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Training Load and Match-Play Performance in Collegiate Division I Basketball

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ABSTRACT

Purpose: This study examined the relationship between training load and match-play team performance in the subsequent game. ***Methods:*** Training load for a NCAA Division I Basketball team was tracked over a 3-year period; 225 practices were observed and recorded. Training load was classified as total duration of training and duration of full-court 5-versus-5 (5v5) during training. In-game performance was tracked for 92 matches during this period. Training load was organized into 48-hours prior to competition (MD-2), 24-hours prior to competition (MD-1), Total Duration, Average Duration, Totals 5v5, and Average 5v5. Performance was determined on how the team faired against the closing point spread differential (CPSD). Training durations were categorized into quartiles representing “very long” (mean ± standard deviation, 219 ± 16 min), “long” (170 ± 15 min), “short” (140 ± 18 min), and “very short” (107 ± 14 min) sessions. A linear mixed model was used to assess the differences among “very long”, “long”, “short”, and “very short” sessions. ***Results:*** Both MD-1 training duration (p = 0.01) and MD-2 training duration (p = 0.03) leading into matches had significant impacts on CPSD outcomes, with longer sessions associated with poorer performances. ***Conclusion:*** Training duration in preparation for competition had a significant impact on ensuing performances. These findings have implications for the acute distribution of high and low training load leading into competition.

Keywords: basketball training; team sports; duration; team performance; points spread

INTRODUCTION

Basketball is a sport requiring players to repeatedly run, jump, accelerate, decelerate, and change direction during competition (1-4). These physical demands are measured either by the athlete’s pyscho-physiological effects such as heart rate and perceived exertion (internal loads), or the results of work done mechanically such as speed and distance (external loads) (19). Monitoring and managing basketball training load is critical for creating an optimal environment for athlete success (5-8), and becomes of particular importance during the competitive season (9). Assessing athletes’ adaptive response to training-imposed stressors provides insight into modulations of both short-term and long-term training (12-14). Once the athlete has demonstrated the ability to tolerate the demands of competition, practitioners can modify training to increase athlete’s readiness for match-play (10-11).

While there is still debate over the best approach for quantifying and applying training load (20-24), the ultimate goal of training load monitoring is to ensure athletes maintain a proper dosage of training to optimize match-play performance (15-18). Previous research has examined the relationship between training load and performance (29,30). For example, Aughey et al. investigated the effect of weekly internal load on wins and losses in elite Australian football; greater acute training load was evident in the weeks where matches were won (30). While wins and losses may be the most important game outcome measure, they alone can be misleading since they do not account for the quality of opponent and how each team was projected to perform during match-play.

Despite the perceived link between training load and performance, very little research has investigated the relationship between basketball training load and match outcomes. Point spreads may be a more valid way to assess outcome because they consider several factors such as recent performances of each team, strength of schedule, location of the game, injuries, and various other factors (28,25). Both economic and financial journals have previously investigated the accuracy of oddsmakers spreads in forecasting outcomes (26,27). The closing point spread differential (CPSD)—the difference between the margin of victory and the closing point spread of a game (28) —has been proposed as a novel way of evaluating projected performance based on the quality of opponent.

Despite the common use of CPSD in sports and the proposed utility of this approach for evaluating basketball performance, no previous research has examined the relationship between training load data and subsequent match-play performance in elite basketball. Furthermore, no published study has used oddsmakers point spreads to account for quality of opponent and gauge in-game performances. Therefore, the purpose of this study is to investigate the effect of basketball practice duration on team performance, as indicated by CPSD. This research will be pertinent in helping coaches make sound decisions on the application of training load during the competitive season.

METHODS

Participants

Training load data was collected from a single NCAA Division I collegiate basketball team during three consecutive seasons (n=21 athletes, 20 ± 1.1 years, 1.93 ± 0.1 m, 92 ± 11kg). Of this cohort of athletes 3 athletes played one season, 13 played two seasons, while 5 athletes competed in all three seasons. Across the 3-year period, 225 practice sessions and 92 matches were recorded. All data was collected between the months of November 2015 and March 2018 by the strength and conditioning staff as routine for daily assessment of training load. Institutional approval was given through the University Internal Review Board (IRB).

