

PROGRAMMING HIGH-INTENSITY TRAINING IN HANDBALL

– *Written by Martin Buchheit, France*

INTRODUCTION

Handball is called a ‘transition game’ because players frequently switch between defensive and offensive play, and the game action is characterised by frequent intermittent running and sprinting. Technical skills, anthropometric characteristics and high levels of strength, muscle power and throwing velocity are the most important factors for gaining a clear advantage for successful participation at elite levels of handball leagues^{1,2}. However, the importance of aerobic capacity should not be underestimated.

During match play, players run about 4 to 6 km³ at a mean intensity close to 80 to 90% of maximal heart rate (HR)⁴. Significant associations between maximal oxygen uptake (VO₂max) and playing level have also

been shown^{1,2}. In fact, elite players have to repeat more than 120 high-intensity actions during a game³; thus, a well-developed aerobic system is likely to be beneficial for metabolic recovery between these efforts^{5,6}.

In terms of the methods used to enhance aerobic fitness, high-intensity training (HIT) has been shown to induce substantial improvements in maximal aerobic capacity and endurance performance⁷⁻⁹. In addition to the classic long intervals (1 to 4 minutes) and short intervals (10 to 60 seconds, interspersed with passive to low-intensity activity), the use of sprints and all-out efforts have also emerged in team sports^{5,10}. These particularly intense forms of HIT include repeated-sprint training (RST) (in which sprints last from 3 to 7 seconds, interspersed with recovery periods lasting generally less

than 60 seconds) or sprint-interval training (SIT) (30-second all-out efforts interspersed with 2 to 4 minute passive recovery periods). However, since running-based training can be perceived as unpleasant by players, and because maintaining technical skills is essential for successful handball performance, the interest in small-sided handball games has increased as an alternative means of improving players’ aerobic power/capacity. Through using this type of training, training time with the ball is maximised, while still maintaining other important handball components, such as agility, reaction time and hand-eye co-ordination. Further, training motivation remains high¹¹⁻¹³.

In this paper, the integration of the different HIT formats in handball will be

HIGH-INTENSITY TRAINING FORMATS

	<i>Short intervals</i>	<i>Repeated-sprint training</i>	<i>Sprint-interval training</i>	<i>Small-sided games</i>
<i>Typical sessions</i>	2 series of 6 to 10 minutes, 15-30 second high-intensity/15-30 second easy	3 to 4 series of 4 to 8 × 15 to 20-m sprints repeated every 20 to 30 seconds	4 to 6 × 30-second sprints repeated every 2 to 4 minutes	3 to 4 × 3 to 4 minutes of play
<i>Intensity</i>	@ 90 to 100% V_{IFT} (or 110 to 120% MAS)	All-out	All-out	Game pace (100 to 150 m/minute)*
<i>Between effort recovery</i>	Passive to jogging	Passive to jogging	Passive	Passive
<i>Expected T@VO₂ max</i>	~50 to 60% of total session time*	~20% of total session time*	~5% of total session time*	~70 to 80% of total session time*
<i>O₂ energy systems targeted</i>	Central ++ Peripheral ++	Central + Peripheral +++	Peripheral ++++	Central ++ Peripheral ++
<i>Expected blood lactate</i>	8 to 14 mmol.l ⁻¹ *	12 to 16 mmol.l ⁻¹ *	16 to 20 mmol.l ⁻¹ *	6 to 10 mmol.l ⁻¹ *
<i>Expected neuromuscular load</i>	++ to +++ (COD)	++++ (All-out intensity)	++++ (All-out intensity)	++ to +++ (COD, variability of displacements)

Table 1: High-intensity training formats commonly used in handball and their respective acute physiological responses (adapted from Buchheit and Laursen 2013a; Buchheit and Laursen 2013b). * Depending on the format and work/rest ratio. T@VO₂max=time spent at or near (≥90%) VO₂max, V_{IFT}=peak speed reached at the end of the 30-15 intermittent fitness test, MAS=maximal aerobic speed, COD=change of direction.

discussed and examples of their practical implementation in the field will be examined. This paper will also consider their respective effectiveness for improving the high-intensity intermittent running capacity and repeated-sprint performance in highly-trained young players.

THE DIFFERENT HIT FORMATS

It has been suggested that HIT protocols that elicit VO₂max, or at least a very high percentage of VO₂max, maximally stress the oxygen transport and utilisation systems, and may thus provide the most effective stimulus for enhancing VO₂max¹⁰. While the evidence to justify the need to exercise at such an intensity remains unclear, it can be argued that only exercise intensities near VO₂max allow for both large motor

unit recruitment (type II muscle fibres)^{14,15} and attainment of near-to-maximal cardiac output. This, in turn, jointly signals for oxidative muscle fibre adaptation and myocardium enlargement (and hence VO₂max)¹⁰.

