Title: Game-simulation drill design alters the speed profiles of wheelchair rugby players

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ABSTRACT

Purpose: This study examined the speed profiles of elite wheelchair rugby (WCR) players during game-simulation training drills of differing player number and shot-clock regulations. A secondary aim was to determine whether the profiles were further influenced by players classification. **Methods:** Eight elite WCR players (low-point *n* = 3; high-point *n* = 5) were monitored using a radio-frequency based, indoor tracking system during training sessions over a 5-month period. Speed profiles were collected for three modified game-simulation drills: i) 3 vs. 3 drills (*n* = 8 observations); ii) 30-s shot-clock (*n* = 24 observations) and iii) 15-s shot-clock (*n* = 16 observations) and were compared with regular game-simulation drills (4 vs. 4, 40-s shot-clock; *n* = 16 observations). Measures included mean and peak speed, exercise intensity ratios – defined as the ratio of time spent performing at high and low speeds (H:L) and the number of high speed activities performed. **Results:** Compared to regular game-simulation drills, 3 vs. 3 drills elicited a moderate increase in mean speed (6.3%; effect size [ES] = 0.7) and the number of high speed activities performed (44.1%; ES = 1.1). Minimal changes in speed profiles were observed during the 30-s shot clock, although moderate to large increases in all measures were observed during the 15-s shot-clock drills. Classification-specific differences were further identified, with increased activity observed for high-point players during the 3 vs. 3 drill and for low-point players during the 15-s shot-clock. **Conclusion:** By reducing the number of players on court and the shot-clock to 15-s coaches can significantly increase the speed profiles of elite WCR players during game-simulation drills.

Keywords: Physical preparation, classification, Paralympic, training, elite athletes

INTRODUCTION

Wheelchair rugby (WCR) is a Paralympic team sport played by individuals with an impairment that affects both upper and lower limbs such as spinal cord injuries, multiple amputations, cerebral palsy and neuro muscular diseases.[1] Given the diversity of impairments, players are classified using a point score depending on the severity of their impairment ranging from 0.5 (most impaired) to 3.5 (least impaired). Teams are made up four players whose total point score must not exceed 8 points at any given time. WCR is played over 8-minute quarters using a 'game-clock' whereby the time is stopped whenever a goal is scored or an offence is committed. Other time regulations exist through the use of a shot-clock, whereby teams have 40-seconds to score a goal once the ball has been inbounded and must advance past the half-way line within 12-seconds otherwise possession is conceded.[2]

Recent research has revealed that WCR is an intermittent sport with players typically covering distances of 2500-4600 m during competition,[3,4] with the majority of time spent performing low speed activities interspersed with frequent bouts of high speed activities.[3] Classification has also been shown to affect activity profiles during competition with greater distances covered and higher peak speeds reached in higher classification players. Moreover, low-point players (≤1.5) spend more time at very low speeds, yet perform more frequent high speed activities than high-point players (≥2.0).[3] Furthermore, the ability to reach high peak speeds and perform a greater number of high speed activities have been associated with successful performance, specifically in the high-point players. [5] Subsequently, the physical demands of WCR competition have been relatively well documented. The physical preparation of athletes requires a multi-disciplinary approach to session planning whereby coaches and practitioners manipulate the training environment to replicate the demands of international competition.[6] However very few studies have explored the physical demands of WCR training.[7-9] Game-simulation drills are a popular training modality with coaches from a

range of team sports because they enable a combination of technical, tactical and physical elements of performance to be developed under competition-specific conditions and were shown to account for 44% of total training time in WCR.[9] Rhodes et al.[9] also revealed that game-simulation drills offered the closest representation of the speed profiles observed during elite competition compared to conditioning (continuous pushing drills designed to develop physical capacity), game-related (half-court drills with coach interaction designed to develop tactical plays under game-specific conditions) and skill-based drills (structured drills designed to develop ball-handling skills). Despite this, subtle differences in speed profiles were observed between game-simulation drills depending on the duration and timing method enforced. It was revealed that 3- and 8-minute game-simulation drills using a 'game-clock' underrepresented the peak speeds and high speed activities observed during competition.[9] Alternatively a 10-minute running clock, whereby timing is continuous and not paused at any point, provided a better representation of competition-specific speed profiles, irrespective of classification.[9] While such results have provided an insight into current WCR training practice, it is currently unclear how game-simulation drills can best be utilised to prepare elite WCR players.

Research in able-bodied team sports have extended the examination of game-simulation drills to explore the impact of manipulating the number of players on court during game-simulation drills[10-16] and modified game rules[12] on players' activity profiles. By reducing player numbers, players have been shown to spend more time performing high speed activities during rugby-[14] and soccer-specific[15] drills. Unfortunately no such information exists with regards to WCR. It is also essential to understand the variability typically observed in activity profiles to determine whether any differences between training modalities are meaningful, which has been adopted by research into able-bodied team sports.[17-19] Subsequently the aim of the current study was to firstly determine the between

observation variability in speed profiles during regular WCR game-simulation drills. The primary objective was then to compare the speed profiles of elite WCR players during game-simulation drills, whilst modifying both player number and shot-clock regulations, in relation to regular game-simulation drills. A secondary aim was to determine whether these comparisons were further affected by classification. This information can support coaches and/or sports science practitioners in the periodisation of court-based training in preparation for competition.

