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To cite this article: Emil Persson, Marcus Andersson & Sven Blomqvist (2021) Differences in Physical Demands Among Offensive and Defensive Players in Elite Men Bandy, Research Quarterly for Exercise and Sport, 92:4, 805-812, DOI: 10.1080/02701367.2020.1788203

To link to this article: https://doi.org/10.1080/02701367.2020.1788203

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Published online: 28 Aug 2020.

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Differences in Physical Demands Among Offensive and Defensive Players in Elite Men Bandy

Emil Persson, Marcus Andersson, and Sven Blomqvist

University of Gävle

ABSTRACT

Purpose: This study examined the physiological sport-specific demands (total distance, mean velocity, effective game time, and time in five velocity zones) in elite bandy players of offensive and defensive playing positions. Method: Data were collected with 10 Hz GPS-units in the Swedish Elite League during the season 2015/16. Ten male elite bandy players were examined during 13 matches. Data were analyzed with Independent Samples Test and with descriptive statistics. Result: Analysis showed that defensive positions covered a significantly longer (p < .001) total distance (23.2 ± 2.4 km vs 21.1 ± 3.5 km) compared to the offensive positions. Significantly higher (p < .001) mean velocity was found in offensive positions (17.8 ± 1.0 km/h vs 15.5 ± 1.6 km/h) in relation to defensive positions. In variable effective game time analysis exposed significant differences (p < .001) between offensive and defensive positions (90.4 ± 3.5 min vs 71.3 ± 11.9 min). Furthermore, in easy and moderate skating defensive positions spent significantly (p < .001) more time and in fast, very fast, and sprint skating offensive positions spent significantly (p < .001) more time in relation to each other. The descriptive analysis of positions indicates that libero, defender, and half have the longest game time, half skate the longest distance, and forward have the highest mean velocity during the game. Conclusion: From a practical perspective, the result can provide coaches knowledge when planning the setup in training drills. Thus, the training sessions could be more specific to the playing position, which could maximize the player’s physiological outcome in order to optimize performance.

A better understanding of movement patterns in bandy or any other team sport can lead to an increased comprehension of the physiological requirements based on different players and positions. Enhanced knowledge of the player’s physical demands may be useful for coaches to develop match-specific training drills for different playing positions. Coaches can also use this information to create more position-related training drills in order to handle the physical match-specific demands (Quarrie et al., 2013).

Bandy is a team winter sport and is mostly played in northern Europe and Russia (Timpka et al., 2002). Bandy is similar to soccer in many ways with regard to game time, size of the plan, the number of players in each team and rules. Bandy are categorized with intermittent work patterns and the endurance capacity is important during the games. (Häkkinen & Sinnemäki, 1990, 1991; Reilly & Thomas., 1976; Di Salvo et al., 2007). Bandy has also similarities to ice hockey regarding the skating movement pattern which includes high-intensity skating, direction changes, and rest periods such as gliding. It has been shown that a combination of dynamic skating movement, shooting, and passing are important qualities in ice hockey (Jackson et al., 2017) and it is reasonable to believe that same fundamental qualities are important in bandy. In ice hockey, it has been demonstrated that offensive position (forwards) has higher anaerobic capacity in relation to defensive players (Douglas et al., 2019). It has also been shown that offensive position (forwards) spends more time in high-intensity skating and glided for a longer time in relation to defensive players (Douglas et al., 2019; Jackson et al., 2017).

The majority of the scientific research in bandy has been focused on investigating maximal oxygen uptake or injuries (Häkkinen & Sinnemäki, 1990, 1991; Risto & Timpka, 2007; Timpka et al., 2007, 2002). A study by Blomqvist et al. (2018) evaluated the physical workload by using heart rate measurement. The results demonstrated that the defensive position defender had the highest physical workload and the defensive position libero had the lowest.

The global position system (GPS) is an effective and accurate way to quantify movement patterns and physiological demands in team sports (Edgecomb & Norton, 2006; MacLeod et al., 2009; Townshend et al., 2008), and it has been used to understand and quantify the sport-specific physical demands (Brewer et al., 2010; Duffield et al., 2009; Gabbett, 2010; Higgins et al., 2009; Ingebrigtsen et al., 2015; Jones et al., 2015; Macutkiewicz...
& Sunderland, 2011; Petersen et al., 2010). GPS measurements can, for example, show the distance, time or distance in different velocity zones, average velocity, and maximum velocity. In soccer, it has been found that offensive position (midfielders) covered the longest total distance and run the longest distance in high-speed zones compared to defensive positions (Hewitt et al., 2014; Di Salvo et al., 2007).