For an optimal stimulus (and forthcoming cardiovascular and peripheral adaptations), it is believed that athletes should spend at least several minutes per HIT session in their 'red zone', which generally means attaining an intensity greater than 90% of VO₂max¹⁰. Consequently, there has been a growing interest by the sport science community to characterise training protocols that allow athletes to maintain the longest time >90% VO₂max (T@VO₂max)¹⁰. However, in addition to T@VO₂max, other physiological variables should also be considered to fully

characterise the training stimulus when programming HIT. Anaerobic energy release and neuromuscular/musculoskeletal strain (acute fatigue and constraints) are likely the main secondary variables of interest following VO₂data¹⁶.

Controlling the level of anaerobic glycolytic energy contribution during HIT sessions may be an important programming consideration. The high anaerobic energy contribution of some HIT formats can quickly deplete glycogen stores¹⁷, which must be considered when the time to recover from the sessions is limited (such as before competitions). Additionally, considering that training sessions associated with high blood lactate levels are generally perceived as difficult, programming fewer 'lactic' sessions might help in maintaining

perceived stress at a low level during heavy training cycles¹⁶.

The acute neuromuscular load/musculoskeletal strain associated with HIT sessions should also be considered with respect to long-term performance development, possible interference with other training content and acute and chronic injury risk. Neuromuscular fatigue, if maintained for several hours or days after the HIT session, can have a direct effect on the quality of subsequent training sessions^{18,19} (both neuromuscularly-oriented as strength or speed sessions – that is, possible interference phenomenon) and on technical and tactical sessions in handball.

Despite limited evidence²⁰, it is believed that residual neuromuscular fatigue post-HIT may reduce the force production capacity and rate of force application during the following (strength/speed) sessions, which can attenuate training stimuli for optimal neuromuscular adaptations. Therefore, handball players tend to perform low-volume HIT sessions with minimal acute neuromuscular load/fatigue^{18,19,21}. However, in the final phase of handball competition preparation, a high neuromuscular load during HIT might also be needed in players to replicate specific game demands³.

The different HIT formats commonly used in handball are presented in Table 1 and categorised with respect to their expected acute physiological responses. In contrast to RST and SIT, HIT with short

intervals and small-sided games (SSG) allows spending a prolonged time at or near VO_2max . Interestingly, SSG are also likely to be associated with substantially lower blood lactate accumulation than the other HIT formats¹². Neuromuscular load/strain is moderate during SSGs, and definitely lower than during sprint-based HIT formats (Table 1). This suggests that SSGs may be better suited than the other HIT formats for the days prior and/or following speed and strength sessions, which likely require neuromuscular freshness. Taken together, these data suggest that, in addition to their high specificity, SSGs are well-suited for in-season training, when coaches seek to maximise training adaptations while not compromising the players' recovery¹⁶.

PRACTICAL IMPLEMENTATION

HIT with short intervals

Controlling running intensity

To ensure that athletes reach the required high intensity, using field running test performance is an objective, accurate, practical (HR monitoring is not required) and likely effective approach¹⁰. For a long time, the speed associated with VO_2max ($v\text{VO}_2\text{max}$ or maximal aerobic speed [MAS]) has been the preferred reference running speed to schedule run-based HIT¹⁰. However, since this speed is only determined by an athlete's VO_2max and energetic cost of running, its use to individualise supramaximal ($> v\text{VO}_2\text{max}$) intermittent

runs, including changes of direction (COD) – as predominantly implemented in handball – is limited. For instance, players with similar $v\text{VO}_2\text{max}$ can present with very different anaerobic, recovery and COD profiles. Thus, programming HIT based on $v\text{VO}_2\text{max}/\text{MAS}$ for these athletes can lead to different levels of aerobic and anaerobic solicitations¹⁰. This prevents the standardisation of training load, and likely limits the possibility of targeting specific physiological adaptations.

To overcome the limitation inherent to $v\text{VO}_2\text{max}/\text{MAS}$ for supramaximal, intermittent and COD-based training prescription, the 30-15 Intermittent Fitness Test (30-15_{IFT}) was developed^{22,23}. The 30-15_{IFT} is an intermittent incremental test (30 seconds of running at increasing speed, interspersed with 15-second passive recovery periods) that was designed to elicit maximum HR and VO_2 and additionally anaerobic capacity, inter-effort recovery capacity, acceleration, deceleration and COD abilities²⁴. The final speed reached at the test, V_{IFT} , is thus a composite velocity that considers all physiological variables elicited when performing HIT, including COD. In other words, the 30-15_{IFT} is highly specific, not to a specific sport, but to the training sessions commonly performed in intermittent sports.

In support of the logical validity of the test, V_{IFT} was shown to be more accurate than $v\text{VO}_2\text{max}$ ²² for individualising HIT with COD in team sport players²². This was exemplified

The 30-15 Intermittent Fitness test is a great tool for HIT prescription. It is highly specific, not to a specific sport, but to the training sessions commonly performed in intermittent sports.

