Title: The between-week reliability of neuromuscular, endocrine, and mood markers in soccer players and the repeatability of the movement demands during small-sided games.

Running head: Reliability of responses to small-sided games.

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ABSTRACT

BACKGROUND: Establishing the reliability and repeatability of both the movement demands and the consequential responses of athletes applied settings is important. Therefore, the primary aim of this study was to assess the between-week reliability of potential fatigue monitoring methods in soccer players. Secondary aims were to establish the repeatability of the movement demands and the changes in monitoring variables from the same small-sided game (SSG) protocol programmed on consecutive weeks. METHODS: Twelve semi-professional soccer players (age, 21±2 years; mass, 80.1±6.8kg; height, 1.81±0.06m) performed the same SSG protocol (4vs4+goalkeepers; 6x7-min, 2-min inter-set recovery) separated by 7 days. Movement demands were monitored using global positioning systems (GPS), with countermovement jump (CMJ), saliva (testosterone and cortisol), and brief assessment of mood (BAM+) collected immediately pre and post SSG training. RESULTS: Results suggest that CMJ variables and hormonal markers have good between-week reliability when measuring athletes at rest (CV, 2.1–7.7%; ICC, 0.82–0.98), however BAM+ did not (CV, 23.5%; ICC, 0.47). GPS variables presented *low* to *high* repeatability during SSG training, with reliability statistics varying between metrics (CV, 4.4–62.4%; ICC, 0.30–0.81). In detecting responses from pre- to post-SSG training, CMJ and hormonal markers showed *moderate* to *very-high* reliability (ICC, 0.68–0.99), whilst BAM + did not (ICC, 0.12). CONCLUSIONS: The findings from this study suggest CMJ and hormonal markers provide good between-week reliability, yet caution should be applied when using short subjective questionnaires. Additionally, some movement demands may not be repeatable when programming the same SSG session on separate occasions.

Key words: monitoring, GPS, soccer, SSG, reliability.

INTRODUCTION

Soccer players perform a high volume of training sessions and matches which can result in positive adaptations, as well as acute and chronic fatigue (43, 44, 45). If the schedule is managed inappropriately, it is possible that underperformance or increased risk of injury may occur (43, 44, 45). Accordingly, monitoring player workload and the consequential responses of athletes is very common in team sports, with the intent of well informed decisions on training prescription and recovery protocols (3, 45, 60). There are a wide range of methods typically implemented, including but not limited to: global positioning systems (GPS), heart rate (HR) analyses, ratings of perceived exertion (RPE), athlete self-report questionnaires, physical performance tests, and various biomarkers (3, 23, 25, 60, 61). However, concerns around the reliability of some monitoring strategies and the logistical feasibility of consistently collecting them may decrease their value in applied settings (3, 11).

Countermovement jump (CMJ) performance is a well-established marker of neuromuscular function used to determine chronic adaptations (i.e., changes that occur after a training cycle or block) and acute responses (i.e., changes that occur immediately and in the hours and days that follow) to both training and competition (19, 20, 21, 32, 44, 46, 60). Performing a CMJ on a force plate permits the calculation of numerous variables, with jump height (JH) and markers of power output being the most commonly reported metrics (18, 19, 32, 56, 61). Furthermore, A survey from 41 elite soccer clubs revealed that 78% of clubs used self-report questionnaires as a tool to determine the overall well-being of players and their ability to undertake training (3). Despite a wide range of literature in this area and numerous questionnaires developed for this purpose (23, 33, 38, 48, 55, 57, 60), there is no consensus on the most appropriate method to use. Due to concerns around the sporting specificity and length of time to complete some of these questionnaires, many teams and organisations have developed their own customised, shorter questionnaires (3, 23, 60, 61). In addition, practitioners and researchers may benefit from monitoring biomarkers that reflect the role of the endocrine system in response to exercise, and there is evidence that acute changes in hormone concentrations can influence athletic performance (17, 49). In particular, the hormones testosterone (T) and cortisol (C) have received much focus in sports and exercise science literature (8, 9, 19, 17, 49, 56). Elevated T is associated with greater muscle hypertrophy, strength, power, cognitive function, and motivation (17, 49). On the other hand, C is considered an indicative stress hormone that reflects catabolic activity (9, 19, 56). As T and C concentrations are thought to vary in distinct ways in response to exercise, the ratio between them (T/C) is commonly reported as a marker of anabolic versus catabolic activity (8, 9, 19, 56).

