La-]}$ ($mmol\cdot L^{-1}$)	-12.7	±11.8	0/35/65	Possibly small	-0.35	±0.38	-1.58	±1.70
	MOG_{HR} (bpm)	-2.6	±2.1	0/24/76	Likely small	-0.48	±0.41	-3.30	±2.81
HIT	$HIT_{[La-]}$ ($mmol\cdot L^{-1}$)	-16.8	±14.6	0/28/72	Possibly small	-0.39	±0.38	-1.35	±1.29
	$HIT_{[H+]}$ ($mmol\cdot L^{-1}$)	-8.1	±5.0	0/9/91	Likely small	-0.52	±0.33	-1.53	±0.88
	$HIT_{[HCO3-]}$ ($mmol\cdot L^{-1}$)	6.3	±6.0	73/27/0	Possibly small	0.44	±0.40	0.88	±0.80
	HIT_{HR} (bpm)	-1.8	±2.4	1/52/47	Possibly small	-0.31	±0.45	-0.79	±1.19
Yo-YoIR1 Test	Distance (m)	17.7	±9.9	98/2/0	Very likely moderate	1.01	±0.52	3.61	±1.92
CMJ test	CMJ_h (cm)	1.5	±4.5	26/70/4	Possibly trivial	0.10	±0.36	0.41	±1.36
	PPO ($W\cdot kg^{-1}$)	2.3	±4.2	38/60/2	Possibly trivial	0.19	±0.36	0.80	±1.52
	PF ($N\cdot kg^{-1}$)	4.7	±3.9	76/24/0	Likely small	0.51	±0.41	1.23	±1.02
	PPO (W)	-12.1	±4.8	0/1/99	Very likely moderate	-0.86	±0.37	-4.86	±2.06
	PF (N)	-10.0	±4.3	0/1/99	Very likely moderate	-0.91	±0.43	-2.62	±1.28
				GUARDS VS CENTRES					
Anthropometric	Stature (cm)	-8.1	±1.2	0/0/100	Almost certain very large	-2.88	±0.44	-	
	Body mass (kg)	-21.9	±2.9	0/0/100	Almost certain very large	-2.74	±0.43	-31.56	±4.97
	Body fat (%)	-4.2	±1.4	0/0/100	Almost certain moderate	-1.20	±0.40	-1.24	±0.38
Mognoni's Test	$MOG_{[La-]}$ ($mmol\cdot L^{-1}$)	-25.2	±11.9	0/3/97	Very likely moderate	-0.68	±0.42	-3.13	±1.75
	MOG_{HR} (bpm)	-1.6	±3.1	3/53/44	Possibly small	-0.22	±0.42	-2.04	±3.48
HIT	$HIT_{[La-]}$ ($mmol\cdot L^{-1}$)	-21.5	±15.0	0/15/85	Likely small	-0.48	±0.43	-1.73	±1.46
	$HIT_{[H+]}$ ($mmol\cdot L^{-1}$)	-5.7	±6.1	1/29/70	Possibly small	-0.37	±0.39	-1.07	±0.92
	$HIT_{[HCO3-]}$ ($mmol\cdot L^{-1}$)	11.2	±8.4	92/8/0	Likely moderate	0.65	±0.44	1.56	±1.01
	HIT_{HR} (bpm)	-1.0	±3.5	7/64/29	Unclear	-0.13	±0.43	-0.45	±1.41
Yo-YoIR1 Test	Distance (m)	35.3	±21.9	99/1/0	Very likely moderate	1.05	±0.53	7.21	±3.26
CMJ test	CMJ_h (cm)	7.9	±6.1	90/10/0	Likely small	0.56	±0.41	2.10	±1.44
	PPO ($W\cdot kg^{-1}$)	9.9	±5.9	97/3/0	Very likely moderate	0.74	±0.41	3.43	±1.80
	PF ($N\cdot kg^{-1}$)	11.0	±5.2	99/1/0	Very likely moderate	1.01	±0.45	2.89	±1.31
	PPO (W)	-14.2	±5.0	0/0/100	Almost certain moderate	-1.09	±0.43	-5.71	±2.24
	PF (N)	-13.3	±4.7	0/0/100	Almost certain moderate	-1.14	±0.46	-3.47	±1.45
				FORWARDS VS CENTRES					
Anthropometric	Stature (cm)	-2.8	±1.1	0/0/100	Almost certain moderate	-1.00	±0.41	-	
	Body mass (kg)	-8.6	±3.1	0/0/100	Almost certain moderate	-1.10	±0.41	-12.39	±4.23
	Body fat (%)	-1.5	±1.6	1/32/67	Possibly small	-0.41	±0.45	-0.42	±0.46
Mognoni's Test	$MOG_{[La-]}$ ($mmol\cdot L^{-1}$)	-14.3	±14.3	1/29/70	Possibly small	-0.39	±0.44	-1.78	±1.91
	MOG_{HR} (bpm)	1.0	±3.1	34/59/7	Unclear	0.12	±0.42	1.29	±4.18
HIT	$HIT_{[La-]}$ ($mmol\cdot L^{-1}$)	-5.7	±19.3	8/59/33	Unclear	-0.11	±0.46	-0.46	±1.84
	$HIT_{[H+]}$ ($mmol\cdot L^{-1}$)	2.6	±7.9	31/63/6	Unclear	0.15	±0.47	0.49	±1.55
	$HIT_{[HCO3-]}$ ($mmol\cdot L^{-1}$)	4.6	±8.2	52/45/3	Possibly small	0.26	±0.45	0.64	±1.12
	HIT_{HR} (bpm)	0.8	±3.4	29/62/9	Unclear	0.07	±0.41	0.35	±1.76
Yo-YoIR1 Test	Distance (m)	15.0	±18.9	79/19/2	Likely small	0.40	±0.53	3.06	±3.56
CMJ test	CMJ_h (cm)	6.3	±6.5	74/26/0	Possibly small	0.45	±0.45	1.66	±1.65
	PPO ($W\cdot kg^{-1}$)	7.4	±6.2	85/15/0	Likely small	0.56	±0.45	2.57	±2.02
	PF ($N\cdot kg^{-1}$)	6.0	±5.0	85/15/0	Likely small	0.54	±0.44	1.59	±1.27
	PPO (W)	-2.4	±5.9	5/60/35	Possibly trivial	-0.17	±0.47	-0.97	±2.63
	PF (N)	-3.6	±4.9	1/41/58	Possibly small	-0.33	±0.44	-0.95	±1.24

Abbreviations: *, in percentage; CL, confidence limits; CMJh, Counter-movement jump height; ES, effect size; MBI (%), percent of chances of positive/trivial/negative effects; MOG, Mognoni's test; HIT, High-intensity Intermittent Test; HR, heart rate; PPO, peak power output; PF, peak force; SNR, Signal to noise ratio; [H+], blood hydrogen ion concentration; [HCO3-], blood bicarbonates concentration; [La-], blood lactate concentration.