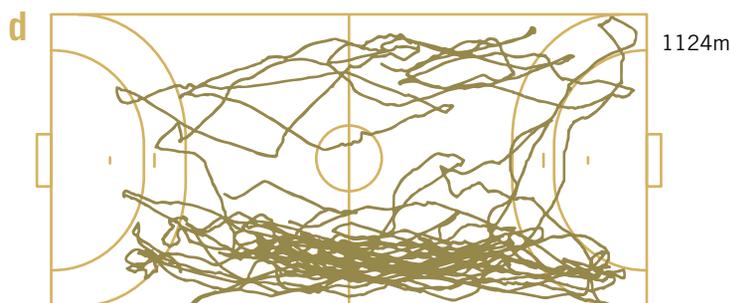
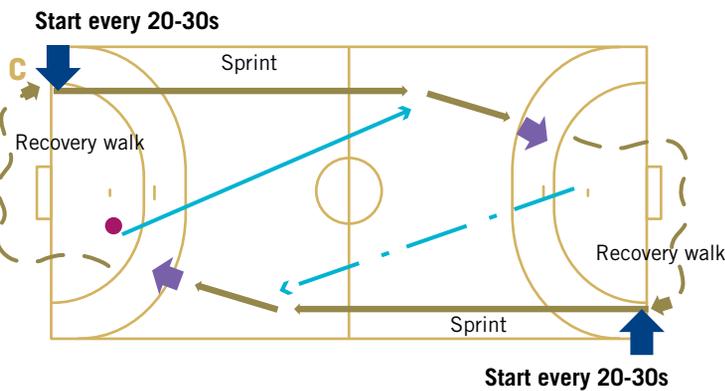
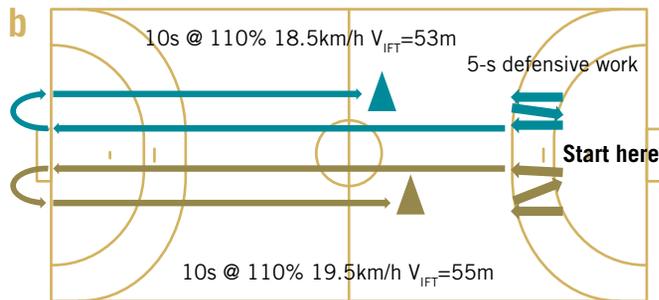
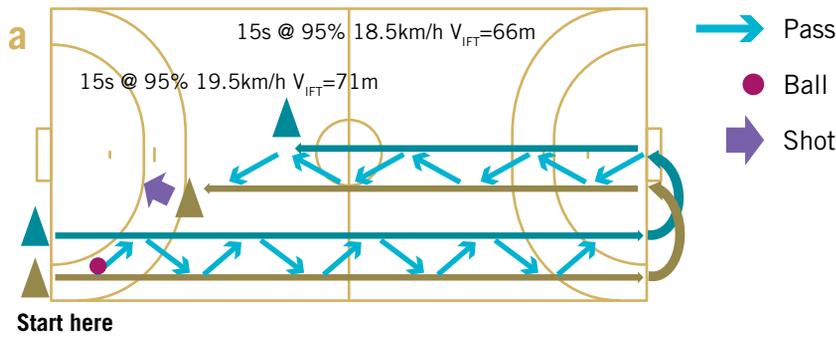


Figure 1: a) Example of handball-specific high-intensity training with short intervals (15 second/15 second format), based on V_{IFT} . The exercise consists of continuously passing the ball between two players while running at a set speed, and finishes with a shoot. The exercise is easier if players with similar V_{IFT} run together, but it can also be implemented using individualised distances. In the following example, the player on the brown course is fitter than the other player on the green course, so he has to cover 5 m more within the same time. b) Defensive actions performed for 5 seconds are combined with individualised running task for the remaining 10 or 15 seconds of the interval. This allows controlling for the exercise intensity (running section) while preserving the specificity of the defensive task (players generally don't defend continuously for 15 to 20 seconds). c) Example of a repeated-sprint sequence, where players sprint, receive the ball from the goalkeeper and shoot, before getting ready to start again on the other side of the pitch (6 repetitions). With mean exercise time is around 6 seconds, up to 5 players can play at the same time (players' rotation ~30 seconds). d) Distance covered by two different players (upper plot, $V_{IFT}=18.5$ km/hour and lower plot, $V_{IFT}=20.5$ km/hour) during an 8-minute 4 vs 4 small-sided handball game over the full pitch²³. For sprint interval training, implementing handball-specific drills is difficult because of both the intensity (all-out) and total distance covered (>160 to 200 m), which requires to perform multiple shuttles. (Figure 1d reprinted with permission from *Journal of Science and Medicine in Sport*).

by lower between-player heterogeneity in cardiorespiratory responses²². Finally, the 30-15_{IFT} is also attractive because 70% of players assessed perceive it to be less 'painful' than the continuous MAS field tests²⁵. For a complete description of the 30-15_{IFT} protocol and associated materials (audio file and articles), the reader is referred to online sources²⁶.

Implementation of HIT with short intervals on the field using the V_{IFT}

Once the 30-15_{IFT} is performed, the only requirement of the conditioning coach is to set the individual running distances on the field for each player (Figure 1a). Running distance is simply calculated from a set running time and the chosen percentage of V_{IFT}. For example, for a player with a V_{IFT}=19 km/hour, and for a 15 second - 15 second HIT ran at 95% of V_{IFT}, the target distance will be:

- $(19/3.6) \times 0.95 \times 15 = 75$ m
- (19 is divided by 3.6 to convert the speed from km/hour to m/second, for convenience).

