POSITIONAL DIFFERENCES IN SOME PHYSIOLOGICAL PARAMETERS OBTAINED BY THE INCREMENTAL FIELD ENDURANCE TEST AMONG ELITE HANDBALL PLAYERS

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Abstract:

The purpose of the study was to assess assumed differences in some physiological parameters, obtained by an incremental intermittent running field test 30–15IFT, among elite handball players to get an insight into the specifics of aerobic capacity profiles of players in different playing positions. Twenty-four elite male handball players were tested using the Cosmed K4 portable telemetry system. The following parameters were analysed: running velocity, heart rate, oxygen uptake, relative oxygen uptake, pulmonary ventilation breath-by-breath, at the three points—lactate threshold (LT), onset of blood lactate accumulation (OBLA), and at the peak velocity achieved on the test (v30–15IFT). Additionally, blood lactate concentration was analysed at v30–15IFT. The players were divided in three groups based on their playing positions: eight backcourt players, eight wing players and eight pivot players. In terms of both the statistically significant and non-significant differences, the wings achieved slightly different results in comparison to the backcourt players and pivots. The wings reached a statistically significant higher velocity at the LT than the players of the other two groups and a significantly higher velocity than the pivots at the OBLA. At all the three points, wings presented the highest HR values, meaning they can operate at higher intensities still within the aerobic work zone. This would probably allow wing players to longer persist in handball game.

Key words: *team handball, playing positions, aerobic incremental field test, men*

Introduction

Handball is a team sport with two opposing teams that alternately take the role of either attackers or defenders, depending on who is in possession of the ball (Sibila, Vuleta, & Pori, 2004). The intensity and volume of work, or of physiological load in handball are highly heterogeneous when observed from the aspects of gender (Michalsik & Aagaard, 2015; Wagner, et al., 2019), standard of play (Wagner, Fuchs, & vonDuvillard, 2017a; Wagner, Fuchs, & Michalsik, 2020), playing positions (Karcher & Buchheit, 2014; Vuleta, Bojic-Cacic, Milanovic, Misigoj Durakovic, & Dizdar, 2020), and, especially, individual players. In a match, acyclic (intermittent) activities (passing the ball, various kinds of throws, jumps, body contacts with an opponent when breaking through or defending the goal, falls, etc.) are executed along with players' cyclic movements (running, walking, jogging, cruising, shuffling, moving sideways or backwards). During play, work-rate, or loading, which may vary in intensity and volume, alternates continuously with periods of a relative rest, i.e. standing or slow walking (Sibila et al., 2004). Although handball is not predominantly an endurance sport, aerobic fitness is still crucial for players' ability to maintain an elevated tempo, i.e. intensity of play in top-level professional leagues nationally and internationally (Gorostiaga, Granados, Ibanez, & Izquierdo, 2005; Povoas, et al., 2012, 2014b). A well-developed aerobic energy-supply ability allows handball players to tolerate high work intensities and physiological load of daily training sessions and facilitates their recovery between training sessions and competitions (Dello Iacono, Karcher, & Michalsik, 2018). This is especially important during long-lasting tournaments when numerous matches are played in a short period of time (Michalsik, Madsen, & Aagaard, 2015).

It has been evidenced that different handball playing positions require, and are based on, different players' morphological and physiological characteristics (Burger, Foretic, & Cavala, 2015; Haugen, Tonnessen, & Seiler, 2016; Karcher & Buchheit, 2014; Michalsik, Madsen, & Aagaard, 2014; Vuleta, Bojic-Cacic, Milanovic, Misigoj-Durakovic, & Dizdar, 2020). Competitive handball involves position-specific differences in the physiological demands as well (Povoas, et al., 2014a). Namely, according to recent research findings from high-level official handball matches (Büchel, et al., 2019), wings showed, probably due to the increased on-court time (51.0±20.9 min), a higher absolute activity and a longer distance covered (4057.9±1630.5 m) compared to backcourt players (35.8±16.5 min; 2881.96±1239.29 m) and pivots (35.4±15.8 min; 2702.8±1180.0 m). Furthermore, times and distances covered at different intensities differed significantly between the positions. Wings covered more distance by a slow speed walking (1.09%±0.2%) and sprinting (9.8%±2.2%) compared to backcourt players (0.7%±0.3%; 33.4±2.0%) and pivots (0.9%±0.2%; 4.4%±1.8%). Therefore, it can be argued that activity profiles in handball are modulated by a playing position and by playing or on-court time (Büchel, et al., 2019).