METHODS

Participants

Eight international WCR players (age: 27.3 ± 5.3 years; mass: 60.9 ± 10.2 kg) provided written informed consent and volunteered to participate in this study. Players were grouped by their International Wheelchair Rugby Federation (IWRF) classification as either low-point (≤1.5; LP: n = 3) or high-point players (≥2.0; HP; n = 5). Written informed consent was obtained from all players and approval for the study was obtained by the University's ethical advisory committee.

Procedures

Data were collected during an elite international WCR squad's training sessions over a 5-month period throughout the competitive phase of the season (January to May; 30 training observations). In consultation with the Head Coach and Sport Scientist, three separate variations of WCR-specific game-simulation drills were developed and the subsequent speed profiles were compared to regular game-simulation drills. Speed profiles were monitored for all player's on-court using a radio-frequency based Indoor Tracking System [ITS] (Ubisense, Cambridge, UK) as previously described and validated for use within WCR.[20] Players were

equipped with a small, lightweight tag (size = 40 x 40 x 10 mm; mass = 25 g) sampling at 8 Hz, positioned on or near the foot-strap of each player's rugby wheelchair. Each player wore the same tag unit during all testing sessions to exclude any potential tag variability. Players were instructed to maintain normal fluid intake and cooling strategies, and no additional dietary interventions were undertaken. All players were familiar with the ITS and its operational procedures.

Players were allocated into balanced teams according to their physical, technical and tactical proficiency, as determined by the head coach and also according to their IWRF classification for each drill. The maximum classification permitted was reduced from 8.0 points to 6.0 points during the 3 vs. 3 format to ensure that teams were balanced according to their classification. The court size (28 m x 15 m), clock format (running-clock), team line-ups and the overall duration (10-minute quarters) of all drills were strictly controlled based on findings from previous research.[9] Three game-simulation drills were developed, whereby the player number and shot-clock regulations were modified. These included a) 3 vs. 3 game format (n = 8 training observations); and modifications to the shot-clock regulations to evaluate b) 30-second shot-clock (n = 24 training observations); and c) 15-second shot-clock (n = 16 training observations) during 4 vs. 4 game formats. The shot-clock was started once a team were in possession of the ball, of which they had the stipulated time to score otherwise, they conceded possession. The speed profiles of all modified drills were compared to that of regular game-simulation drills with a 10-minute running-clock format and 40-second shot clock (n = 16 observations). The order in which the drills were performed were randomly varied across the collection period, with a training observation characterised for each individual as the accumulation of activity observed during the respective four quarters of that drill. Speed profiles for game-simulation drills were therefore presented as the mean of all training observations for each individual player. Game-simulation drills were preceded by a

20-minute standardised warm-up involving moderate- to high-intensity continuous pushing, dynamic stretching and maximal linear sprints. Coaches verbally encouraged the players throughout the drills.

Measures

Mean and peak speed ($m \cdot s^{-1}$) were analysed during the aforementioned training drills for each player. The relative time spent in five arbitrary speed zones was calculated based upon the percentage of each player's mean peak speed attained during the regular game-simulation drills. The percentage thresholds as previously used in team sports,[3,21] were: very low (≤ 20%), low (21-50%), moderate (51-80%), high (81-95%) and very high (> 95%). These thresholds were subsequently used to calculate the ratio of time spent performing high speed activities (high and very high speed zones) in relation to low speed activities (very low and low speed zones) to determine the exercise-intensity ratio (H:L) as used previously within WCR.[9] Further analysis of the combined time spent in high and very high speed zones was extended to include the time spent (%), relative number ($n \cdot min^{-1}$), and the mean distance (m) and duration (s) of high speed activities.

Statistical Analyses

Data were processed and analysed using a customised Excel spreadsheet (Microsoft, Redmond, USA). Data are presented as mean ± SD for each parameter reported. Between-observation variability of the measures was calculated from the regular game-simulation drills (10-minute running-clock, 40-second shot clock) from a larger cohort of athletes (n = 26 observations; LP = 10 observations; HP = 16 observations)[9] and were expressed using the coefficient of variation (CV [%]) and presented with 95% confidence limits (CL) as markers of the estimates uncertainty. Effect sizes (ES) were calculated as the ratio of the mean difference to the pooled standard deviation of the difference. Data were interpreted using ES

with 95% confidence intervals (± CI) and the percentage change to determine the magnitude of effects, classified as trivial < 0.2; small 0.2 to 0.6; moderate 0.6 to 1.2; large 1.2 to 2.0; and very large > 2.0.[22] The smallest worthwhile change (SWC; %) in speed profiles were defined as 0.2 multiplied by the between subject standard deviation.[23] The SWC in measures were again calculated from the larger cohort, and can be used to interpret the magnitude of effects reported here. This statistical approach was utilised to identify worthwhile changes in performance while accounting for the variability of measurement.