This can be repeated for each single player or at least for players grouped by V_{IFT} (with 1 km/hour groups). A spread sheet that completes this calculation for 15 players at a time is available online²⁶.

Since most runs have to be performed with COD in handball, the time needed for a COD has to be considered when calculating the target running distance in order to ensure a similar cardiorespiratory load in comparison with straight-line runs. Not surprisingly, covering the same distance with COD during the same time substantially increases the relative exercise intensity²⁷ (which is related to the number of CODs and actual running speed)²⁸. Along these lines, the COD correction factor can vary between 3 and 30%. While stronger scientific evidence is still lacking, players' height and training volume might have to be taken into account for individual adjustments, with smaller and more trained athletes presenting with better COD ability²⁹, thereby requiring a lower correction factor. At present, in the abovementioned spreadsheet, the correction factor is still not individualised and is based on an average player's profile. However, this is enough to begin with, since the difference will not be greater than 1 to 2 m, and the distance

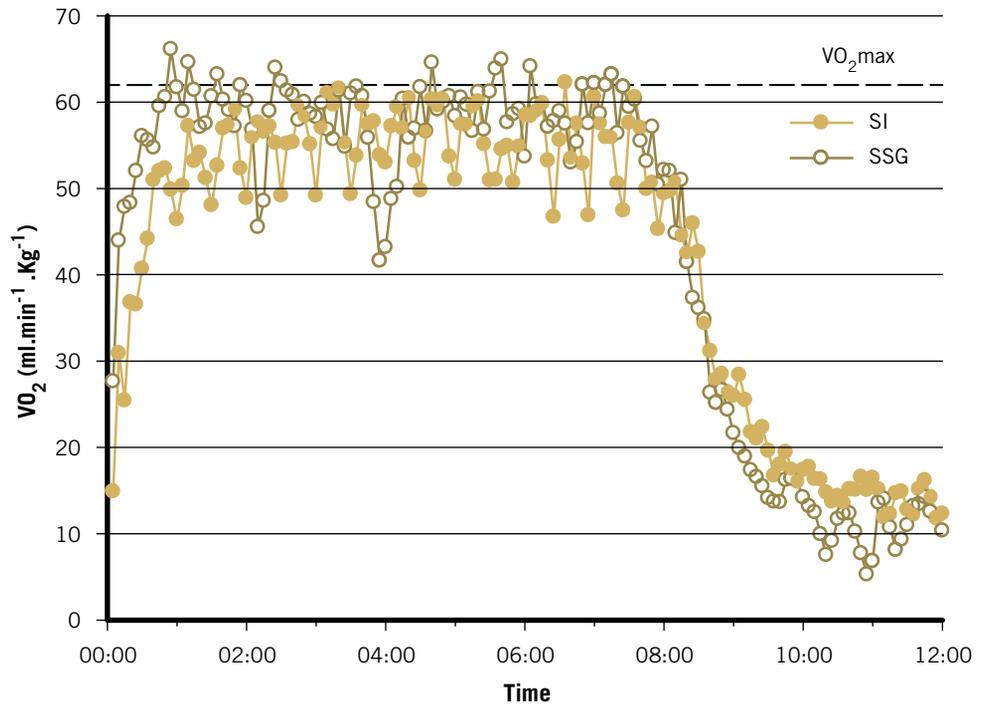


Figure 2: Example of oxygen uptake ($\dot{V}O_2$) response obtained in the same player during an 8-minute SSG and SI (15 seconds [95%]/15 seconds [passive]). $\dot{V}O_{2max}$ refers to the maximal oxygen uptake measured during the graded aerobic test²³. SSG=small-sided game, SI=short intervals. (Reprinted with permission from *Journal of Science and Medicine in Sport*).