By using GPS measurements in bandy it becomes possible to determine specific training procedures that can replicate match requirements while quantifying the match contribution to the athletes’ training load. This information can help the coaches to increase the understanding of the players’ movement patterns in order to enhance performance.

To date, there are no published studies that have investigated the physical demands of different playing positions in elite bandy during official matches using GPS technology. Against this background, there is an obvious need for more research in bandy. The aim of this study was to quantify and compare the physiological sport-specific demands in total distance, mean velocity, effective game time, and time in five velocity zone for elite bandy players categorized in offensive and defensive positions and with descriptive statistics describe the different positions’ requirements. The hypotheses were that offensive positions skate the longest distance in comparison to the defensive positions and that offensive position spends more time in the two highest velocity zones.

**Methods**

**Study design**

The approach was a study based on a convenience sample. To test the hypothesis, GPS-data were collected in the variables total distance, time spent in different velocity zones, and average velocity to quantify the physiological sport-specific demands in elite bandy. To compare data, two subgroups were distributed of defensive positions (libero, defender, and halves) and offensive positions (midfielder and forward).

**Participants**

Ten outfield Swedish professional male bandy players from the Elitserien (the top level of the Swedish bandy league system) participated in the study. Anthropometry from the participants was as follows: age, 30.0 ± 4.8 years; weight, 82.8 ± 4.2; height, 180.6 ± 4.4 cm; and body mass index 25.4 ± 1.3. The team-lineup for each home game aside the goalkeeper was chosen to participate in the study. All participants had at least 5 years of competitive experience at the elite level and they trained three to five bandy specific training sessions per week during the data collection period.

All players were informed that they were free to withdraw from participation in the study at any time at their discretion. The participants received both detailed verbal and written information about the purpose of the study, all procedures, the consent to participate, the research benefits, and the potential risks. The study was approved by the regional ethical review board in Uppsala, Sweden (Dnr: 2015/009), and was performed in accordance with the Declaration of Helsinki.

**Procedure**

Data collection was performed during 13 home games in the Swedish Elite League between October and February during the 2015/2016 season. The study obtained 130 GPS data files; 10 GPS data files were lost because of injury or sickness. All home game matches were performed outdoors on artificial ice in various weather conditions. The mean temperature for all matches was 3.7° C ± 7.4°C and the wind speed was approximately 0–5 m/s.

The participant’s current playing position for the match was always registered during the study. To analyze the sport-specific physiological demands, the players were divided into two groups of defensive and offensive positions. Defensive positions include libero (n = 1), defender (n = 2) and halves (n = 2) and offensive position includes midfielders (n = 3) and forwards (n = 2). Each player provided at least 11 GPS data files, and the largest number of files provided by a player was 13 GPS data files. Participants always wore the same assigned GPS microtechnology unit (OptimEye X4, 50 × 90 mm, 67 g, Catapult Innovations, Melbourne, VIC, Australia) throughout the study. The micro-unit captured GPS data with a sampling frequency of 10 Hz and 3D ±16 g accelerometer data of 100 Hz. Johnston et al. (2014) showed that the Catapuls 10 Hz, GPS-unit had a high intraclass correlation (ICC) of >0.8. The GPS-unit was placed in a pocket of an elastic vest positioned between the shoulder blades on the upper thoracic spine. All participants were familiarized with the GPS-unit as a part of their daily training activity before data collection began. The participants were instructed to start the GPS-unit themselves about 15 min before the match to ensure a full high-quality satellite signal in accordance with the manufacturer’s manual. A GPS receiver was set up and connected to the software program Catapult Sprint 5.1.2. (Catapult Innovations, Melbourne, Australia) before capturing data. Before every match, a standardized 20 min warm-up on the ice was performed. Each warm-up included easier aerobic activity followed by passive and
active stretches recovery. Data collection began when the referee was giving the start signal and ended when the referee giving the end signal for both halves. Inclusion criteria for data analysis were that every player must have completed the entire match including the bench time. Data sampling was continuously taken during both halves (2 x 45 min) including any additional time, substitutions, time-outs, and penalties. After the match, raw data files were downloaded and analyzed, and the participant’s substitutions and penalties were observed in the software. Effective game time is explained as the time the player spends on the ice during the match exclusive bench time and penalties. Mean velocity was calculated in total distance divided with effective game time. The raw data were later exported from Catapult Sprint 5.1.2 software into Statistical Package for the Social Sciences (SPSS, Windows Version 20.0, Inc., Chicago, IL, USA).