RESULTS

The between-observation variability and SWC in speed profiles are reported in Table 1. Overall, variability was greatest for the time spent performing high speed activities (22.4% CV) and the relative number of high speed activities performed (16.0% CV). Lowest variability was observed for mean (1.9% CV) and peak speed values (2.4% CV). Between-observation variability was also shown to be greater in LP compared to HP (Table 1).

TABLE 1 ABOUT HERE

Table 2 illustrates the speed profiles observed during modified game-simulation drills in relation to regular game-simulation drills, with Figure 1 demonstrating the magnitude of any differences between these drills. Compared to regular game-simulation drills, the 3 vs. 3 drills elicited a moderate increase in mean speed (6.3%; ES = 0.6; 95% CI 0.4 to 0.8), the exercise-intensity ratio (15.1%; ES = 0.8; 95% CI 0.5 to 1.1), time spent performing high speed activities (44.1%; ES = 1.1; 95% CI 0.8 to 1.4) and the relative number of high speed

activities (43.5%; ES = 1.0; 95% CI 0.8 to 1.2) performed (Figure 1). Only trivial to small increases in speed profiles were observed during the 30-second shot-clock compared to regular game-simulation drills (Figure 1). Large increases in mean speed (12.9%; ES = 1.5; 95% CI 1.4 to 1.6), peak speed (8.8%; ES = 1.3; 95% CI 1.1 to 1.5) and the relative number of high-intensity activities performed (57.1%; ES = 1.3; 95% CI 1.0 to 1.6) were observed during the 15-second shot clock in relation regular game-simulation drills. Moderate increases in the exercise-intensity ratio (15.1%; ES = 0.6; 95% CI 0.3 to 0.9) and the time spent performing high speed activities (27.1%; ES = 0.8; 95% CI 0.6 to 1.0) were also observed during the 15-second shot-clock (Figure 1).

TABLE 2 ABOUT HERE

FIGURE 1 ABOUT HERE

Table 3 demonstrates the speed profiles of both classification groups during the modified game-simulation drills compared to regular game-simulation drills, with the corresponding effect sizes illustrated in Figure 2. When categorised by classification, the 3 vs. 3 drills elicited large increases in mean speed (10.1%; ES = 1.6; 95% CI 1.4 to 1.8) and the exercise-intensity ratio (18.4%; ES = 1.2; 95% CI 1.0 to 1.4) and a moderate increase in the relative number of high speed activities performed (25.0%; ES = 1.0; 95% CI 0.8 to 1.2) for HP compared with regular game-simulation drills. During the 30-second shot-clock drill, moderate to large decreases in peak speed (1.7%; ES = 0.7; 95% CI 0.5 to 0.9), the relative time spent performing high speed activities (22.6%; ES = 1.4; 95% CI 1.1 to 1.7) and the mean distance (21.0%; ES = 1.1; 95% CI 0.9 to 1.3) and duration (22.9%; ES = 1.1; 95% CI

0.8 to 1.4) of these activities were observed in relation to regular game-simulation drills for LP (Figure 2). Alternatively, the 15-second shot-clock drills elicited large to very large increases in mean speed (19.7%; ES = 2.0; 95% CI 1.8 to 2.2), peak speed (11.9%; ES = 1.8; 95% CI 1.6 to 2.0), exercise-intensity ratio (40.9%; ES = 2.3; 95% CI 2.0 to 2.6), the time spent performing high speed activities (41.9%; ES = 1.4; 95% CI 1.1 to 1.7) and the relative number of high-intensity activities (62.5%; ES = 1.4; 95% CI 1.2 to 1.6) performed by LP (Figure 2). For HP, large increases in mean speed (10.0%; ES = 1.2; 95% CI 1.0 to 1.4), peak speed (7.4%; ES = 1.3; 95% CI 1.1 to 1.5) and the relative number of high-intensity activities performed (50.0%; ES = 1.2; 95% CI 1.0 to 1.4) were observed in relation to regular game-simulation drills.

TABLE 3 ABOUT HERE

FIGURE 2 ABOUT HERE

DISCUSSION

Changes in player number and shot-clock regulations both influenced the speed profiles of elite WCR players during game-simulation training drills. Classification-specific differences in speed profiles were also identified between drills, most notably during the 3 vs. 3 and 15-second shot clock manipulations for LP and HP respectively. These findings provide an evidence-base upon which to plan and periodise classification-specific training strategies to prepare players for international competition.