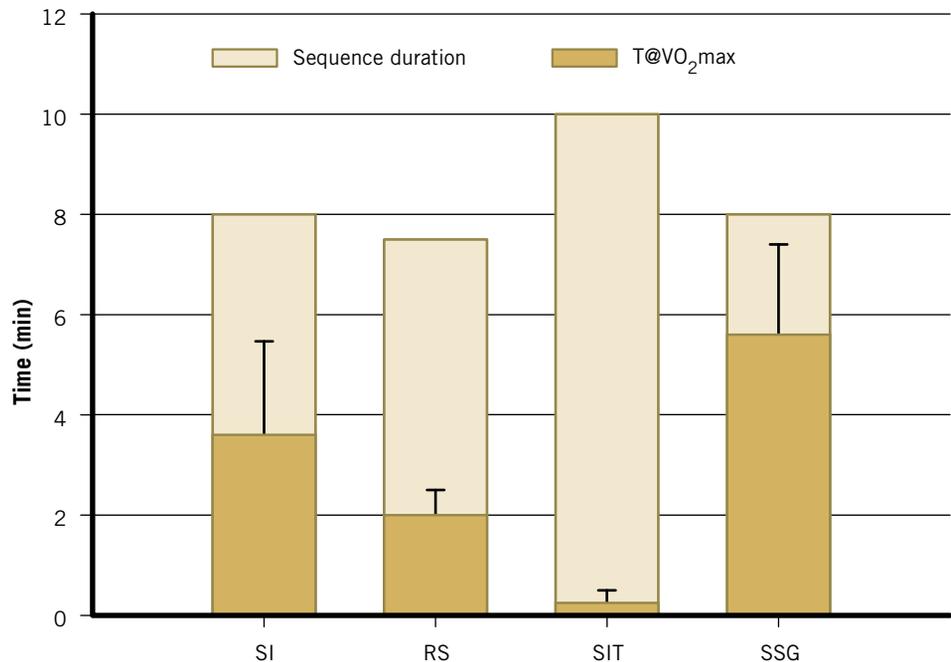


Figure 3: Total exercise time and time spent at or near maximal oxygen uptake (T@ $\dot{V}O_{2max}$) for typical HIT formats: 1 x 8-minute series of SI, 1 x RS (2 sets of 6 sprints), 1SIT (4 sprint repetitions) and an 8-minute SGG. HIT=high intensity training, SI=short intervals, RS=repeated-sprint sequences, SIT=sprint-interval session, SGG=small-sided game.

can still be modified *a posteriori*, if needed. Taking the abovementioned example, a player running at 95% V_{IFT} over a 40-m shuttle will have to cover 71 m (instead of 75 m in a straight line). If the shuttle length is divided by two (20-m shuttle), the distance to cover drops to 65 m²⁹.

To make HIT with short intervals more handball-specific, the ball can be used on different occasions. For example, the players can run together and continuously pass the ball to each other, before the last player with the ball at the end shoots at the goal (Figure 1a). A further way to individualise HIT with short intervals is to use the position-specific work/rest ratio and/or effort distributions during games³. In this setting, wingers would need to perform HIT with more intense runs interspersed with longer rest periods (for example, 10 seconds [110%] / 20 seconds [passive]) than backs (20 seconds [95%] / 20 seconds [jog] or 30 seconds [90%] / 30 seconds [jog])³.

Finally, introducing specific movement patterns as defensive actions into short intervals is also possible; however, at least two important points should be considered. First, repeating these actions again and again for the entire duration of the interval decreases the effort quality, and is actually non-specific – that is, a defender generally reaches once or twice an attacker per defensive action – then the game is either stopped (technical fault) or continues with other players. Second, only using these kinds of movement patterns does not allow control over intensity, as with run-based drills. Thus, an attractive option is to combine the defensive actions for 5 seconds, with individualised running tasks for the remaining 10 or 15 seconds of the interval (Figure 1b).

Repeated-sprint training

RST consists of two to four sets of five to eight sprints of 15 to 30-m, interspersed with 14 to 25 seconds of passive or active (jog or ~45% V_{IFT}) recovery¹⁰. This type of HIT is well-suited for team relay and counterstrike work (Figure 1c). Sprints can also be performed in shuttle (which would, from an injury-prevention perspective, decrease stride length and be likely to decrease hamstring strain¹⁶). As for HIT with short intervals, sprinting game demands can be used to design position-specific repeated-

sprint sequences³, such as 20- to 30-m sprints vs 10- to 15-m sprints for wingers and backs, respectively.

Sprint-interval training

SIT training consists of three to six repetitions of 30-second all-out shuttle sprints over 40-m shuttles, interspersed with 2 to 4 minute of passive recovery¹⁰. Given their intensity and duration, it is difficult to incorporate the ball during these drills, however, it can nevertheless be added at the end of the runs.

Game-based training

SSGs are often organised in teams with four on each side (excluding goalkeepers) playing over the full handball court (40 × 20 m)^{11,12}. Coaches are requested to encourage players to achieve high intensity during the games. Typical handball rules are simplified to avoid game breaks that would unnecessarily reduce exercise intensity. For example, dribbling and defence contacts are not allowed, infringements of minor technical rules (such as 'walking' and 'double dribble') are not sanctioned, throw-on after a goal is immediately made by goalkeepers from their 6-m area, and coaches are always available to immediately replace the ball when it is kicked away from the playing area. Finally, all four players have to be in the opponent half of the court for a goal to be validated³⁰.

The only study to date demonstrates that specially designed handball-specific 4 vs 4 games are an effective means of achieving a high percentage of VO_2 max during training (Figures 2 and 3)¹² and may be perceived as less painful by athletes than classical high-intensity interval training. However, there is very little data on how to manipulate physiological loading during handball games. Recent data show that changes in court dimensions or game rules can be used, as in other team sports, to manipulate the acute physiological demands of handball games. While an increase in playing area had no predictable effect on HR responses during SSG, the greater the pitch area, the greater the running pace (Figures 1d and 4a-b)^{23,13}. The lack of a clear effect of pitch area on HR responses could be related to the fact that, over smaller playing areas, the number of changes in velocity, COD and contacts increase, compared with larger pitches¹³, which compensates for the lower running-only demands^{23,13}.