According to previous research, repeated sprinting and shuttle run performance of players and their during the test measured energy-supplying abilities play an important role, among numerous other factors, in playing performance in team sports (Castagna, Abt, & D'Ottavio, 2007; Castagna, Impellizzeri, Rampinini, D'Ottavio, & Manzi, 2008; Covic, et al., 2016; Mohr, Krustrup, & Bangsbo, 2003; Sirotic & Couts, 2007; Thomas, Dawson, & Goodman, 2006). There is a number of field-based fitness tests aiming to predict aerobic capacity with varying levels of accuracy, including: the Montreal Track Test (Uger & Boucher, 1980); Yo-Yo Intermittent Recovery Test Level 1 (IR1) (Castagna, Impellizzeri, Chamari, Carlomagno, & Rampinini, 2006; Dupont, et al., 2010); and the multi-stage fitness test (Léger, Mercier, Gadoury, & Lambert, 1988). A limitation of most of these aerobic field fitness tests is that athletes with lower maximal running velocities are required to perform supramaximally (>120% of aerobic capacity); their exertion must be much higher if they want to keep the same pace as faster athletes in directional changes, therefore, in turn, they utilize a higher proportion of their anaerobic velocity reserve (Thomas, Dos Santos, Jones, & Comfort, 2015).

For the purpose of resolving training intensity prescription issues in intermittent team sports, the 30–15 Intermittent Fitness Test (30–15IFT) was developed (Buchheit, 2008a; Haydaret, Al Haddad, Ahmaidi, & Buccheit, 2011). The 30–15IFT estimates aerobic capacity (VO2max), determines maximal heart rate (HRmax) and anaerobic and intermittent HR capacity (Buchheit & Rabbani, 2014; Thomas, et al., 2015). The primary outcome measure of the 30–15IFT is running velocity (v30–15IFT) for the last completed stage (Buchheit, 2010), a suitable alternative to running velocity at the maximal oxygen uptake (vVO2max) and HR peak (Rabbani & Buchheit, 2015). As demonstrated, running velocity at the vVO2max in continuous straight-line cardiorespiratory fitness tests is much lower than running velocity in 30–15IFT (v30–15IFT), implying that the anaerobic metabolism engagement is much higher in the 30–15IFT (Buchheit, 2010). Lactic acid was up to 40% greater following the 30–15IFT in comparison to the Léger-Boucher track test (Buchheit, 2010; Buchheit, et al., 2009). In addition, v30–15IFT is highly correlated (r=.80) to other intermittent fitness tests (e.g., Léger-Boucher test and Yo-Yo IR1) and velocity (Buchheit, 2008b). The validity of the 30–15IFT simultaneously reflects a broad spectrum of physiological, mechanical, and neuromuscular components (Buchheit, 2008b). The reliability of the 30–15IFT and its effectiveness in monitoring intermittent fitness changes was also demonstrated in the previously mentioned studies. The 30–15IFT is highly reliable (ICC=.90–.96) across a range of sports including ample accelerations and decelerations, suggesting that a v30–15IFT change of 0.5 km·h^{-1} (one running stage) is substantial (Buchheit, 2010) for detecting actual changes in performance.

The aim of this study was to determine expected differences in certain physiological parameters obtained by means of the 30–15IFT between wings, backcourt players (or backs), and pivots in elite male handball. Due to positionally generated differences in morphological and physiological profiles and because of different activity profiles of players in the game, we hypothesized that differences would occur among these three groups of players in certain physiological parameters obtained at the LT, OBLA and peak velocity achieved in the 30–15IFT.

Methods

Participants

The participants of this study were 24 elite male handball players, members of the adult national team of Slovenia (age = 23.17±5.1 years, body height = 1.88±0.067 m, body mass = 89.0±9.3 kg and body mass index = 25.23±1.99). According to their playing positions, there were eight backcourt players (age = 20.65±2.0 years, body height = 1.89±0.045 m, body mass = 86.6±0.031 kg, BMI = 24.14±1.99), eight wings (age = 25.7±5.9 years, body height = 1.84±0.063 m, body mass = 83.6±7.5 kg, BMI = 24.82±1.50), and eight pivots (age = 23.2±5.7 years, body height = 1.91±0.076 m, body mass = 96.7±10.5 kg, BMI = 26.64±1.34).