Design

Training volume was recorded as the total duration of training, whereas training intensity was indicated by the total duration of full-court 5-versus-5 scrimmage play (5v5). During basketball training sessions 5v5 was agreed upon as the most intense practice drill by the technical/tactical staff, and most closely replicated the physical demands of match-play. Each training session duration was tracked via stopwatch and manually input into a customized spreadsheet (Microsoft ExcelTM 2016, USA). Training duration and 5v5 duration were further classified as being 48-hours prior to competition (MD-2), or 24-hours prior to competition (MD-1). Average duration was represented as the averages of all practices in preparation for a given competition (i.e., total duration/# of practices), whereas total duration and total 5v5 were expressed as the aggregate of all practices before competition (Table 1). Tracking averages and totals of duration and 5v5 was done to account for the variable nature of the collegiate basketball competitive schedule. Early during each season, the competition schedule fluctuated and had as many as 3 practices leading into a competition; while the latter part of the competitive season schedule was consistent with 2 practices (i.e., MD-1; MD-2) leading into competition. However, all 92 matches examined in this study had a MD-1 and MD-2 in anticipation for competition. Averages and totals for duration and 5v5 were used to normalize for the seasonal variations of the competitive collegiate basketball season. All training load combinations were compared to how the team performed against the spread (CPSD).

Match-play performance was assessed from 92 matches based on how the team performed relative to the forecasted oddsmakers. Point spreads were obtained from a longitudinal database on the world-wide-web (covers.com), which lists the CPSD for all games in NCAA Division I Basketball dating back to the 2006-2007 season. For this study, we analyzed

Table 1. Description of training load variables.

Training Load Variable	Description
Closing Point Spread Differential (CPSD)	This was the difference between the spread and actual score, or how the team fared against the spread.
Duration MD-2	Duration of training for the session 48-hours prior to competition (MD-2)
5v5 MD-2	Duration of 5v5 full-court for the session 48-hours prior to competition (MD-2)
Duration MD-1	Duration of training for the session 24-hours prior to competition (MD-1)
5v5 MD-1	Duration of 5v5 full-court for the session 24-hours prior to competition (MD-1)
Total Duration	The aggregate of duration for all training sessions leading into competition
Average Duration	The average duration for all training session leading into competition (i.e., Total Duration/# of practices)
Total 5v5	The aggregate of duration of 5v5 full-court for all training sessions leading into competition

if (1) training load influenced performance relative to the CPSD, and (2) the dose-response relationship between training load and performance.

For the analysis, training data was organized into quartiles based on the distribution of training duration. The four categories were defined as “very long”, “long”, “short”, and “very short” training durations to determine the effect, and magnitude of training load on performance against the published point spread. “Above” games were considered an above-average performance because the team outperformed the spread, and “below” games were considered a below-average performance because the team did not cover the spread. This method was used to account for the quality of opponent during competition. For example, a loss in a game may have still yielded an “above” performance if the team covered the forecasted points spread.

Data was summarized as mean, standard deviation, and 95% confidence interval (Table 2). Normality and homogeneity of variance were checked via Shapiro-Wilk test (<0 50). Total duration and 5v5 duration for MD-2, and MD-1 across both days were determined for “very long”, “long”, “short”, and “very short” training sessions and compared fitting linear mixed models (alpha = 0.05). This allowed for the dependent structure among repeated measures variables to be modeled. For the analysis, the category of CPSD was set as the dependent variable, training MD-1 and MD-2 were set as the fixed effects, and training duration and 5v5 were considered random effects.

RESULTS

Table 2 shows the distribution of training load for “very long”, “long”, “short”, and “very short” sessions. Duration MD-1 ($p=0.01$), Duration MD-2 ($p=0.03$), and Total Duration ($p=0.02$) leading into competition all had a significant impact on the team’s CPSD performance.