It is also worth noting that, because of the static phases and handball-specific muscular contractions, which increase HR independently of muscle O_2 demands, HR responses during SSG become dissociated from VO_2 values. Therefore, extrapolating metabolic responses from HR is limited in this special situation²³. The running pace reached during four SSGs was actually higher than that during games³, which

The running pace reached during SSGs is actually higher than that during games³, which suggests that they represent an appropriate overload for both the locomotor and metabolic systems

suggests that they represent an appropriate overload for both the locomotor and metabolic systems (Figure 4b). Interestingly, playing 4 vs 4 on the full handball pitch allows players to reach the same running pace as during short-interval HIT (Figure 4b), which is ~50% greater than game demands.

Finally, because exercise intensity cannot be controlled during SSGs – as with run-based drills – coaches would have to rely on players' motivation to ensure they all engage at the required (likely maximum) intensity during the drills. However, because fit and less fit players have to play together (to preserve game-specific relationships between players), the relative work of the fitter players can actually be lower than that of the less fit players. A negative correlation ($r=-0.88$) was actually reported between relative exercise intensity during a 4 vs 4 SSG (% of VO_{2max} maintained during the SSG) and players' VO_{2max} ¹². This suggests that, over time, the fitter players might not benefit enough from these drills to improve their aerobic power/endurance capacity. To overcome these limitations, several specific rules can be implemented. These include:

1. Every time they release the ball, the identified fitter players have to perform two push-ups.
2. Every time they release the ball, the fitter players have to place one foot on the court's external lines.
3. One identified fit player is always involved in the attacking team, so that his volume of play is increased.

TRAINING EFFECTS OF HIT SUPPLEMENTATION IN HIGHLY-TRAINED YOUNG PLAYERS

There are limited data in the literature comparing the influence of different HIT-based programmes on the physical capacities of handball players. Figure 5 shows that both high-intensity running capacity (V_{IFT}) and repeated-sprint performance (average time of six repeated sprints) can be improved during the season, after 4 to 10 weeks of HIT supplementation (~2 sessions per week, in addition to usual training) in highly-trained young players (~10 hours of training + one competitive game per week). Importantly, all changes reported in Figure 5 can be considered substantial because they were all small to