None of the participants had been injured six months before the initial testing or during the testing programme. Nutritional supplements were not included in their diets and participants were not taking exogenous anabolic-androgenic steroids or other drugs that might have affected their physical performance. The study was approved by the Ethics Committee of the Faculty of Sport, University of Ljubljana, in compliance with the Helsinki Declaration. Participants were fully informed about the experiment and signed a consent form saying, among other things, that they could withdraw from the study at any time.

Procedures

Basic anthropometric parameters (stature and body mass) were registered in the study protocol. To prevent unnecessary fatigue accumulation, players and coaches were instructed to avoid intense exercise for at least a 24-hour period before each testing session. Immediately prior to testing, participants performed a standard 25-minute warm-up consisting of 10 min of self-paced jogging, 10 min of dynamic stretching and 5 x 30 m of fast-running exercises. During testing, the air temperature ranged from 20°C to 22°C. Testing always commenced at 10 a.m. and was completed by 1 p.m.

After the 25-minute warm-up protocol, the players' shuttle run performance was tested using the 30–15IFT (Buchheit, 2008a) in an indoor sports complex. This incremental test consists of 30-s shuttle runs interspersed with 15-s active recovery periods. Running pace was set at 8 $km{\cdot}h^{-1}$ for the first 30-s run, and velocity was increased by 0.5 $km{\cdot}h^{-1}$ every 30-s stage thereafter. Players were required to run back and forth between two lines set 40 m apart at the set pace that was governed by a pre-recorded beep. The pre-recorded beep allows the players to adjust their running velocity when they enter a 3-m zone placed in the middle and at each extremity of the test field. During the 15-s recovery period, players walked forwards towards the closest line (either in the middle or at the end of the running area, depending on where their previous run had finished); this line was where they would start the next run stage from. Players were instructed to complete as many stages as possible, and the test ended when the player could no longer maintain the required running velocity or when he was unable to reach the 3-m zone in time with the audio signal for three consecutive times. The velocity of the last stage successfully completed was recorded as the test score, i.e., the peak running velocity (v30–15IFT).

To obtain physiological parameters we used a portable gas analyser K4 *b2* (COSMED, S.r.l. Italy). This device is light (about 0.8 kg), small and provides values of oxygen uptake (VO_2), carbon dioxide production (VCO_2), and pulmonary ventilation (VE) breath-by-breath. The device is further able to supply other important derived variables such as respiratory exchange ratio (RER) and oxygen pulse (OP) as the VO_2 vs. HR ratio (volume of oxygen consumed by the body per heartbeat).

Arterialised blood samples (20 µL) were collected from the earlobe after each third running interval during the test (every 2 min 15 seconds) and at the 3rd and 5th minute of recovery after the last completed run stage; the samples were analysed for blood lactate concentration ($[LA^-]$) using a Kodak Ektachrome analyser.

Heart rates were measured by Polar S-610 heart rate meters (Polar Electro, Kempele, Finland). The data were recorded in 5-s intervals and the data were processed using the original software program provided with the instrument.

Statistical analysis

The statistical Package for Social Sciences SPSS (v22.0, SPSS Inc., Chicago, IL) was used to statistically process all the collected data and descriptive statistics were calculated. The Kolmogorov-Smirnov test was used to test if the data were normally distributed. Since the data were not normally distributed, we used non-parametric methods, i.e. a Kruskal-Wallis one-way ANOVA and Mann-Whitney's U-test to determine the differences among players in different playing positions. Data were presented as mean±SD, and the alpha level for significance was set at $p{\leq}.05$.

Results

A non-parametric statistical approach was applied to determine values of maximal blood lactate concentrations (LA_{max}) at v30–15IFT, running velocity, heart rate (HR), oxygen uptake (VO_2 in L·min), relative oxygen uptake (VO_2·in $mL{\cdot}kg^{-1}{\cdot}min^{-1}$) and pulmonary ventilation breath-by-breath (VE) at the lactate threshold (LT), onset of blood lactate accumulation (OBLA), and at the peak velocity achieved on the test (v30–15IFT).