Figure 1 is a boxplot showing the influence of total Training Duration on performance CPSD when organized into “very short”, “short”, “long”, and “very long” categories. Figure 2 shows the distribution of training duration MD-1 relative to the spread when organized into “very short”, “short”, “long”, and “very long” categories. Figure 3 demonstrates the distribution of training duration MD-2 relative to the spread when organized into “very short”, “short”, “long”, and “very long” categories. Longer sessions were associated with poorer performances.

Table 2. Training and match-play durations in Very Long, Long, Short and Very Short sessions.

	Very Long	Long	Short	Very Short	p-value	(95% CI)
Duration MD-1 (min)	97 ± 9	83 ± 12	74 ± 13	60 ± 11	0.01	(-0.9-3.8)
5v5 MD-1 (min)	17 ± 3	16 ± 4	12 ± 5	9 ± 4	0.55	(-0.4-0.1)
Duration MD-2 (min)	121 ± 15	75 ± 22	65 ± 20	47 ± 17	0.03	(-0.5-0.9)
5v5 MD-2 (min)	23 ± 8	14 ± 8	9 ± 6	1 ± 2	0.82	(-0.03-0.4)
Total Duration (min)	219 ± 16	170 ± 15	140 ± 18	107 ± 14	0.02	(2.4-16.9)
Average Duration (min)	109 ± 8	85 ± 7	70 ± 9	53 ± 7	0.11	(-0.3-0.5)

5v5, 5 versus 5 full-court; MD-1, Matchday -1; MD-2, Matchday -2; Intensity %, Duration/5v5 Duration; CI, confidence interval *P < 0.05.

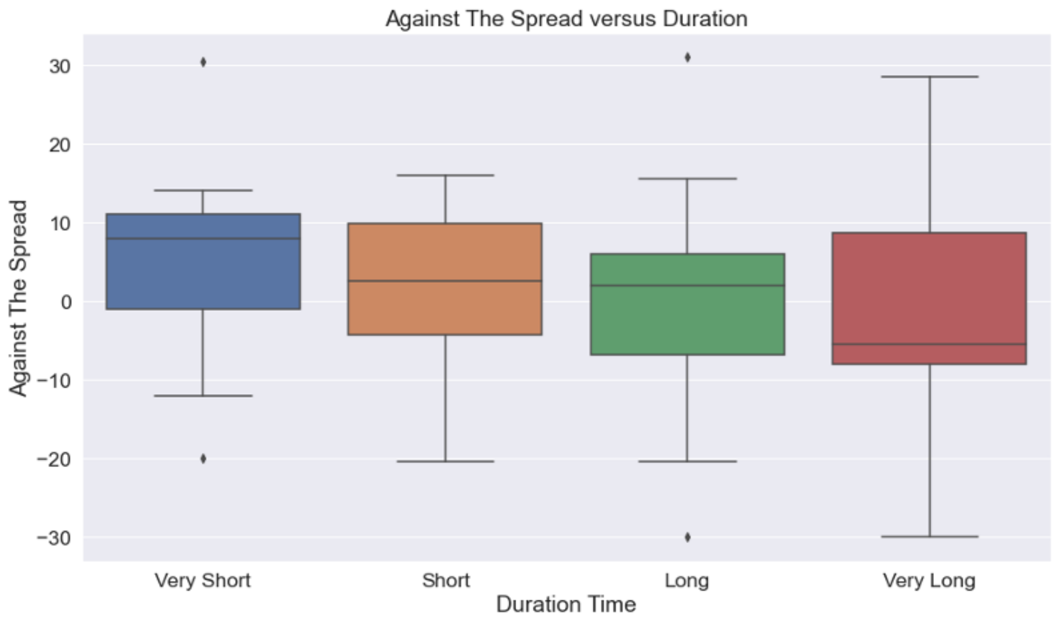

Figure 1. Box Plot examining Total Duration versus ATS. Duration was classified as Very Short (0-129 min.) Short (130-150 min.) Long (151-200) and Very Long (201-259).