The velocity threshold classification was designed through unpublished data and in consultation with advice from experts within the sport. Velocity thresholds were categorized accordingly: Standing (0–4 km/h), easy skating (4–15 km/h), moderate skating (15–20 km/h), fast skating (20–25 km/h), very fast skating (25–30 km/h), and sprint skating (>30 km/h). The velocity zone 0–4 km/h was considered as a passive activity, and was therefore not included in the study.

Statistical analysis

The distribution of normality data was verified by using Shapiro-Wilk’s test, inspection of the skewness and kurtosis and a visual inspection of the histograms, Q-Q plots, and Box-Plots (Razali & Wah, 2011; Shapiro & Wilk, 1965). Data were expressed as means and ± standard deviation (SD). Independent Samples Test was used to determine the significance of differences. Cohen’s d effect size (ES) was calculated to establish the magnitude of difference between groups. The ES was categorized as small (0.2), medium (0.5), and large (0.8) (Cohen, 1988). The study used a significance level at p < .05. Descriptive statistics for each position was described with box plot diagram. All data were analyzed in the statistical program Statistical Package for the Social Sciences (SPSS) (Windows version 24.0, Inc., Chicago, IL, USA).

Results

In Table 1 the results of effective game time, total distance, and mean velocity are presented. For the variable total distance, defensive positions were significantly (p ≤ 0.001) greater than the offensive positions (23.2 ± 2.4 km vs 21.1 ± 3.5 km) and the magnitude of the difference were categorized as medium (ω2 = 0.7). The analysis showed that the offensive positions (17.8 ± 1.6 km/h vs 15.5 ± 1.0 km/h) had the highest mean velocity, which were significantly (p ≤ 0.001) different in relation to the defensive positions. The dimension of the difference in mean velocity was categorized as large (ω2 = 1.7). Additionally, the variable effective game times were significantly (p ≤ 0.001) higher in the defensive positions (90.4 ± 3.5 min vs 71.3 ± 11.9 min) in comparison to the offensive positions and showed a large difference (ω2 = 2.2).

Table 2 shows time in five velocity zones easy, moderate, fast, very fast, and sprint skating. In easy (35.5 ± 12.1 min vs 15.4 ± 4.7 min) and moderate skating (29.8 ± 5.6 min vs 21.1 ± 5.6 min) the defensive positions spent the most time and had significant higher values (p ≤ 0.001) in relation to the offensive positions. The differences in easy and moderate skating were categorized as large (ω2 = 2.2 and ω2 = 1.6). In the three fastest velocity zones, fast (20.8 ± 5.5 min vs 13.9 ± 6.0 min), very fast (7.3 ± 2.2

### Table 1. Effective game time, total distance, and mean velocity for defensive and offensive players in bandy during 13 home matches.

<table>
<thead>
<tr>
<th>Position</th>
<th>Defensive players (n = 60)</th>
<th>Offensive players (n = 62)</th>
<th>p value</th>
<th>Effect size</th>
<th>95% CI for d_{obs}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean effective game time in min (SD)</td>
<td>90.4 (± 3.5)</td>
<td>71.3 (± 11.9)</td>
<td>.001</td>
<td>2.178</td>
<td>2.629–1.726</td>
</tr>
<tr>
<td>Total distance in meters (SD)</td>
<td>23.2 (± 2.4)</td>
<td>21.1 (± 3.5)</td>
<td>.001</td>
<td>0.7</td>
<td>1.068–0.331</td>
</tr>
<tr>
<td>Mean velocity of effective game time in km/h (SD)</td>
<td>15.5 (± 1.6)</td>
<td>17.8 (± 1.0)</td>
<td>.001</td>
<td>1.724</td>
<td>2.143–1.305</td>
</tr>
</tbody>
</table>

Independent Samples Test mean difference at p ≤ 0.05. Effect size calculated with Cohen’s d. SD = Standard deviation. n = number of measurement files.