Statistically significant differences ($p{\leq}.05$) between the three playing positions were found in running velocity and HR (Table 1) at the LT, OBLA and peak velocity.

The wings achieved statistically significant higher velocity at the LT than both the backs (13.58±0.46 vs. 12.65±0.78 $km{\cdot}h^{-1}$; p=.020) and pivots (13.58±0.46 vs. 12.90±1.02 $km{\cdot}h^{-1}$; p=.022). They also achieved statistically significant higher velocity at the OBLA than the backs (17.24±0.81 vs. 16.26±0.70 $km{\cdot}h^{-1}$; p=.016). The statistically significant differences occurred in HR at the LT, OBLA and peak velocity—at the LT: backs 146.13±8.41 $b{\cdot}min^{-1}$ vs. pivots 155.88±7.55 $b{\cdot}min^{-1}$; p=.015; and wings 161.75±8.96 $b{\cdot}min^{-1}$ vs. backs 146.13±8.41 $b{\cdot}min^{-1}$; p=.015; at the OBLA: backs 171.75±9.18 $b{\cdot}min^{-1}$ vs. wings 182.25±9.36 $b{\cdot}min^{-1}$; p=.024; and at the peak velocity: wings 188.63±9.02 $b{\cdot}min^{-1}$ vs. pivots 178.13±5.11 $b{\cdot}min^{-1}$; p=.016) (Table 1).

No statistically significant differences between the three playing positions were found in VO_2, *Rel* VO_2 and VE at the LT, OBLA and peak velocity nor in LA_{max}.

There was also no statistically significant difference in peak velocity achieved among all the three groups of players. The highest velocity was achieved by wings (20.06±1.02 km·h^{-1}), followed by backs (19.19±1.33 km·h^{-1}) and pivots (19.13±0.99 km·h$^{\text{-1) (Table}}$ 1).

The lowest average values of VO$_2$ at the LT were found in backs (3162±457 mL·min^{-1}), somewhat higher were in wings (3397±429 mL·min^{-1}) and the highest values were found in pivots (3412±618 mL·min^{-1}). The lowest average values of VO$_2$ at the OBLA were found in backs (4150±624 mL·min^{-1}), followed by wings (4171±503 mL·min^{-1}), whereas the highest values were in pivots (4227±500 mL·min^{-1}). The lowest average values of VO$_2$ at peak velocity were found in backs (4646±565 mL·min^{-1}), followed by wings (4679±387 mL·min^{-1}) and the highest in pivots (4782±561 mL·min^{-1}). The differences were not statistically significant at any stage (Table 1).

The highest calculated values of *Rel* VO$_2$ at the LT were obtained for wings, with average values of 38.67±5.61 mL·kg^{-1}·min^{-1}, whereas pivots had average values of 37.32±5.35 mL·kg^{-1}·min^{-1} and backs 34.42±3.74 mL·kg^{-1}·min^{-1}, although this difference was not statistically significant. The highest calculated values of *Rel* VO$_2$ at the OBLA were obtained for wings, with average values of 47.44±6.22 mL·kg^{-1}·min^{-1}, whereas pivots had average values of 46.45±5.90 mL·kg^{-1}·min^{-1} and backs 45.13±4.94 mL·kg^{-1}·min^{-1}, although this difference was not statistically significant either. The highest calculated values of *Rel* VO$_2$ at peak velocity were obtained for wings, with average values of 53.22±5.13 mL·kg^{-1}·min^{-1}, whereas pivots had average values of 52.43±3.49 mL·kg^{-1}·min^{-1} and backs 48.97±8.22 mL·kg^{-1}·min^{-1}, although this difference was not statistically significant (Table 1).

Similarly, no statistically significant differences were found for VE at the LT, where wings had average values of 89.70±14.53 L·min^{-1}, pivots 81.96±9.96 L·min^{-1} and backs 78.68±16.22 L·min^{-1}. Also, no statistically significant differences for VE occurred at the OBLA (wings 132.69±17.02 L·min^{-1}, pivots 125.28±18.12 L·min^{-1} and backs 124.87±25.46 L·min^{-1}) nor at peak velocity (wings 155.52±16.48 L·min^{-1}, backs 154.64±19.36 L·min^{-1} and pivots 146.91±9.83 L·min^{-1}) (Table 1).