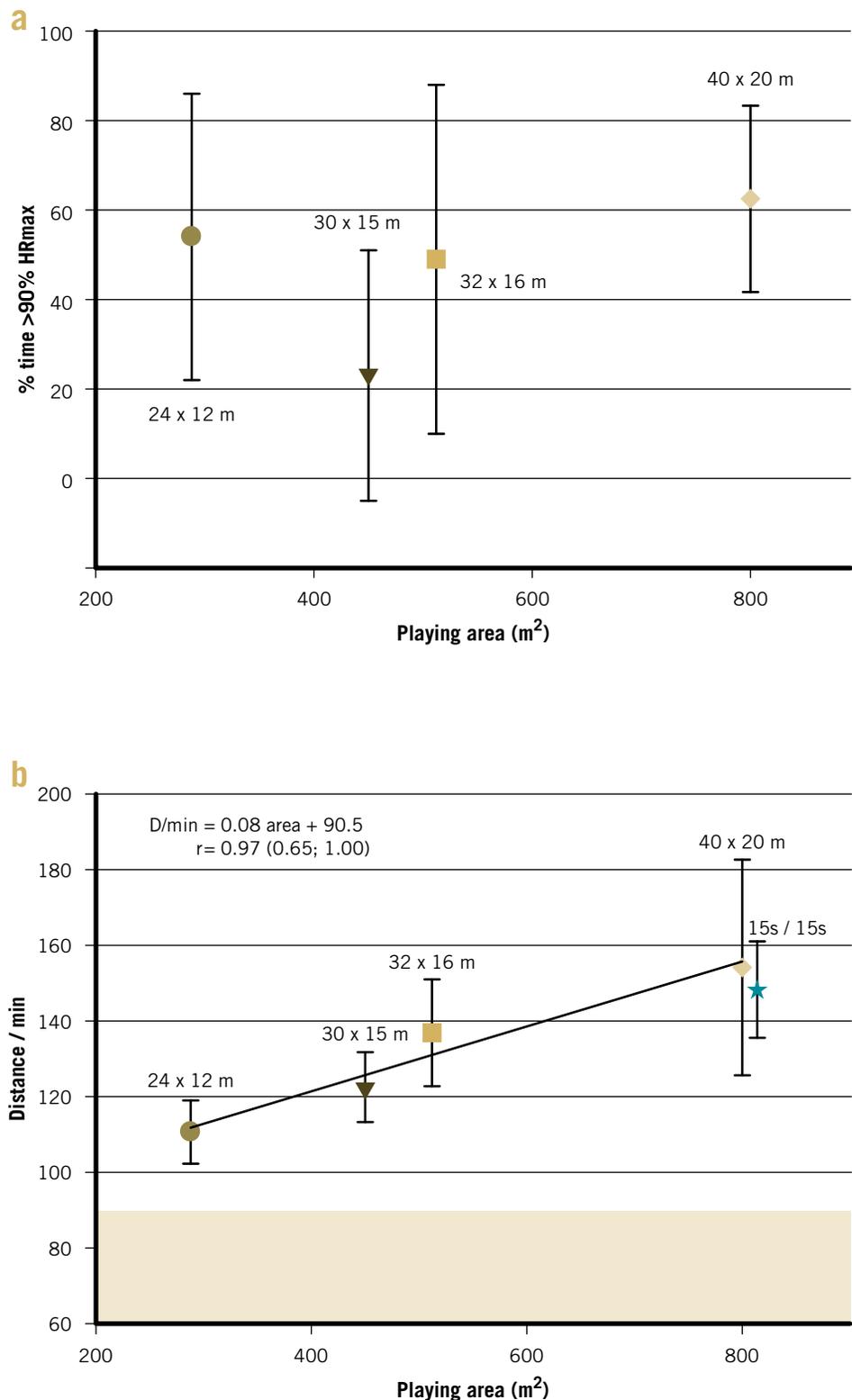


Figure 4: a) Time spent above 90% of HRmax (90% confidence intervals) and b) Distance covered per minute as a function of playing area during small-sided handball games. The grey area represents distance per minute during games³. The distance per minute covered during the short intervals exercise (15 seconds/15 seconds) is also provided for comparisons. HRmax=maximum heart rate.

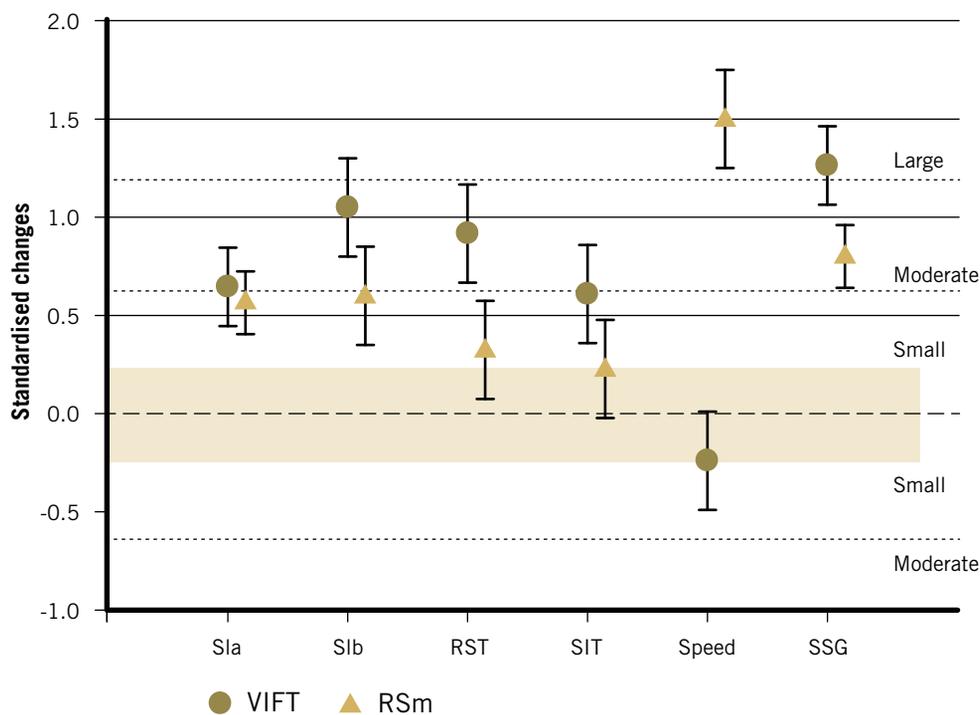


Figure 5: Standardised changes in the peak speed reached at the 30-15 IFT (V_{IFT}) and mean repeated-sprint time following different training interventions based on SI, RST, SIT, Speed and SSG in highly-trained young handball players. The grey area represents trivial changes. The short-interval (Sla) programme consisted of 2× per week 6 to 12 minutes of intermittent running for 15 seconds (95 % V_{IFT}) interspersed with 15 seconds of passive recovery, for 10 consecutive weeks¹¹. The short-interval (Sib) programme consisted of 2× per week 6 to 12 minutes of intermittent running for 15 (95 % V_{IFT}) to 20 (90 % V_{IFT}) seconds interspersed with 15 to 20 seconds of passive recovery, for 9 consecutive weeks³². Repeated-sprint training programme consisted, for 9 consecutive weeks, of 2 to 3 sets of 5 to 6 × 15- to 20-m shuttle sprints interspersed with 14 seconds of passive or 23 seconds of active recovery (45% V_{IFT})³². SIT training consisted, for 4 consecutive weeks, of 3 to 6 repetitions of 30-second all-out shuttle sprints over 40 m, interspersed with 2 minutes of passive recovery³³. Speed training consisted, for 4 consecutive weeks, of 4 to 6 series of 4 to 6 exercises (e.g. agility drills, standing start and very-short shuttle sprints, all of <5 seconds duration); each repetition and series interspersed with at least 30 seconds and 3 minutes of passive recovery respectively³³. SSG training consisted of small handball games (2 to 4 × 2-minute 30 seconds to 4-minute games), for 10 consecutive weeks¹¹. SI= HIT with short intervals, RST=repeated-sprint training, SIT=sprint-interval training, Speed=speed agility, SSG=small-sided games.

large in magnitude, and clearly greater than the so-called smallest worthwhile change³¹ (the shaded area represents trivial to non-substantial changes).