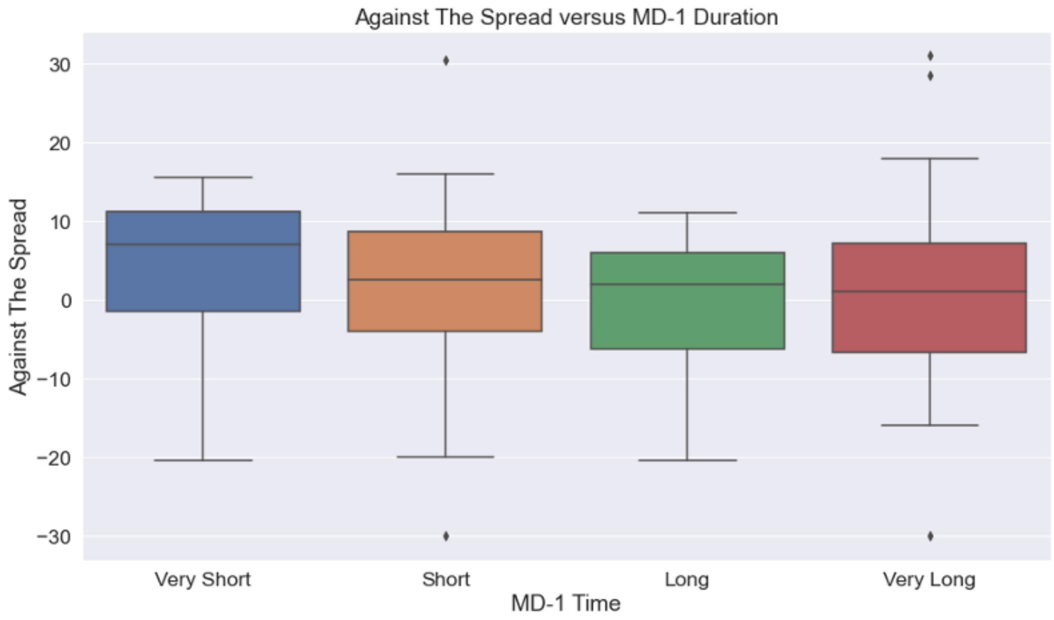

Figure 2. Box Plot examining MD-1 Training Duration versus ATS. Duration was classified as Very Short (0-60 min.) Short (61-75 min.) Long (76-90) and Very Long (90-120).