There were also no statistically significant differences in LA$_{max}$ concentration among all the three groups of players. The highest LA$_{max}$ concentration was obtained for backcourt players (9.35±4.12 mmol·L^{-1}), followed by wings (9.19±3.08 mmol·L^{-1}), whereas pivots achieved the lowest values (9.13±2.72 mmol·L^{-1}), but the difference was not statistically significant (Table 1).

The wings had the lowest [LA$^-$] on average at all velocities, whereas the values of [LA$^-$] in pivots and backcourt players were the same on average at all

Table 1. Obtained values of velocities, heart rates, blood lactate concentration [LA$^-$] and respiratory parameters of the subjects according to team positions during the 30–15IFT test at the LT, OBLA, and peak velocity during the 30–15IFT

	All	Backcourt players	Pivot players	Wing players
LT_Velocity (km·h^{-1})	13.04±0.85	12.65±0.78*	12.90±1.02‡	13.58±0.46
LT_Heart rate (b·min^{-1})	154.58±10.33	146.13±8.41*†	155.88±7.55†	161.75±8.96*
LT_VE (L·min^{-1})	83.45±14.03	78.68±16.22	81.96±9.96	89.70±14.53
LT_VO$_2$ (mL·min^{-1})	3324±499	3162±457	3412±618	3397±429
LT_ *Rel VO2* (mL·min^{-1}·kg)	36.80±5.08	34.42±3.74	37.32±5.35	38.67±5.61
OBLA_Velocity (km·h^{-1})	16.63±1.14	16.26±0.70*	16.39±1.58	17.24±0.81*
OBLA_Heart rate (b·min^{-1})	176.25±9.15	171.75±9.18*	174.75±6.04	182.25±9.36*
OBLA_VE (L·min^{-1})	127.61±19.97	124.87±25.46	125.28±18.12	132.69±17.02
OBLA_VO$_2$ (ml·min^{-1})	4183±522	4150±624	4227±500	4171±503
OBLA_*Rel VO2* (ml·min^{-1}·kg)	46.34±5.20	45.13±4.94	46.45±4.77	47.44±6.22
MAX_VE (L·min^{-1})	152.35±15.55	154.64±19.36	146.91±9.83	155.52±16.48
MAX_VO$_2$ (ml·min^{-1})	4646±565	4475±726	4782±561	4679±387
MAX_*Rel VO2* (ml·min^{-1}.kg)	51.54±5.98	48.97±8.22	52.43±3.49	53.22±5.13
MAX_Velocity (km·h^{-1})	19.46±1.16	19.19±1.33	19.13±0.99	20.06±1.02
MAX_Heart rate (b·min^{-1})	182.88±7.40	181.88±2.75	178.13±5.11‡	188.63±9.02‡
MAX_[LA$^-$] (mmol·l^{-1})	9.22±3.21	9.35±4.12	9.13±2.72	9.19±3.08

Note. * – statistically significant difference (p≤.05) – backcourt players vs wings; † – statistically significant difference (p≤.05) – backcourt players vs pivots; ‡– statistically significant difference (p≤.05) – pivots vs wings.

LT_Velocity – velocity achieved at LT; LT_Heart rate – heart rate at LT; LT_VE – pulmonary ventilation at LT; LT_VO$_2$ – oxygen uptake at LT; LT_ *Rel VO2* – relative oxygen uptake at LT; OBLA_Velocity – velocity achieved at OBLA; OBLA_Heart rate – heart rate at OBLA; OBLA_VE – pulmonary ventilation at OBLA; OBLA_VO$_2$ – oxygen uptake at OBLA; OBLA_*Rel VO2* – relative oxygen uptake at OBLA; MAX_Velocity – peak velocity; MAX_Heart rate – maximal heart rate; MAX_[LA$^-$] – maximal blood lactate concentration; MAX_VE – maximal pulmonary ventilation; MAX_VO$_2$ – maximal oxygen uptake; MAX_*Rel VO2* – maximal relative oxygen uptake.