When selecting an appropriate monitoring tool, an important factor to consider is whether the measure holds an acceptable level of test-retest consistency (i.e., reliability) when repeated within a practical timeframe (7, 30). Concerning the above monitoring markers highlighted, there is often limited information on the between-week reliability and also the consistency of the changes in these markers in response to training exercises in soccer players. This should be both established and considered before informing important programming decisions based on the data (7, 23).

During soccer training, small-sided games (SSGs) are a very popular tool utilised by coaches to optimise training time, as they are often thought of as being able to simultaneously replicate some of the physical, technical and tactical demands of competition (10, 29, 52, 56). Indeed, it has been repeatedly shown that some SSG formats can induce similar aerobic adaptations to interval training (5, 6, 10, 52), whilst simultaneously working with the ball and maintaining the enjoyment of the players (5, 54). Much of the focus in previous literature has characterised the internal and external demands of SSGs, via HR analyses, GPS data, blood lactate responses, and RPE (4, 12, 16, 29, 54). While many studies have shown that manipulating variables such as the playing area, the number of players and the rules of the game can influence the acute physiological and perceptual response (4, 10, 12, 16, 29, 52), it is less well understood how reproducible the movement demands when the same SSG protocol is repeated on separate occasions, particularly in well-trained soccer players (14).

Understanding the repeatability of the movement demands during SSGs and the consequential responses of athletes may be of interest to those responsible for the design of soccer training programs. Therefore, this study aimed to assess the between-week reliability of potential monitoring methods in soccer, and also the repeatability of the movement demands and responses to the same SSG protocol repeated on separate occasions.

MATERIALS AND METHODS

Experimental approach to the problem

This study profiled the movement demands and the responses to two SSG training sessions performed under the same conditions but separated by 7 days. The study took place midway through the 2017-18 competitive season and players were in the maintenance phase of their training programs. On a typical microcycle, which consisted of 1 game·week^{-1}, players completed two on field training sessions (~ 60 – 90-min) and one resistance-training session (~1-hour). The SSG training session was performed 2 days prior to match day, with players being given 3 days of rest prior to each protocol. Movement demands during SSG training were monitored using 10 Hz GPS devices, with CMJ performance (peak power output, PPO; jump height, JH), saliva (T and C concentrations), and brief assessment of mood (BAM+) collected immediately before (pre) and after (post) SSG training during both protocols.

Subjects

Data are presented from 12 male semi-professional soccer players (age: 21 ± 2 years, mass: 80.1 ± 6.8 kg, height: 1.81 ± 0.06 m). Despite the involvement of goalkeepers in the SSG protocol, only data from outfield players were included in the analyses. All players were healthy and injury free at the time of data collection. Ethical approval was granted by the ethics advisory board of Swansea University (ethical approval number= 2016-003). Participants were informed of the risks and benefits and provided written informed consent prior to participation if they opted in.

Main trial procedures

On arrival at the training centre (17:00 h), pre-salivary samples, BAM+, and CMJ performance were assessed. Prior to CMJ testing, players completed a 5-min standardized warm up consisting of jogging and dynamic stretching, with focus on the lower body musculature. The SSG training session began at 17:30 h and players wore 10Hz GPS devices. Immediately post completion of SSG training, CMJ performance, saliva, and BAM+ were reassessed. The methodological procedure was repeated with the same conditions and timings on the following week.