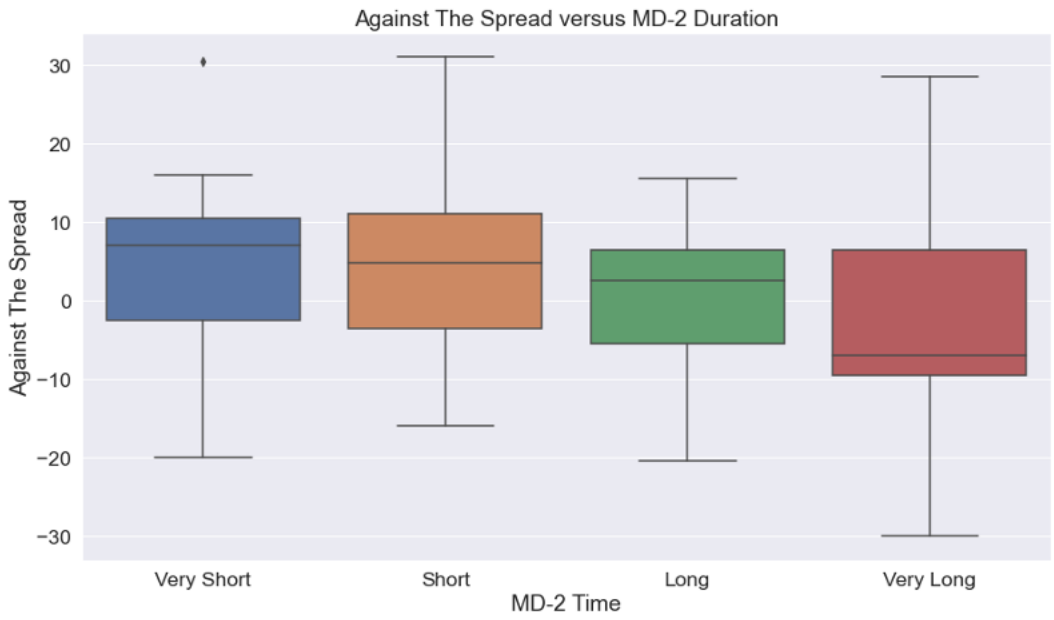

Figure 3. Box Plot examining Duration MD-2 versus ATS. Duration was classified as Very Short (0-50 min.) Short (51-80 min.) Long (81-120) and Very Long (121-200).

DISCUSSION

The present study examined the effects of preceding training load on ensuing match performance in collegiate basketball. The main findings indicate that in preparation for competition, higher duration training sessions yielded poorer team performance outcomes when compared to the forecasted spread. These results suggest that longer practices one day prior to competition may have deleterious effects on match-play performance.

The current findings suggest there is an acute dose-response relationship between training load and match-play performances. The present study is novel in that it uses longitudinal data over multiple years and a standardized and repeatable means of quantifying the effects of training load on match-play performance. When comparing the application of a training stimulus relative to match-play, MD-1 had a greater impact on in-game performance than MD-2. Similar results have recently been replicated within the literature (31). For example, Olthof et al. found that player performance was increased when training load was greater MD-2 compared to MD-1 in NCAA Division I basketball (31). These findings may be expected given that higher intensity training in the 24-hours before competition would generate greater acute fatigue. Also, of note relative to the present study, when training duration was high in all of the practices in preparation for competition, the match-play results were poor. Therefore, practitioners may be advised to undulate high and low training when sequencing sessions in preparation for competition.

The limitations of the present study should be addressed. Firstly, only five athletes competed on the team for all three seasons. Also, total duration and duration of 5v5 were the only training load metrics recorded. This does not account for total mechanical values applied during training as well as internal load. However, examination of 106 training sessions from the pre-season and in-season periods of the 2015-2016 season confirmed that training sessions with higher 5v5 duration also yielded greater mechanical loads (as measured from accelerometry data, Zephyr BioharnessTM, Zephyr Technology Corporation, Annapolis, MD, US). Therefore, duration of 5v5 served as a proxy for training intensity in this study. Nevertheless, 225 training sessions and 92 matches were examined over a 3-year period with the universal and reliable metric of duration. Future studies could perform an in-depth analysis of training duration and scaled intensity of training drills to examine the effects of training volume and intensity on match-play performance. Secondly, it is important to consider the individual response to a training stimulus. Training and in-game performance were measured for the entire team; however, some individual athletes may have responded differently based on the applied stimulus. This also does not account for the need for supplemental fitness items during training for athletes not playing high minutes during competition. The main purpose of the present study was to examine the influence of preceding training load on performance outcomes in a team environment. Individual needs within the team should be examined thoroughly in future research.

In summary, shorter duration practices leading into match-play resulted in better team performances in basketball. Training MD-1 had more of an impact on in-game performance than MD-2. These findings could impact the application of training load during the competitive season. Coaches should consider the duration and intensity of in-season practice in order to optimize match outcomes.

CONCLUSION AND PRACTICAL APPLICATIONS

The findings of this study have important implications for the sequencing of training load in preparation for match-play. This information can be extremely helpful to coaches and practitioners attempting to create an ideal state of physiological readiness in preparation for competition. Once the athlete has demonstrated adequate levels of game fitness, it may be more advantageous for coaches to focus on technical and tactical development rather than rigorous training sessions involving a high volume of accelerations, decelerations, and changes of direction. Conversely, if practitioners feel that these intense training sessions are necessary during season, they should be placed as far away from competition as possible based on the game schedule.