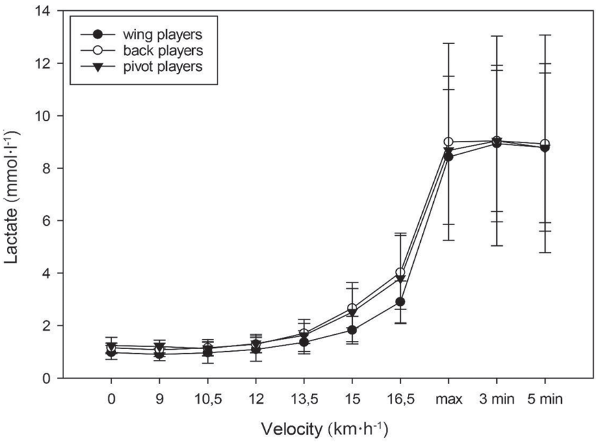

Figure 1. The average values of blood lactate concentration [LA-] during the test up to the velocity at which all the three groups of male handball players still managed to carry out the test and at three and five minutes after the test.

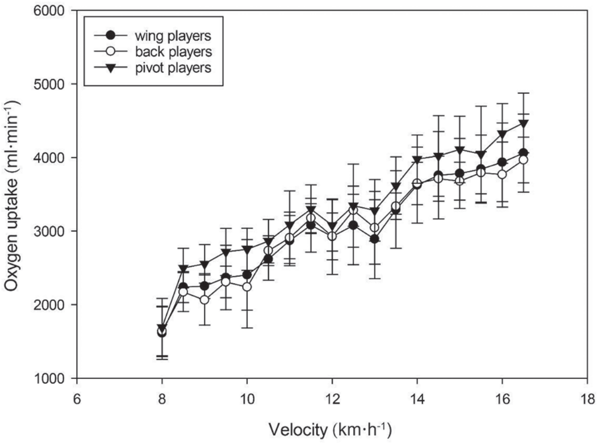

Figure 2. The average values of oxygen uptake (VO_2) during the test up to the velocity at which all the three groups of male handball players still managed to carry out the test.

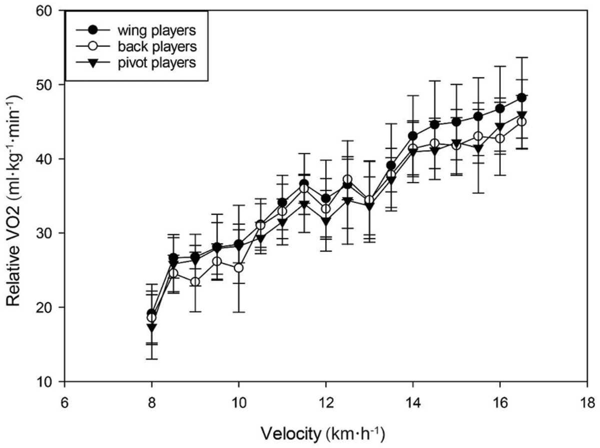

Figure 3. The average calculated values of relative oxygen uptake (Rel VO_2) during the test up to the velocity at which all the three groups of male handball players still managed to carry out the test.

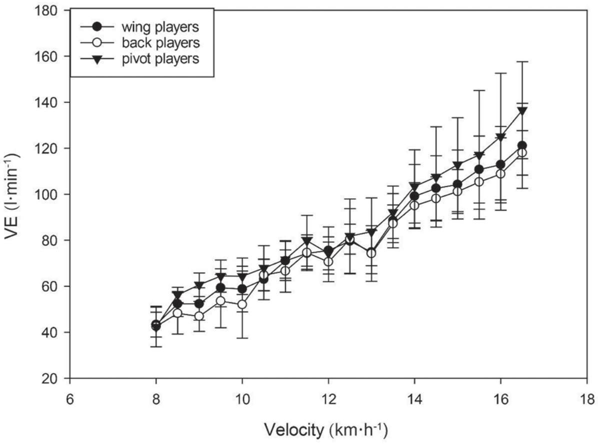

Figure 4. The average values of pulmonary ventilation (VE) during the test up to the velocity at which all the three groups of male handball players still managed to carry out the test.

velocities, so no statistically significant difference was obtained between the three groups of players (Figure 1).