************ INSERT FIGURE 1 HERE ************

Mood assessment

Mood state was assessed using a modified version of the brief assessment of mood questionnaire (BAM+) (9, 55, 56). This 10-item questionnaire is based on the Profile of Mood State assessment (22) and consists of a scale where athletes mark on a 100 mm line stating how they feel at that moment in time. Scale anchors ranged from 'not at all' to 'extremely'. The questions assess the following mood adjectives: anger, confusion, depression, fatigue, tension, alertness, confidence, muscle soreness, motivation, and sleep quality. Players completed the questionnaires in isolation of teammates, and it took approximately 2-min to complete. The BAM+ has been shown to be sensitive in monitoring the fatigue and recovery responses to competition in elite soccer (55) and netball (9). The scores were totalled up into a composite rating of mood by giving the six unfavourable questions (i.e., anger, confusion, depression, fatigue, tension, muscle soreness) a positive value, and the four favourable questions (i.e., alertness, confidence, motivation and sleep quality) a negative value. The original total mood score ranged from -40 – 60, before adding 40 to each score so that the scale ranged from 0 – 100, with 0 indicating the best mood and 100 indicating the worst mood.

Countermovement jump performance

A portable force platform (Type 92866AA, Kistler) was used to measure neuromuscular performance of the lower body. Two CMJs were performed at maximum effort, with arms akimbo to isolate the lower body musculature. The vertical ground reaction forces from the jumps were used to determine PPO from previously established methods (46). Additionally, JH was calculated by multiplying the velocity at each sampling point by the time (0.005 s) and was then defined as the difference between vertical displacement at take-off and maximal vertical displacement. As CMJs were performed in duplicate at each timepoint, the intra-day test-retest (i.e., between jumps at the same timepoint) coefficient of variations (CV%) for PPO and JH were 2.3% and 3.2%, respectively. The best trial was included in the subsequent analyses.

Hormonal analysis

At both timepoints, 2 ml of saliva was collected via passive drool into sterile containers, which were subsequently stored at -80 °C until assay (22). After thawing and centrifugation (2000 revolutions·min^{-1} x 10 min), the saliva samples were analysed in duplicate for T and C concentrations using commercially available kits (Salimetrics LLC, USA). To prevent saliva contamination, participants refrained from eating, brushing their teeth, or drinking fluids other than water in the hour before sampling. Samples for each participant were assayed in the same plate to eliminate inter-assay variability. The minimum detection limit for the T assay was 6.1 pg·ml^{-1} with an inter-assay CV of 5.8%. The C assay had a detection limit of 0.12 ng·ml^{-1} with inter-assay CV of 5.5%.

Small-sided games

The SSG format complemented the players normal training regime and was similar to previous literature (34, 56). After a standardized 5-min warm up, consisting of dynamic stretching and short sprints, players were split into 4 teams of 5 players by coaching staff. The teams were organized so that the playing positions were balanced within and between-teams (e.g., 1 goalkeeper, 1 defender, 1 midfielder, 1 winger, and 1 attacker). Players competed against the other team for 6 blocks of 7-min (overall worktime = 42-min) with 2-min given between each repetition for players to passively rest and drink water ad libitum. Pitch size was 24 by 29 m (width x length) and full-sized regulation goals with goalkeepers were used. Players were allowed unlimited touches of the ball (i.e., free play) and the aim was to win each individual SSG repetition (i.e., score more goals than the opposition). The total time of the training session (from the start of the warm-up to the players leaving the field) was 1-hour.