### Table 2. Total game time in minutes spent in different zones of velocity.

<table>
<thead>
<tr>
<th>Position</th>
<th>Zone of velocity</th>
<th>Defensive players (n = 59)</th>
<th>Offensive players (n = 62)</th>
<th>p value</th>
<th>Effect size</th>
<th>95% CI for d_{obs}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easy skating 4–15 km/h in min (SD)</td>
<td>35.5 (± 12.1)</td>
<td>15.4 (± 4.7)</td>
<td>.001</td>
<td>2.19</td>
<td>2.641–1.739</td>
<td></td>
</tr>
<tr>
<td>Moderate skating 15–20 km/h in min (SD)</td>
<td>29.8 (± 5.6)</td>
<td>21.1 (± 3.6)</td>
<td>.001</td>
<td>1.568</td>
<td>1.975–1.16</td>
<td></td>
</tr>
<tr>
<td>Fast skating 20–25 km/h in min (SD)</td>
<td>13.9 (± 6.0)</td>
<td>20.8 (± 5.5)</td>
<td>.001</td>
<td>1.199</td>
<td>1.586–0.812</td>
<td></td>
</tr>
<tr>
<td>Very fast skating 25–30 km/h in min (SD)</td>
<td>4.1 (± 2.5)</td>
<td>7.3 (± 2.2)</td>
<td>.001</td>
<td>1.359</td>
<td>1.754–0.964</td>
<td></td>
</tr>
<tr>
<td>Sprint skating 30-faster km/h in min (SD)</td>
<td>0.9 (± 0.8)</td>
<td>1.2 (± 0.6)</td>
<td>.045</td>
<td>0.422</td>
<td>0.785–0.064</td>
<td></td>
</tr>
</tbody>
</table>

Independent Samples Test mean difference at p ≤ 0.05. Effect size calculated with Cohen’s d. SD = Standard deviation. n = number of measurement files.
min vs 4.1 ± 2.5 min) and sprint skating (1.2 ± 0.6 min vs 0.9 ± 0.8 min) the result showed that the offensive positions had significant more ($p \leq 0.001$) time in comparison to defensive positions. The differences in fast and very fast were categorized as large ($\omega^2 = 1.2$ and $\omega^2 = 1.4$) and sprint skating small ($\omega^2 = 0.4$).

The result in effective game time (Figure 1) implies that libero, defender, and half have a game time that is almost the full match. Midfielder spends about 62 min and forward spend about 76 min. In total distance (Figure 1), half showed greater values than to all other positions. Additionally, forward skated the shortest total distance among all positions. In mean velocity (Figure 1) the data indicate that forward had the highest value. Furthermore, results in both mean velocity (Figure 1) and easy skating (Figure 2) indicate a quite large difference from libero and defender to half, midfielder, and forward. In moderate skating (Figure 2) the visual analysis indicates that the offensive position forward showed less time in comparison to the other positions. In variables fast skating (Figure 2) and very fast skating

![Mean effective game time in minutes](image1)

![Total distance](image2)

![Mean velocity of effective game time in km/h](image3)

**Figure 1.** Shows effective game time, total distance, and mean velocity. Box-plots whiskers show max-min values, the box is 50% of the measurements and the line in the box is the median value of the measurement. Outlier is marked with o in the diagram.
libero and defender seemed to spend less time compared to half, midfield, and forward.

**Discussion**

The present study was designed to quantify and compare the physiological sport-specific demands in offensive and defensive positions. The result highlights that the defensive positions had higher values in effective game time and skated the longest total distance in comparison to the offensive positions. Additionally, analysis exposed significant differences between offensive positions and defensive positions in mean velocity and time in the three fastest velocity zones (fast, very fast, and sprint skating).

These findings contradict the offensive positions skate the longest distance, but support that offensive positions spend more time in the two highest speed zones.

In this current study, defensive positions found to cover the longest total distance in comparison to the offensive position during a bandy match. In literature, for example,
in soccer, it has been reported that the offensive positions cover the longest distance (Ingebrigtsen et al., 2015; Mallo et al., 2015). Moreover, in ice hockey, the opposite has been reported that the defensemen skate the longest total distance (McGuinness et al., 2019). One explanation of the result in the present study may be that defensive positions have a playing role that involves high demands in both the defensive and offensive parts of the game, as compared to the offensive positions that mostly focus to score goals and attack strategies. Another factor that strongly affects the total distance is that the offensive positions had around 19 minutes less effective game time than the defensive positions. The differences in effective game time can among other factors, depend on the coach’s philosophy, positional roles, and the individual's physiological capacity (Rampinini et al., 2007). The study also demonstrated that less effective game time was associated with higher mean velocity. A possible explanation could be that if a player gets longer rest time, it is reasonable to assume that the player can use more physical power at the field and thereby achieve a higher mean velocity. On the opposite, a higher effective game time contributes to a greater total distance. The defensive positions mostly play the full game time without any substitutions. In bandy there are free substitutions, which enable the coach to control the players' effective game time and thereby can manipulate the players' physical demands. A potential suggestion to increase the mean velocity in the defensive positions is to frequently use more substitutions.