The current study was the first to explore the variability in speed profiles during WCR training to facilitate the detection of meaningful changes in performance. Mean (1.9% CV)

and peak speed (2.4% CV) were shown to be the most stable measures of speed profiles during WCR game-simulation drills, which were similar to the variations reported in peak speed for soccer (2.4% CV),[17] rugby league (3.6% CV)[18] and Australian football (5.3% CV).[19] In contrast, the variability in high speed activities observed in the current study (16-39% CV) was slightly greater compared to the aforementioned studies (18-20% CV). Such findings are likely attributable to the notable differences in impairment severity, positional-roles[3,5,24] and physical capacity[25] between players that may influence this variability in high speed profiles. Despite the small cohort of players, descriptive data in relating to classification revealed clear differences in the responses of LP and HP to different drill manipulations. It was originally considered that greater variations in speed profiles would be experienced by HP since they are typically more involved in the play than LP.[5,24] However this was not the case as the largest variations were in fact observed for LP. The speed profiles of LP are thought to be influenced as much by their defensive role on court as opposed to their functional capabilities[5] and as such their roles may have been influenced even further by the modifications to player number and shot-clock regulations thus accounting for the larger between-observation variability. Regardless of classification, these findings suggest caution is required when using high speed activities to interpret changes in a WCR players performance.

Reducing the number of players on court from 4 vs. 4 to 3 vs. 3 whilst maintaining a 40-second shot clock had a substantial effect on the speed profiles observed during game-simulation drills. The relative number of high speed activities performed during the 3 vs. 3 drills increased with a moderate effect compared to regular game-simulation drills. Even though this measure demonstrated large variability (16.0% CV), the magnitude of change detected was twice the CV%, and several orders of magnitude larger than the SWC for this parameter. The greater available court-ratio per player during the 3 vs. 3 drills (70.0 m^2 vs.

52.5 m²) was likely to account for the increased speed profiles based on the positive correlations between increased relative pitch-ratio per player and activity profiles in able-bodied team sports.[11,14,16] Differences in speed profiles during the 3 vs. 3 drill were further influenced by functional classification. Whilst speed profiles were comparable between 3 vs. 3 and regular 4 vs. 4 game-simulation drills for LP, HP performed at a higher mean speed and exercise-intensity ratio during the 3 vs. 3 manipulation. The increased activity for HP was likely due to the positional requirements during these drills. As offensive players, HP are responsible for handling the ball and are typically more involved in the play than LP whose defensive role primarily requires them to block opponents.[5,24] Subsequently, the reduced passing options during 3 vs. 3 drills may instigate an increased activity from HP in order to continually create space to receive the ball. These findings suggest that 3 vs. 3 drills provide a greater stimulus for developing both aerobic and anaerobic capabilities in training than regular game-simulation drills, especially in HP.

Reducing the shot-clock from 40- to 30-seconds had a limited influence on the speed profiles of WCR players. Compared to regular game-simulation drills, the 30-second shot-clock increased the mean speed of players by ~3%. However such a change may have a relatively minor impact on training adaptation as even though minimal variability was reported for mean speed (1.9% CV), the magnitude of change detected during these drills was not large enough to interpret as a worthwhile change. Accordingly, it is important that coaches and practitioners interpret changes based on the magnitude of change, rather than a statistical difference. The comparable profiles between the 30-second shot clock and regular game-simulation drills could be due to the fact that the average time of each offensive-play during competition is typically less than 30-seconds (~23 seconds; unpublished data). Therefore, a reduction from 40- to 30-seconds may not have been substantial enough to significantly alter the activities of WCR players. The comparable speed profiles elicited

during the 30-second shot-clock manipulation drill were not conclusive for LP who experienced a 22.6% decrease in the time spent performing high speed activities. While such a change was larger than the SWC, the magnitude of change detected here was only marginally greater than the CV for this parameter. Therefore, it is unclear whether this change was a true reflection of the demands of this specific drill.

The greatest change in speed profiles were observed when the shot-clock was further reduced to 15-seconds. Large to very large increases in mean and peak speed values occurred during this manipulation. Furthermore, players performed ~57% more high speed activities during the 15-second shot-clock drills (1.1 per minute) compared to regular game-simulation drills (0.7 per minute). The magnitude of change detected during the 15-second shot-clock drill was again more than double the between-observation variability. However, given the high variability of the number of high speed activities observed in the current study, individual responses should be monitored to ensure that all players receive the intended training stimulus.[14] LP actually performed at a greater mean speed (1.43 $m \cdot s^{-1}$) and exercise-intensity ratio (1:2.2) to values previously observed during WCR-specific conditioning drills (1.32 $m \cdot s^{-1}$; 1:2.4).[9] Coaches may therefore achieve the required dose of conditioning for LP, whilst maintaining the sport specificity during the 15-second shot-clock game-simulation drill. An advantage of game-simulation drills is the potential multifunctional training benefit they provide by simultaneously addressing physical, tactical and technical aspects of performance altogether.[13] However, increasing the speed profiles of drills may also elicit changes in the quality of technical actions.[15] It is plausible to suggest players may not be able to consistently sustain the technical skills required and as such, training may become counterproductive in terms of technical performance. Unfortunately, this has not been empirically examined and was outside the scope of this study, although worthy of future investigation.