The backcourt players exhibited the lowest VO_2 values on average at all velocities and pivots exhibited the highest VO_2 values at all velocities, although the difference was not statistically significant (Figure 2).

Again, no significant differences were found for *Rel* VO_2, although wings had slightly higher relative values compared to backcourt players and pivots at the same velocity (Figure 3).

Up to the velocity of 14 km·h^{-1}, the VE of all the groups of players was very similar on average, whereas at higher velocities, a non-significant tendency of lower values was seen in the backs and wings compared to the pivots, who had the highest measured values of VE at all velocities (Figure 4).

Discussion and conclusions

Only a few statistically significant differences were found among the groups of players in the various physiological parameters monitored during the 30–15IFT test. This fact can be attributed to various factors. The players that made up the groups were very similar in performance standard (elite players). Regardless of different body constitutions of theirs (wings had the lowest body height and low body mass, pivots had a high body height and body mass, and backcourt players had a high body height and body mass slightly lower compared to pivots) and their different in-game activities' profiles, apparently elite players in different playing positions achieve similar results in many aerobic ability parameters as measured by the 30–15IFT. Another reason may be the absence of a physiological strategy regarding aerobic endurance—very few selection criteria used in handball for the orientation of individuals in playing positions are associated with their level of aerobic capacity. In addition, the lack of differences could be related to deficits in resources for individual training of aerobic abilities and for testing different capacities in the team-developing process. Coaches may consider that aerobic performance factors are of less importance in the total perspective, so that it is not worth to dedicate extra time and resources to emphasize them for different team positions—like it was stated for soccer (Nilsson & Cardinale, 2015). Gorostiaga et al. (2005) even suggested that endurance capacity did not represent a limitation for performance in handball. However, most researchers report on the playing position specificities regarding the load of players during matches (Büchel, et al., 2019; Karcher & Buchheit, 2014; Wagner, Finkenzeller, Würth, & von Duvillard, 2014). In a typical match pattern, pivots cover generally the smallest distance on the court, but still must work at a relative high intensity due to a high number of body contacts they give and receive. Wings perform the greatest number of high-intensity runs, receive and give the least number of body contacts, apparently meeting the lowest physiological demands. Finally, playing activities of backcourt players are somewhere in between those described for the two other in-field positions, but they perform substantially more throws and passes than all the other players (Karcher & Buchheit, 2014). Since handball as a start-stop sport is characterized by short, intensive-to-high-intensive activities, such as short sprints, changes of direction, duels, or jumps, anaerobic endurance is considered to play a key role (Groeger, et al. 2019). Several studies (Bautista, et al., 2016; Massuca, Fragoso, & Teles, 2014) have suggested that anaerobic capacity and other functional abilities of handball players, such as vertical jumping ability, speed, agility, and acceleration abilities, are better predictors of success in handball compared to aerobic capacity. Notwithstanding all the above, some differences do occur. In terms of both statistically significant and non-significant differences, we can say that the wings achieved slightly different results in comparison to the backs and pivots. We find particularly interesting that the wings reached a statistically significant higher velocity at the LT than players in the other two groups and a significantly higher velocity than the pivots at the OBLA. In view of this, we could presume that wings are able to play for a long time, or to achieve a higher velocity, within the aerobic metabolism range. In principle, this allows them to have a longer on-court time without need to be substituted than is case with backcourt players and pivots (Büchel, et al., 2019). The wings also reached the highest average peak velocity (v30–15 IFT), but no significant difference was observed among the groups. It is also interesting to note that the wings reached the highest values of HR at all the observed levels. Upon a more detailed analysis of the results, it becomes apparent that the wings achieved their advantage in terms of a better end result in peak velocity compared to the other two groups of players in the aerobic range—meaning they came to the anaerobic area (OBLA) at higher speeds than the players of the other two groups (Table 1). In the range from the OBLA to the end of the test (peak velocity), the differences in velocity between the groups remained almost the same. The largest difference in velocities occurred in the test range from the start to the LT (Table 1). The wings reached their LT at the velocity that was almost by 1 km·h^{-1} higher than the velocity of the backs and 0.6 km·h^{-1} higher than the velocity of the pivots. However, the differences were not statistically significant. In the range between the LT and OBLA, the difference between the wings and pivots increased slightly and amounted to more than 0.8 km·h^{-1} at the OBLA. Nevertheless, it was still statistically