The magnitude of improvement in both V_{IFT} ($r=0.56$) and mean repeated-sprint time ($r=-0.75$) after HIT training (excluding speed) was linearly related to training duration (number of weeks). In addition, the magnitude of improvement in mean repeated-sprint time after HIT training (excluding speed) was inversely related to baseline performance ($r=-0.68$); however, this relationship was unclear for V_{IFT} . The magnitude of improvement in mean

repeated-sprint time (excluding speed) and V_{IFT} was also largely correlated (-0.73). Therefore, while it is difficult to compare the respective effects of the different interventions because of the differences in training duration and performance baseline, the 10-week SSG programme was the only training method associated with large and moderate improvements in V_{IFT} and repeated-sprint performance, respectively¹¹. While in all these studies, only one type of HIT was used (for study design purposes), the optimal physical conditioning scenario likely involves a combination of all types of HIT supplementation (Table 2). Further

studies comparing these HIT programmes over a similar duration in players matched for baseline physical performance are required to draw definitive conclusions.

CONCLUSION

While research in HIT in handball is limited compared with other team sports, the present data suggest that specially designed small-sided handball games can constitute an effective means of achieving a high percentage of maximal O_2 uptake during training (Figures 2 and 3)¹². Changes in court dimensions or game rules can be used, as in other team sports, to manipulate the acute physiological demands of handball games, with the larger the playing area, the greater the running pace – but not necessarily the HR. Despite the inability to tightly control the exercise intensity, as with generic run-based HIT (each player running at a given percentage of V_{IFT})²⁹, the results from longitudinal studies in highly-trained adolescent players show that small-sided handball games may be as effective (if not more) as classical high-intensity short-interval training and RST to improve high-intensity intermittent running capacity and repeated-sprint performance^{32,11,33}.

While the optimal physical conditioning scenario likely involves a combination of all types of HIT supplementation (Table 2), SSGs additionally allow to maximise time with the ball, while still maintaining other important handball components, such as agility, reaction time and hand-eye coordination. Such games are also likely to induce a lower anaerobic glycolytic energy contribution than the other HIT formats, and are generally perceived as less painful by the majority of players^{11,12}. Therefore, the present data suggest that small-sided handball games represent an interesting alternative to traditional HIT, especially in-season (Table 1), provided that some specific rules are implemented to increase the relative exercise intensity of the fitter players. However, further research is still required to improve the programming of these games (such as the duration, repetitions, number of players, rules and playing position-specific formats)¹³, as well as their periodisation within the yearly training plan¹¹.

References at www.aspetar.com/journal

HIGH-INTENSITY TRAINING FORMATS

	Short intervals	Repeated-sprint training	Sprint-interval training	Small-sided games	Total HIT time (T@VO ₂ max)
Week 1	(1) 2 x 6 min 15 s [95%] / 15 s [jog] +				~28 min (14-18 min)
Week 2	(2) 2 x 6 min 20 s [95%] / 20 s [passive] (1) 2 x 7 min 30 s [90%] / 30 s [jog] +			(3) 3 x 3 min 4 vs 4	~31 min (17-20 min)
Week 3	(1) 10 min 15 s [100%] / 15 s [passive]	(2) 4 x (6 x 15+15 m shuttle every 30 s)		(3) 4 x 4 min 4 vs. 4	~38 min (18-22 min)
Week 4	(1) 6 min 10 s [95%] / 10 s [passive]		(2) 6 x 30 s every 2 min (40 m shuttles)	(3) 4 x 4 min 4 vs 4	~32 min (16-20 min)
Week 5					
Week 6	(1) 10 min 10 s [105%] / 20 s [passive]			(2) 3 x 4 min 4 vs 4	~32 min (14-16 min)

Table 2: Example of a 6-week pre-season conditioning programme using the different high-intensity training formats. It is suggested that the HIT sessions are included within/following 2 to 3 different technical sessions, as indicated by the numbers into (). Numbers in [] refer to running intensity as either a percentage of V_{IFT}, i.e. the peak speed reached at the end of the 30-15 Intermittent Fitness Test, or jog. Number of players for small-sided games refers to field players. For more details on the reason behind the programming, please refer to the two recent reviews on the topic^{10,16}. HIT=high intensity training.

Martin Buchheit M.Sc., Ph.D.

Sport Science Unit

Myorobie Association

Montvalezan, France

Contact: mb@martin-buchheit.net