Future studies could also benefit from exploring other subtle rule changes that could be used to manipulate players' activity profiles during game-simulation drills. For instance, time stipulations could be implemented for teams to cross the half court, to further increase workload. In addition, research into the effects of different number of repetitions of each drill with different rest periods would further benefit coaches with training prescription. As previously reported by Paulson et al.[8] high speed profiles do not always equate to high physiological loads, since maintaining momentum is physically less demanding than activities requiring high intensity accelerations. Unfortunately the indoor tracking system does not sample at a frequency capable of accurately quantifying acceleration to help investigate this statement. However, the inclusion of mean distance and duration of high speed activities does provide coaches with some insight as to whether changes in speed profiles result from longer or more frequent efforts. Subsequently future research would be advised to collect data about acceleration performance during different drill types, but should also explore the effect that these drills can have on a players internal responses as well as the impact the drills may have on aspects of their technical performance. This would provide coaches with even more detailed information about which drills should be prescribed at specific points throughout the season.

PRACTICIAL APPLICATIONS

Although specific training objectives alter throughout the season, the ultimate objective of training during the competitive phase of the season should be to induce similar responses to those encountered during competition. The current data provide evidence that subtle changes to the design of game-simulation drills can influence the external training responses of elite WCR. Coaches can subsequently impose a greater external load on players simply by

reducing the shot-clock to 15-sec. A reduction in player numbers from 4 vs. 4 to 3 vs. 3 is another strategy that can be employed by coaches to overload players, although as previously highlighted this effect was more pronounced for HP. Therefore a players classification must also be considered.

CONCLUSIONS

The current study demonstrated that reducing the shot-clock from 40- to 30-sec during game-simulation drills has little bearing on the speed profiles of elite WCR players, whereas a 15-sec shot clock increased the mean speed and high speed activities experienced by players. A reduction in player numbers from 4 vs. 4 to 3 vs. 3 has a similar impact on the speed profiles of WCR players, although this response was only observed for HP.