Movement demands

The movement demands of the SSGs were collected via 10 Hz GPS units embedded with 100 Hz tri-axial accelerometers (OptimEye S5, Catapult Innovations, Melbourne, Australia). Each player wore the same GPS unit across the study period, and it was harnessed to their upper back using a specifically designed vest garment provided by the manufacturer. Data were downloaded and processed automatically using Catapult Sports software (Openfield, Catapult Innovations, Melbourne, Australia). GPS derived metrics reported in the current study were total distance, moderate-speed running (MSR), high-speed running (HSR), maximum velocity (MV), player load [Playerload™], and high-intensity (HI) accelerations and decelerations. The MSR and HSR thresholds were defined as the distance (m) covered at a velocity greater than $\geq 4\ m \cdot s^{-1}$ and $\geq 5.5\ m \cdot s^{-1}$, respectively, and were set in line with previous work in soccer time-motion analysis (51, 56, 59). Playerload™ is defined as the sum of gravitational forces on the accelerometer in each individual axial plane (anteroposterior, mediolateral, and vertical), and has been reported previously in soccer time-motion analysis (47, 56). HI accelerations and decelerations were operationally defined and were included when a change in velocity of $\geq 3\ m \cdot s^{-2}$ occurred (2, 51). It is well established across the literature that 10Hz GPS devices hold an acceptable level of reliability and validity when tracking team sport movements (53, 62).

Statistical analysis

After screening data for normality, week 1 vs week 2 reliability was calculated for each variable and expressed as the standard error of the mean (SEM), coefficient of variation (CV%) and two-way mixed effects intraclass correlation coefficient (ICC), using a custom-made spreadsheet (31). To define the reliability of the data, an acceptable threshold of <10% for CV was set (23, 30). For ICC, qualitative inferences were based on the following thresholds: <0.2%, *very low*; 0.20 – 0.50%, *low*; 0.50 – 0.75, *moderate*; 0.75 – 0.90%, *high*; ≥0.90%, *very high* (37). The minimum detectable change (MDC; 75% confidence level) was also calculated to determine the minimum change that could be considered “real” (63).

RESULTS

Monitoring variables pre SSG

Reliability data for the monitoring variables at pre SSG on week 1 vs week 2 are presented in Table 1. ICC values for PPO, T, C and T/C were all >0.90 (*very high*), whilst JH was 0.82 (*high)* and BAM+ was 0.47 (*low)*. All variables met the acceptable criteria for CV (<10%), apart from the BAM+ (CV= 23.5%). The SEM and MDC are reported in Table 1.

*********** INSERT TABLE 1 HERE **********

Movement demands of SSGs

Repeatability data for the GPS outputs from the SSGs on week 1 vs week 2 are presented in Table 2. CV values for total distance, MV and Playerload^{TM} were 5.9%, 4.4% and 7.5% respectively, which met the acceptance criteria for reliability (CV <10%). However, CV values for MSR, HSR, and HI accelerations and decelerations were all >10%. ICC for total distance, MSR, HSR, MV and Playerload^{TM} ranged from 0.54 – 0.70, which were classified as *moderate*. ICC for HI accelerations and decelerations were 0.81 (*high*) and 0.30 (*low*), respectively. The SEM and MDC for each GPS metric are displayed in Table 2.

********** **INSERT TABLE 2 HERE** **********

Pre to post SSG changes in monitoring variables

The consistency of the changes in monitoring variables from pre to post SSG on week 1 vs week 2 are presented in Table 3. ICC for the changes in T, C and T/C were 0.93, 0.99, and 0.85, respectively (*high – very high*). Changes in both CMJ variables presented as *moderate*, with ICC values for JH and PPO being 0.77 and 0.68, respectively. The ICC for the changes in BAM+ was 0.12 (*very low*). SEM and MDC are presented in Table 3.

************ INSERT TABLE 3 HERE ************

DISCUSSION

The primary aims of this study were to assess the between-week reliability of potential fatigue monitoring methods in soccer players, both at rest and in response to an SSG training session. Furthermore, this study aimed to establish the repeatability of the GPS measured movement demands during the same SSG format performed on separate weeks but under the same conditions. Endocrine and CMJ variables showed good reliability when measured at rest, whilst a short subjective questionnaire did not (Table 1). The GPS measured movement demands during SSG training presented a metric dependant repeatability, with distances covered at higher velocities and changes in velocity more variable than other metrics (Table 2). In detecting the responses from pre to post SSG training, the endocrine and CMJ markers showed *moderate* to *high* consistency, whilst the subjective questionnaire did not (Table 3).