insignificant. However, between the groups of backs and wings, the difference in the velocities achieved at the OBLA remained almost unchanged with respect to the difference at the LT, but the difference became statistically significant (Table 1). The difference, as already mentioned, at peak velocity remained practically unchanged between the groups compared to the difference achieved at the LT and OBLA. The wings demonstrated the highest value of the achieved running velocity among all the groups at all the three measuring points (LT, OBLA and peak velocity). We find it interesting, however, that the difference was achieved only in the area up to the OBLA (mostly even in the area up to the LT). A possible explanation is probably in the very nature of the test used since the increase in velocity significantly increases neuromuscular load as well. Namely, at higher velocities (especially above the velocity of 18-19 km·h^{-1}), the participants must execute more changes of movement direction, thus exploiting more neuromuscular potential than when performing a test task at a lower speed (Buchheit & Brown, 2020). Thus, even physically well-prepared players are not able to withstand the load of the test, which with increasing velocity disproportionately includes the neuromuscular part (so beside metabolic factors, persistence in the test becomes very dependent on neuromuscular factors as well). At each new stage of the test there is ever less straight running at a constant speed and there are more stops and accelerations, which cause rapid increase of fatigue and the consequent completion of the test. The limitation of this kind of inference is a lack of data on muscle lactate, which would have given us a more solid basis for these speculations (Chwalbinska-Moneta, Robergs, Costill, & Fink, 1989). These findings enable different profiles of handball experts (physical conditioning coaches, head coaches, and scientists) to better understand the course of physiological events during the 30–15IFT for various groups of handball players. They must be careful and exact in the interpretation of the results in terms of taking into consideration the specificities expressed by the players in various playing positions. An important factor here is players' morphological structure, which significantly varies, especially in wings. Among all team positions wings have the lowest values of body height and body mass. In principle, it is highly recommended to monitor the level of aerobic fitness of handball players with the help of the 30-15IFT test and to prepare an appropriate programme to improve their aerobic and anaerobic endurance (Buchheit, 2008b). It is an attractive alternative to classical continuous incremental field tests for defining a reference velocity for interval training prescription in team sport athletes (Buchheit, et al., 2009). Based on our results, coaches in practice can predict that, on average, better results (peak velocity) in the test will be achieved mainly by players in wing positions compared to the players in backcourt and pivot positions. This can be the basis for the individualized preparation (or working in groups) in the field of endurance development as well. Handball is a complex sport and numerous performance components must be trained. This may reduce the time available for the development of basic aerobic performance factors (achieved at the LA, OBLA, and v30–15IFT). The time conflict with the need to develop other important components of the game as well, such as team tactics and the development of other physical abilities, might be a problem. In this sense and for practical application purposes, coaches can be advised to reinforce their effort in the design of high intensity, short-duration, and short-recovery exercise programmes, consisting of repeated sprints, jumps, pulling/pushing actions, and contacts, to be practised during both conditioning and mixed (tactical and physically-based) training sessions, regardless of the fact that handball rules allow unlimited number of substitutions (Michalsik, 2018). Similar recommendations for training programming can also be found in the relevant literature (Wagner, et al., 2017b). Obviously, the mentioned is more important for handball performance than for pure aerobic capacity development. Based on our results, however, we would suggest that players, especially in the positions of backcourt players and pivots (players with a larger body height and body mass) increase their abilities, with the help of specific aerobic training of a slightly lower intensity, to the point that they will be able to operate well within the physiological aerobic or aerobic-anaerobic range (below the OBLA point) at higher load intensities. This should be considered especially for the off-season period. In doing so, however, the neuromuscular aspect of conditioning should not be neglected either—aerobic ability-developing exercises should indispensably incorporate changes of direction with a lot of braking and acceleration. Whilst it is a limitation of this study that anaerobic performance and other functional abilities (agility, jumping ability, acceleration, explosivity, etc.) were not measured, this study is the first attempt to understand physiological characteristics of handball players in different playing positions using the 30–15IFT and as such has provided some interesting findings. However, these results suggest that a very few differences occurred in the selected physiological parameters between elite-level wings, backcourt players, and pivots.

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No author has any potential conflict of interest.