REFERENCES

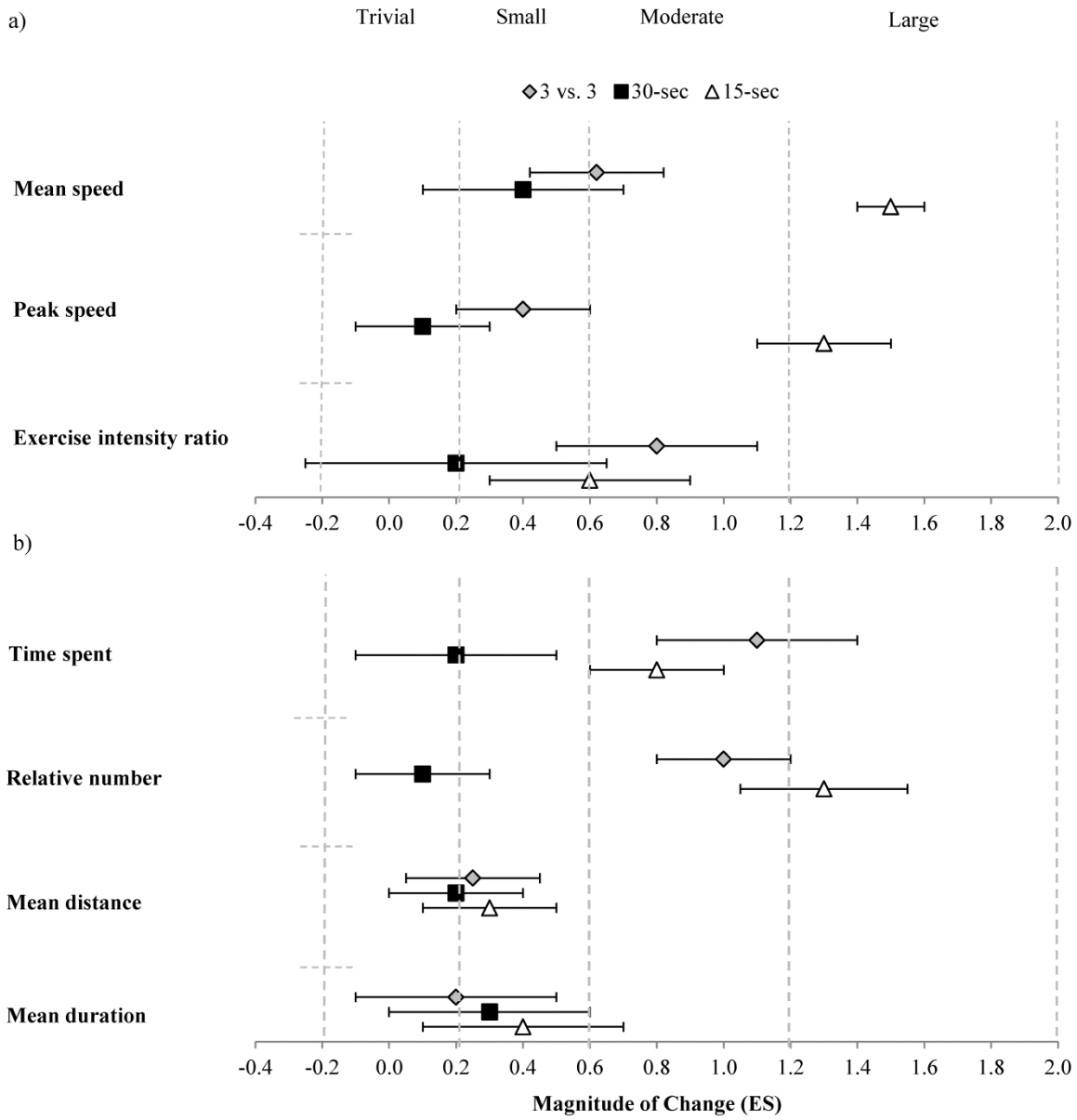
1. International Wheelchair Rugby Federation (IWRF). International wheelchair rugby classification manual 3rd edition revised 2015. Retrieved from http://www.iwrf.com/classification.htm.
2. Orr K, Malone LA. Wheelchair rugby. In: Goosey-Tolfrey, ed. Wheelchair Sport. Leeds, UK: Human Kinetics; 2010:151-166.
3. Rhodes JM, Mason BS, Perrat B, Smith M, Malone LA, Goosey-Tolfrey VL. Activity profiles of elite wheelchair rugby players during competition. *Int J Sports Physiol Perform*. 2015;10:318-324.
4. Sarro KJ, Misuta MS, Burkett B, Malone LA, Barros RML. Tracking of wheelchair rugby players in the 2008 demolition derby final. *J Sports Sci*. 2010;28:193-200.
5. Rhodes JM, Mason BS, Malone LA, Goosey-Tolfrey VL. Effect of team rank and player classification on activity profiles of elite wheelchair rugby players. *J Sports Sci*. 2015;30:2070-2078.
6. White AD, MacFarlane NG. Analysis of international competition and training in men's field hockey by global positioning system and inertial sensor technology. *J Strength Cond Res.* 2015;29:137-143.
7. Barfield J, Malone L, Arbo C, Jung A. Exercise intensity during wheelchair rugby training. *J Sports Sci*. 2010;28:389-398.
8. Paulson TAW, Mason B, Rhodes J, Goosey-Tolfrey VL. Individualized internal and external training load relationships in elite wheelchair rugby players. *Front Physiol*. 2015;6(388):1-7.
9. Rhodes JM, Mason BS, Paulson TAW, Goosey-Tolfrey VL. A comparison of speed profiles between training and competition in elite wheelchair rugby players. *Int J Sports Physiol Perform.* 2016;In Press.
10. Rampinini E, Impellizzeri FM, Castagna C, Abt G, Chamari K, Sassi A, Marcora SM. Factors influencing physiological responses to small-sided soccer games. *J Sports Sci.* 2007;25(6):659-666.
11. Castellano J, Casamichana D. Time–motion, heart rate, perceptual and motor behaviour demands in small-sides soccer games: Effects of pitch size. *J Sports Sci*. 2010;28(14):1615-1623.
12. Hill-Haas SV, Coutts AJ, Dawson BT, Rowsell GJ. Time-motion characteristics and physiological responses of small-sided games in elite youth players: the influence of player number and rule changes. *J Strength Cond Res*. 2010;24(8):2149-2156.
13. Dellal A, Owen A, Wong DP, Krustrup P, Van Exsel M, Mallo J. Technical and physical demands of small vs. large sided games in relation to playing position in elite soccer. *Hum Mov Sci*. 2012;31(4):957-969.
14. Kennett DC, Kempton T, Coutts AJ. Factors affecting exercise intensity in rugby-specific small-sided games. *J Strength Cond Res*. 2012;26(8):2037-2042.
15. Morgans R, Orme P, Anderson L, Drust B. Principles and practices of training for soccer. *J Sport Health Sci*, 3(4), 251-257, 2014.
16. Owen AL, Wong DP, Paul D, Dellal A. Physical and technical comparisons between various-sided games within professional soccer. *Int J Sport Med*. 2014;35(4):286-92.
17. Rampinini E, Coutts AJ, Castagna C, Sassi R, Impellizzeri FM. Variation in top level soccer match performance. *Int J Sports Med*. 2007;28:1018-1024.
18. Kempton T, Sirotic AC, Coutts AJ. Between match variation in professional rugby league competition. *J Sci Med Sport*. 2014;17(4):404-407.

19. Kempton T, Sullivan C, Bilsborough JC, Cordy J, Coutts A J. Match-to-match variation in physical activity and technical skill measures in professional Australian Football. *J Sci Med Sport*. 2015;18(1):109-113.
20. Rhodes JM, Mason BS, Perrat B, Smith M, Goosey-Tolfrey VL. The validity and reliability of a novel indoor player tracking system for use within wheelchair court sports. *J Sports Sci.* 2014;32(17):1639-1647.
21. Cahill N, Lamb K, Worsfold P, Headey R, Murray S. The movement characteristics of English Premiership rugby union players. *J Sports Sci*. 2013;31:229-237.
22. Batterham A, Hopkins W. Making meaningful inferences about magnitudes. *Int J Sport Physiol Perform*. 2006;1:50-57.
23. Hopkins WG. How to interpret changes in an athletic performance test. *Sportscience*. 2004;8:1-7.
24. Morgulec-Adamowicz N, Kosmol A, Bogdan M, Molik B, Rutkowska I, Bednarczuk G. Game efficiency of wheelchair rugby athletes at the 2008 Paralympic Games with regard to player classification. *Hum Mov*. 2010;11:29-36.
25. Morgulec-Adamowicz N, Kosmol A, Molik B, Yilla AB, Laskin J.J. Aerobic, anaerobic, and skill performance with regard to classification in wheelchair rugby athletes. *Res Q for Exerc Sport*. 2011;82(1):61-69.