CMJ testing is a popular method utilized in professional sport to measure neuromuscular function. In the current study, the test-retest data obtained from the athletes at rest (pre-SSGs) fell in line with previous work in this area, with both CMJ variables presenting CV values of less than 5% (Table 1) (18, 23, 41). When comparing between both CMJ variables measured at rest in the current study, PPO showed the highest reliability with an ICC of 0.95 (*very high*) and a CV of 2.1%, whilst JH held an ICC of 0.82 (*high*) and a CV of 3.9% (Table 1). The data here supports previous research that suggests both force platform measured variables (PPO and JH) are reliable when assessing athletes at rest.

When assessing the consistency of both CMJ variables in the current study in detecting the changes from pre to post SSG training, PPO and JH presented ICC values of 0.68 and 0.77 respectively, which were both classified as *moderate* (Table 3). Whilst some researchers have questioned the sensitivity of JH as a metric to detect true changes in the neuromuscular system due to participants altering the mechanics of their jump to maintain the greatest possible height (19), the data here suggest it was as consistent as PPO in assessing these changes. However, it cannot be discounted that if practitioners or researchers have the necessary means (i.e., a force plate sampling >1000 Hz), then monitoring PPO or other jump derived metrics (i.e., mean force, peak velocity, or time to take-off), at least in conjunction with JH, may be of benefit to give a comprehensive representation of neuromuscular function and its pattern in response to exercise.

The hormonal markers in the present study all presented *very high* between-week reliability when testing the athletes pre SSGs, with ICC values for T, C and T/C all ≥0.93, and CV values ≤7.7% (Table 1). In addition, the hormonal markers presented the best consistency of all the variables in the changes from pre to post SSG training, with ICC values ≥0.85 (*high – very high*). This is an interesting finding considering that some researchers have previously raised questions concerning the large inter and intra-individual variability in these markers, particularly in response to exercise (8). On the surface, it seems possible that the consistent pre to post response of the hormonal markers could reflect the normal circadian patterns of T and C (35, 58), as opposed to a response of the SSGs. However, given that T concentrations were consistently maintained during both SSG protocols (Table 3), it could be theorised that the metabolic stress accumulated during the SSGs alleviated the normal circadian declines in T, which supports previous work in this area (17, 49). The data presented in the current study supports the use of salivary T, C and the ratio between them as reliable and consistent markers to assess hormonal changes in response to exercise and across training weeks.

The self-report questionnaire used to assess mood in the current study showed poor between-week reliability, both in assessing athlete status at rest and also in the changes from pre to post SSG training. This is possibly due to the short length of the BAM+ (i.e., 10 questions) and also as we present a total summation of mood score expressed as a composite of all 10 questions asked. Longer questionnaires such as the Recovery-Stress questionnaire have shown large test-retest correlations ($r = 0.79$) (33). However, due to the length of completion (76 questions), this is unlikely to be practical when implementing this method regularly with athletes. Our findings agree with a recent study which reported that a 5-point questionnaire held poor reliability when assessed 7 days apart in elite-youth soccer players (23). This, along with data presented in the current study, suggests that practitioners should use caution when influencing programming decisions guided solely by the results of short, subjective questionnaires, particularly when a composite score for total wellbeing is applied (23). Researchers and practitioners would also be advised to seek to establish the reliability of these questionnaires when developing them internally and recognise the potential trade-off between the length of completion time and reliability.