The accumulation of longer duration practices during the competitive season resulted in worse performance in the ensuing competitions over a 3-season period in elite collegiate basketball. The training performed in the 24-hours prior to competition had the greatest impact on subsequent performance. If duration of training for all training sessions leading into competition were high, the results were poor. In turn, the duration of training further away from competition had less of an impact on in-game performance. These finding shed light on the prescription of training load leading into competition. Ultimately, the goal of training is to prepare athletes for competition. The present results suggest that reducing training intensity leading into competition may increase the likelihood of optimal performance.

REFERENCES

1. Petway AJ, Freitas TT, Calleja-Gonza´lez J, Medina Leal D, Alcaraz PE. Training load and match-play demands in basketball based on competition level: A systematic review. PLoS One. 2020;15(3): e0229212. DOI: 10.1371/journal.pone.0229212
2. Sampaio J, McGarry T, Calleja-Gonza´lez J, Jime´nez Sa´iz S, Schelling i del Alca´zar X, Balciunas M, et al. Exploring game performance in the National Basketball Association using player tracking data. PLoS One. 2015;10(7):1–14. DOI: 10.1371/journal.pone.0132894
3. Svilar L, Jukić I, Castellano J, et al. Load monitoring system in top-level basketball team: relationship between internal and external training load. Kinesiology. 2018; 50(1): 25–33. DOI: 10.26582/k.50.1.4
4. Conte D, Kolb N, Scanlan AT, Santolamazza F, et al. Monitoring training load and well-being during the in-season phase in National Collegiate Athletic Association Division I men's basketball. Int J Sports Physiol Perform. 2018;13(8):1067–1074. DOI: 10.1123/ijspp.2017-0689
5. Manzi V, D'Ottavio S, Impellizzeri F, Chaouachi A, Chamari K, Castagna C, et al. Profile of weekly training load in elite male professional basketball players. J Strength Cond Res. 2010; 24(5):1399–1406. DOI: 10.1519/JSC.0b013e3181d7552a
6. Petway, A.J.; Freitas, T.T.; Calleja-Gonzalez, J.; Torres-Ronda, L.; Alcaraz, P.E. Seasonal variations in game activity profiles and players' neuromuscular performance in collegiate division I basketball: Non-conference vs. Conference Tournament. Frontiers. 2020;2,2705. DOI: 10.3389/fspor.2020.592705
7. Heishman AD, Curtis M, Saliba E, Hornett R, Malin S, Weltman A, et al. Noninvasive assessment of internal and external player load: implications for optimizing athletic performance. J Strength Cond Res. 2018;32(5):1280–1287. DOI: 10.1519/JSC.0000000000002413
8. Aoki MS, Torres Ronda L, Marcelino PR, Drago G, Carling C, Bradley PS, et al. Monitoring training loads in professional basketball players engaged in a periodized training program. J Strength Cond Res. 2016;31(2): 348–358. DOI: 10.1519/JSC.0000000000001507
9. Bowen L, Gross AS, Gimpel M, Li FX. Accumulated workloads and the acute:chronic workload ratio relate to injury risk in elite youth football players. Br J Sports Med. 2017;51(5):452–459. DOI: 10.1136/bjsports-2015-095820
10. Menaspà P. Are rolling averages a good way to assess training load for injury prevention? Br J Sports Med. 2017;51(7):618–619. DOI: 10.1136/bjsports-2016-096131
11. Buchheit M, Racinais S, Bilsborough JC, et al. Monitoring fitness, fatigue and running performance during a pre-season training camp in elite football players. J Sci Med Sport. 2013;16(6):550–555. DOI: 10.1016/j.jsams.2012.12.003
12. Huxley DJ, O'Connor D, Healey PA. An examination of the training profiles and injuries in elite youth track and field athletes. Eur J Sport Sci. 2014;14(2):185–192. DOI: 10.1080/17461391.2013.809153
13. Lyman S, Fleisig GS, Andrews JR, Osinski ED. Effect of pitch type, pitch count, and pitching mechanics on risk of elbow and shoulder pain in youth baseball pitchers. Am J Sports Med. 2002;30(4):463–468. DOI: 10.1177/03635465020300040201
14. Dennis RJ, Finch CF, Farhart PJ. Is bowling workload a risk factor for injury to Australian junior cricket fast bowlers? Br J Sports Med. 2005;39(11):843–846. DOI: 10.1136/bjsm.2005.018515
15. Ferioli D, Bosio A, Bilsborough JC, La Torre A, Tornaghi M, Rampinini E, et al. The preparation period in basketball: training load and neuromuscular adaptations. Int J Sports Physiol Perform. 2018;13(8):991–999. DOI: 10.1123/ijspp.2017-0434
16. Scanlan A, Wen N, Tucker P, Dalbo V et al. The relationships between internal and external training load models during basketball training. J Strength Cond Res. 2014;28(9):2397–2405. DOI: 10.1519/JSC.0000000000000458
17. Busso T. Variable dose-response relationship between exercise training and performance. Med Sci Sports Exerc. 2003;35(7):1188–1195. DOI: 10.1249/01.MSS.0000074465.13621.37
18. Scanlan A, Fox J, Borges N, Dascombe B, Dalbo V, et al. Cumulative training dose effects on interrelationships between common training-load models during basketball activity. Int J Sports Physiol Perform. 2017;12(2):168–174. DOI: 10.1123/ijspp.2015-0708
19. Schelling X, Torres L. accelerometer load profiles for basketball-specific drills in elite players. J Sports Sci Med. 2016;15(4):585–591.
20. Fox JL, Stanton R, Scanlan AT. A Comparison of training and competition demands in semiprofessional male basketball players. Res Q Exerc Sport. 2018;89(1):103–111. DOI: 10.1080/02701367.2017.1410693
21. Akenhead R, French D, Thompson KG, Hayes PR. The acceleration dependent validity and reliability of 10 Hz GPS. J Sci Med Sport. 2014;17(5):562–566. DOI: 10.1016/j.jsams.2013.08.005
22. Jennings D, Cormack S, Coutts AJ, Boyd LJ, Aughey RJ. Variability of GPS units for measuring distance in team sport movements. Int J Sports Physiol Perform. 2010;5(4):565–569. DOI: doi.org/10.1123/ijspp.5.4.565
23. Varley MC, Fairweather IH, Aughey RJ. Validity and reliability of GPS for measuring instantaneous velocity