Figure Legends

Figure 1 - Magnitude of change as determined by effect sizes (ES) in (a) speed profiles; and (b) high speed activities during modified game-simulation drills in relation to regular game-simulation drills. Error bars represent 95% CI.

Figure 2 - Magnitude of change as determined by effect sizes (ES) in (a) speed profiles; and (b) high speed activities for LP (black) and HP (grey) during modified game-simulation drills in relation to regular game-simulation drills. Error bars represent 95% CI.


a)
Trivial
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Moderate
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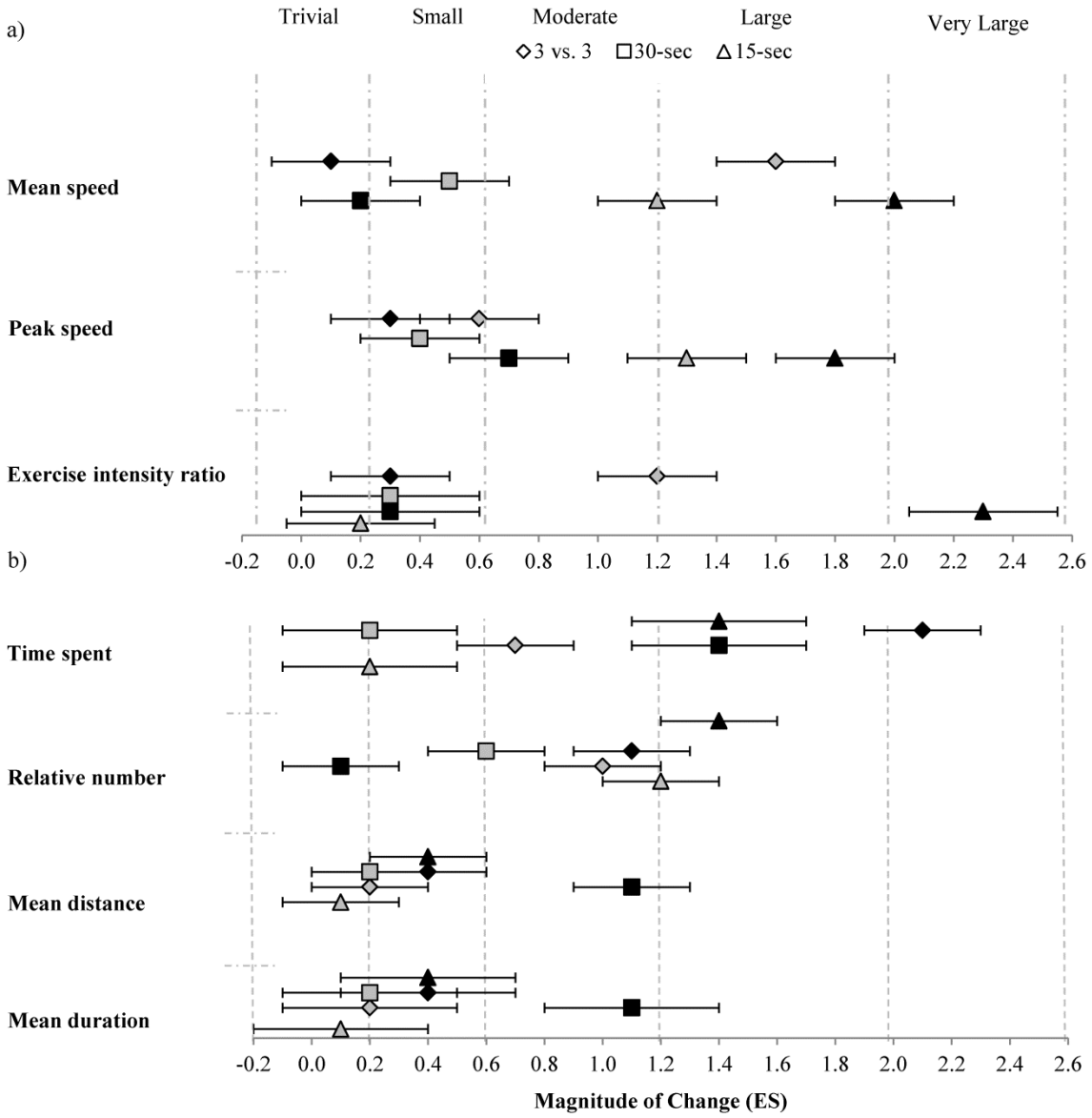
3 vs. 3
30-sec
15-sec
Mean speed
Peak speed
Exercise intensity ratio
-0.4
-0.2
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
b)
Time spent
Relative number
Mean distance
Mean duration
Magnitude of Change (ES)

428

429


a)
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-0.2 0.0 0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0 2.2 2.4 2.6
Magnitude of Change (ES)

430

431

Table 1 - Between-observation variability (CV ± 95% CL) and the smallest worthwhile change (%) required for speed profile measures.