The between-session reproducibility of the movement demands during SSG training is a topic that has gained increased interest recently (14). In the present study, GPS derived metrics for total distance, Playerload^{TM}, and MV showed *moderate* repeatability with ICC values ranging from 0.55 – 0.70 and CV values ≤7.5% (Table 2). Perhaps most notably, the variables most associated with muscle damage and fatigue in soccer (24, 44, 49) presented the lowest consistency, with distances covered at higher speeds (i.e., MSR and HSR) and changes in velocity (i.e., HI accelerations and decelerations) presenting CV values ranging from 17.5 – 62.4%. These findings agree with previous literature in this area over a range of SSG scenarios (e.g., 1 vs 1 – 6 vs 6), which suggests that total distance and summary data derived from accelerometers are relatively stable (CV ~1 – 8%) between-sessions, whereas distances covered at high speeds and acceleration and deceleration activities are generally reported as more variable (CV ~7 – 146%) (1, 15, 28, 40, 64). This is perhaps unsurprising given that the movement demands of soccer are habitually random and uncontrolled, and indeed, previous authors have suggested that one of the benefits of running-based interval training over SSG training is that player speed and work rate can be controlled more efficiently (36). This may have important implications for monitoring, and practitioners would be advised to pay close attention to the external load of players during SSG activities and identify the players who are doing significantly more or less than expected by the coaching or sports science staff (13). Then, a strategy of complimenting the SSGs with additional tasks (e.g., isolated HSR or speed drills) may be beneficial if the training session aim is to expose highlighted players to those demands (13). Alternatively, some players may be exposed to more external load than projected, and if the training session aims to taper for an upcoming competition or match, then practitioners should be aware of this and make changes accordingly.

Whilst this study has high ecological validity as it presents data from in-season semi-professional soccer players, it is noted that there are some limitations to the present study and potential areas for future research. Firstly, no internal load measures (i.e., HR) were recorded during the SSG training, which may have presented a more comprehensive measure of the overall demands. Secondly, whilst we focused on the most popular CMJ derived metrics highlighted in previous literature (i.e., PPO and JH), it would have been interesting to include additional force platform derived metrics (e.g., mean power, peak velocity, rate of force development), or other jumps (e.g., squat jumps, drop jumps) to assess their reliability in this context. Finally, the findings presented here are representative of the participants recruited (*n* =12), the monitoring variables selected and the SSG format chosen, therefore future research may be beneficial to assess the reliability of other metrics, with larger sample sizes, and the physical demands of other formats of SSG (e.g., 2 vs 2 – 8 vs 8) in different pitch area sizes. Nevertheless, there are numerous practical applications which can be derived from this study.

PRACTICAL APPLICATIONS

- When monitoring athlete status at rest and the changes from pre- to post-training, force platform derived CMJ variables (PPO and JH) and endocrine markers (T, C, and T/C) have displayed good between-week reliability, suggesting practitioners can have confidence in these markers when influencing programming decisions.
- Caution should be used when making decisions based solely on data derived from short subjective questionnaires without first determining its reliability, particularly when a composite score of overall mood is applied.
- Movement demands show variable dependent reproducibility during the same SSG format repeated on separate occasions. Total distance and Playerload^{TM} may be stable metrics to monitor, whereas the metrics most associated with fatigue in soccer (i.e., HSR and intense changes in velocity) may be more variable.
- It is suggested that practitioners closely monitor the HSR and changes in velocity produced by each athlete and determine whether they are performing more or less than expected. Then, depending on the physical goals of the training session set by the coaching staff, or time in the microcycle, a strategy of implementing isolated running drills may be necessary when attempting to target certain metrics that have not been achieved using SSG (e.g., HSR or intense changes in velocity). Alternatively, players may be exposed to more external load than projected, therefore reducing their load in subsequent training exercises or sessions may be warranted.

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DECLARATION OF INTEREST STATEMENT

The authors report no conflict of interest.

AUTHORS CONTRIBUTIONS

All authors contributed equally to the manuscript and read and approved the final version of the manuscript

Figure 1. Schematic to show study design.