during acceleration, deceleration, and constant motion. J Sports Sci. 2012;30(2):121–127. DOI: 10.1080/02640414.2011.627941
24. Linke D, Link D, Lames M. Validation of electronic performance and tracking systems EPTS under field conditions. PLoS ONE. 2018;13(7): e0199519. DOI: 10.1371/journal.pone.0199519
25. Hoffer A, Pincin JA. Quantifying NFL players' value with the help of vegas point spreads values. J Sports Econ. 2019; 152700251983206. DOI: 10.1177/1527002519832060
26. Stern, H. On the probability of winning a football game. Am Stat.1991;45,179–183. DOI: 10.1080/00031305.1991.10475798
27. Pankoff LD. Market efficiency and football betting. J Bus. 1968;41:203–214. DOI: 10.1086/295077
28. Paul RJ, Weinbach AP, Coate P. Expectations and voting in the NCAA football polls: The wisdom of point spread markets. J Sports Econ. 2007;8(4):412-424. DOI: 10.1177/1527002506287696
29. Hulin BT, Gabbett TJ, Pickworth NJ, Johnston RD, Jenkins DG. Relationships among player load, high-intensity intermittent running ability, and injury risk in professional rugby league players. Int J Sports Physiol Perform. 2019;14:1-7. DOI: 10.1123/ijspp.2019-0139
30. Aughey RJ, Elias GP, Esmaeili A. Lazarus B, Stewart AM. Does the recent internal load and strain on players affect match outcome in elite Australian football? J Sci Med Sport. 2015; DOI: 10.1016/j.jsams.2015.02.005
31. Olthof SB, Tureen T, Tran L, Brennan B, Winograd B, Zernicke RF. Biomechanical loads and their effects on player performance in NCAA D-I male basketball games. Front. Sports Act. Living. 2021; DOI: 10.3389/fspor.2021.670018