	Overall		LP		HP	
	CV%	SWC (%)	CV%	SWC (%)	CV%	SWC (%)
Speed profiles						
Mean speed ($m \cdot s^{-1}$)	1.9 ± 0.1	2.6	2.5 ± 0.1	1.6	1.9 ± 0.1	1.7
Peak speed ($m \cdot s^{-1}$)	2.4 ± 0.2	2.3	2.9 ± 0.1	0.7	2.4 ± 0.1	1.4
Exercise-intensity ratio (H:L)	6.8 ± 0.3	4.4	6.8 ± 0.7	5.1	5.8 ± 0.3	3.6
High speed activities						
Time spent (%)	22.4 ± 0.5	8.9	38.8 ± 0.9	9.7	22.4 ± 0.7	6.4
Relative number ($n\ min^{-1}$)	16.0 ± 0.1	6.3	23.9 ± 0.2	7.0	16.0 ± 0.1	6.0
Mean distance (m)	6.6 ± 0.9	6.2	20.5 ± 1.6	8.2	6.6 ± 0.9	4.5
Mean duration (s)	4.5 ± 0.2	4.7	12.5 ± 0.4	6.0	4.5 ± 0.3	3.6

Note: CV – Coefficient of variation; CL – Confidence limits.

Table 2 – Descriptive statistics (mean ±SD) for modified drills in comparison to regular game-simulation drills.

	Drills			
	3 vs. 3	30-second shot-clock	15-second shot-clock	Regular
Speed profiles				
Mean speed ($m \cdot s^{-1}$)	1.31 ± 0.13	1.27 ± 0.08	1.41 ± 0.11	1.23 ± 0.11
Peak speed ($m \cdot s^{-1}$)	3.79 ± 0.33	3.72 ± 0.34	3.98 ± 0.24	3.68 ± 0.28
Exercise-intensity ratio (H:L)	1:3.1	1:3.7	1:2.9	1:3.5
High speed activities				
Time spent (%)	4.1 ± 1.4	2.8 ± 0.8	3.6 ± 1.1	2.8 ± 0.4
Relative number ($n\ min^{-1}$)	1.0 ± 0.4	0.7 ± 0.2	1.1 ± 0.4	0.7 ± 0.2
Mean distance (m)	7.1 ± 1.1	6.6 ± 1.8	6.0 ± 2.2	7.1 ± 1.6
Mean duration (s)	2.2 ± 0.3	2.0 ± 0.5	1.6 ± 0.3	2.1 ± 0.4

Table 3 – Descriptive statistics (mean ± SD) of modified drills for players of different classification compared with regular game-simulation drills.

	Drills							
	3 vs. 3		30-second shot-clock		15-second shot-clock		Regular	
	LP	HP	LP	HP	LP	HP	LP	HP
Speed profiles								
Mean speed ($m \cdot s^{-1}$)	1.19 ± 0.13	1.38 ± 0.07	1.20 ± 0.03	1.30 ± 0.08	1.43 ± 0.07	1.38 ± 0.12	1.19 ± 0.15	1.26 ± 0.08
Peak speed ($m \cdot s^{-1}$)	3.50 ± 0.27	3.97 ± 0.23	3.39 ± 0.09	3.90 ± 0.18	3.86 ± 0.32	4.09 ± 0.12	3.45 ± 0.07	3.81 ± 0.27
Exercise intensity ratio (H:L)	1:2.9	1:3.1	1:3.2	1:4.1	1:2.2	1:3.5	1:3.1	1:3.8
High speed activities								
Time spent (%)	5.3 ± 0.8	3.4 ± 1.1	2.4 ± 0.5	2.8 ± 0.8	4.4 ± 1.2	2.8 ± 1.1	3.1 ± 0.5	2.7 ± 0.8
Relative number ($n \cdot min^{-1}$)	1.2 ± 0.5	0.8 ± 0.2	0.8 ± 0.1	0.7 ± 0.1	1.3 ± 0.5	0.9 ± 0.3	0.8 ± 0.1	0.6 ± 0.2
Mean distance (m)	6.8 ± 1.5	7.3 ± 0.9	4.9 ± 0.9	7.6 ± 1.8	6.8 ± 1.3	6.9 ± 0.5	6.2 ± 1.4	7.6 ± 1.6
Mean duration (s)	2.2 ± 0.4	2.2 ± 0.3	1.6 ± 0.3	2.2 ± 0.5	1.7 ± 0.4	1.6 ± 0.2	2.0 ± 0.4	2.2 ± 0.3