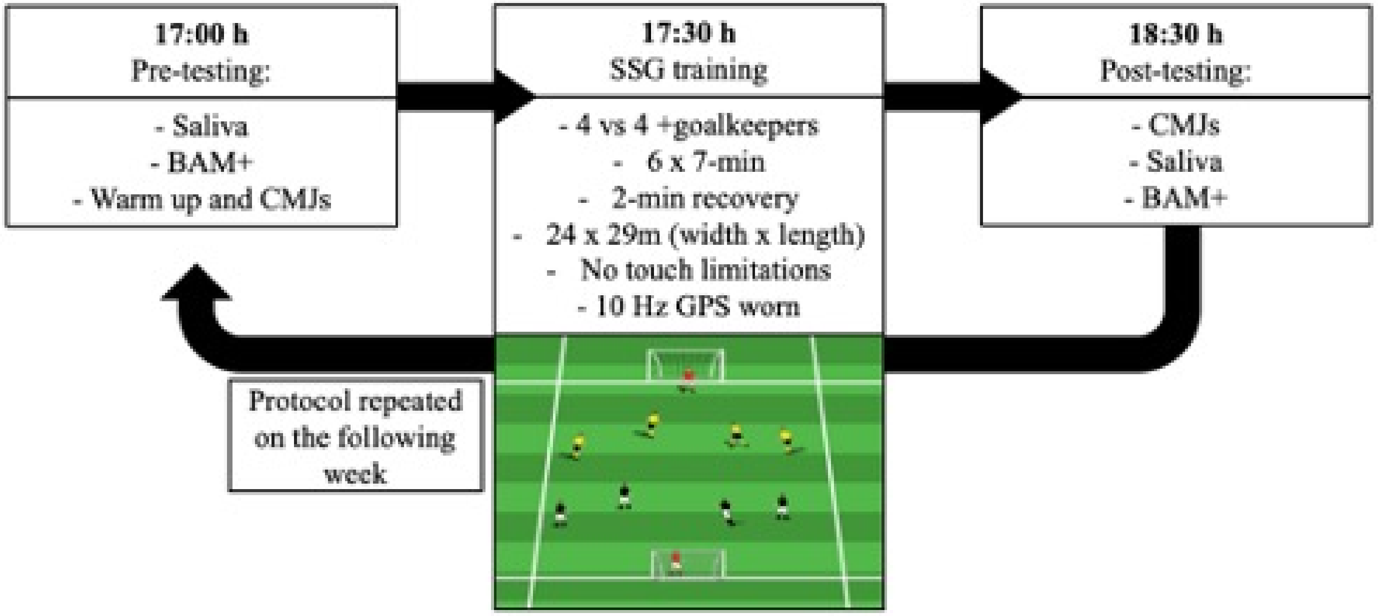

Table 1. Reliability data for monitoring variables at pre SSGs on week 1 vs week 2. Data are presented as group means (±SD) and mean differences (95% CI). Statistics are presented as interclass correlation coefficient (ICC), coefficient of variation (CV%), standard error of the mean (SEM) and minimum detectable change (MDC) (75% confidence level).

	Pre SSG week 1 (SD)	**Pre SSG week 2 (SD)**	**Mean difference (95% CI)**	**ICC (95% CI)**	**CV% (95% CI)**	**SEM**	**MDC**
Jump height (cm)	36.3 (4.1)	35.3 (3.6)	-1.0 (-2.6, 0.6)	0.82 (0.41, 0.93)	3.9 (1.8, 6.0)	2.3	3.8
Peak power output (W)	4235 (115)	4140 (111)	-95 (-203, 13)	0.95 (0.84, 0.99)	2.1 (0.7, 3.5)	152	248
Mood score (AU)	29.0 (9.0)	32.9 (12.6)	3.9 (-3.6, 11.3)	0.47 (-0.11, 0.81)	23.5 (13.5, 33.6)	11.5	18.7
Testosterone ($pg \cdot ml^{-1}$)	195.2 (66.9)	194.9 (66.8)	-0.3 (-8.7, 8.0)	0.98 (0.95, 1.00)	4.0 (3.0, 5.0)	11.6	18.9
Cortisol ($ug \cdot dl^{-1}$)	0.538 (0.210)	0.530 (0.186)	-0.008 (-0.057, 0.040)	0.94 (0.81, 0.98)	7.7 (4.3, 11.0)	0.068	0.111
T/C Ratio (AU)	384.3 (109.4)	390.4 (133.6)	6.1 (-26.0, 38.1)	0.93 (0.78, 0.98)	7.6 (4.6, 10.5)	45.3	73.7

Table 2. Repeatability data for the GPS outputs from the SSG session on week 1 vs week 2. Data are presented as group means (±SD) and mean differences (95% CI). Statistics are presented as interclass correlation coefficient (ICC), coefficient of variation (CV%), standard error of the mean (SEM) and minimum detectable change (MDC) (75% confidence level).

	Week 1 (SD)	**Week 2 (SD)**	**Mean difference (95% CI)**	**ICC (95% CI)**	**CV% (95% CI)**	**SEM**	**MDC**
Total distance (m)	4475 (397)	4315 (641)	-160 (-469, 148)	0.63 (0.12, 0.88)	5.9 (2.0, 9.9)	465	757
Moderate-speed running (≥4 $m \cdot s^{-1}$) (m)	278 (115)	311 (111)	33 (-33, 99)	0.62 (0.10, 0.87)	22.1 (11.8, 32.5)	100	162
High-speed running (≥5.5 $m \cdot s^{-1}$) (m)	21 (22)	30 (35)	9 (-9, 27)	0.54 (-0.01, 0.84)	62.4 (30.8, 94.1)	28.1	45.7
Maximum velocity (km/h)	21.5 (1.9)	21.6 (1.6)	0.0 (-1.1, 1.1)	0.55 (0, 0.85)	4.4 (1.9, 6.8)	1.7	2.7
Playerload™ (AU)	452 (59)	444 (85)	-8 (-46, 30)	0.70 (0.24, 0.90)	7.5 (3.7, 11.4)	56	92
HI accelerations (>3 $m \cdot s^{-2}$)	10 (5)	10 (4)	0.2 (-1.8, 2.1)	0.81 (0.46, 0.94)	17.5 (5.4, 29.5)	3	5
HI decelerations (>3 $m \cdot s^{-2}$)	18 (6)	15 (5)	-3.8 (-8.3, 0.8)	0.30 (-0.31, 0.73)	29.0 (18.5, 39.5)	7	12

Table 3. Reliability data for the changes in monitoring variables pre to post SSGs on week 1 vs week 2. Data are presented as group means (±SD) and mean differences (95% CI). Statistics are presented as interclass correlation coefficient (ICC), standard error of the mean (SEM) and minimum detectable change (MDC) (75% confidence level).

	Pre to post change week 1 (SD)	**Pre to post change week 2 (SD)**	**Mean difference (95% CI)**	**ICC (95% CI)**	**SEM**	**MDC**
Jump height (cm)	-1.5 (2.8)	-1.8 (3.8)	-0.3 (-1.9, 1.2)	0.77 (0.37, 0.93)	2.2	3.6
Peak power output (W)	-41 (277)	-80 (288)	-39 (-191, 113)	0.68 (0.21, 0.90)	225	366
Mood Score (AU)	10.5 (11.2)	10.1 (7.4)	-0.4 (-9.4, 8.5)	0.12 (-0.46, 0.63)	14.2	23.1
Testosterone ($pg \cdot ml^{-1}$)	3.5 (33.1)	3.1 (36.3)	-0.4 (-9.4, 8.6)	0.93 (0.79, 0.98)	12.7	20.6
Cortisol ($ug \cdot dl^{-1}$)	-0.038 (0.294)	-0.018 (0.282)	0.020 (-0.007, 0.047)	0.99 (0.97, 1.0)	0.037	0.060
T/C Ratio (AU)	137 (325)	75 (183)	-62 (-162, 37)	0.85 (0.57, 0.96)	144	235