Bandy is a fast winter sport with maximum velocities up to 37 km/h and is categorized with intermittent movements’ patterns. Additionally, it has been demonstrated that offensive positions spend more time (midfielder about 28 min and forwards 21 min) above lactate threshold vs defensive positions (libero 0.8 min, defender, and half about 15 min (Blomqvist et al., 2018). To skate in high-velocity zones the player’s anaerobic capacity can be an important key performance indicator. In these high physically demanding activities, one must also have a good aerobic capacity to handle the total distance and to be able to have a good recovery between substitutions within the game. The player’s game intelligence in bandy may influence the movement pattern which can contribute to smarter skate patterns in order to lower the energy consumption.

In bandy, a gliding phase is used which is an essential aspect of skating (van Ingen Schenau, 1982), and this helps the players to rest and at the same time maintain a high velocity compared to running in soccer where the players must invest a lot of energy to maintain a high velocity (Margaria et al., 1963). In ice hockey, it has been shown that forward spend more time in high-intensity skating and glided for a longer time in relation to defensive positions (Douglas et al., 2019). It is reasonable to believe that there are the same gliding conditions in bandy. In the present study, the offensive positions spend more time in high and very high-intensity skating, which could contribute to a longer time in gliding than among the defensive positions. To spend a lot of time in the high intensity skating the gliding phase is an important factor. If a player can make the most out of the gliding phase, it allows the player to save energy by short time of resting. It is also reasonable to believe that the gliding phase is a more important factor in bandy than ice hockey due to that the bandy players cover larger areas in the game field. More knowledge is needed on how a bandy player in the best way can use the gliding ability to enhance match performance.

The measurements in our study were collected with a 10 Hz GPS-unit that currently seems to be the most valid and reliable in team sports, and it gives more accurate data than a 5 Hz GPS-unit in measuring instantaneous velocity, distance covered in higher velocity and elements of intermittent movement patterns (Rampinini et al., 2015; Scott et al., 2016; Varley et al., 2012). However, it has been demonstrated that some limitations remain with 10 Hz GPS-units regarding movements that are performed at velocities of 20 km/h or faster (Johnston et al., 2014). Aside from that, data were collected in a valid and systematic way.

It is important to note that an analysis of the variables (total distance, mean velocity, effective game time, time spent in different velocity zones) alone does not provide a comprehensive profile of the movement demands in elite bandy. The physical internal workload measured by heart rate is probably an important factor of match play. Blomqvist et al. (2018) reported that the defensive position (defender) had the highest internal workload of all playing positions. In this present study, a visual analysis of all figures indicates that halves, midfielder, and forward had the highest overall demands for the variables total distance, mean velocity, and time spent in highest velocity zones. An explanation of the differences between this present study and Blomqvist et al. (2018) may be due to the demands in acceleration and deceleration. In soccer, for example, it has been demonstrated that a high acceleration and repeated sprint ability are important factors of performance (Hoff & Helgerud, 2004; Mohr et al., 2003).

The current study should be considered with the limitation that only one team was investigated. Therefore, there is a risk that the outcome could reflect the individual’s movement patterns rather than the actual position demands. This study has not categorized the movement as forward, backward, or sideways skating, which also may have an impact on the physiological
demands that are required for the specific playing position. In a future study, it would be interesting to investigate the direction for each position and how it affects the results in total distance, mean velocity, and time in different velocity zones. Another sport-specific physiological factor that would be interesting to investigate is the demands in acceleration and deceleration and how it affects different playing positions.

In conclusion, the present study highlights that, compared to defensive positions, the offensive positions have higher demands in fast, very fast, and sprint skating during a bandy match. These data indicate that offensive positions should spend more time in higher velocity zones during bandy training to meet the match-specific demands. Defensive positions skated the longest total distance during matches, which tends to increase the aerobic fitness demands compared to the other positions. These data and knowledge provide valuable information to coaches about the sport-specific physical demands between differences in offensive and defensive positions and this is something that may contribute to develop and adjust better match-specific training programs.

What does this study add?
Bandy is the second largest winter sport after ice hockey with over 350,000 practitioners. The research on bandy is very sparse and therefore more research is needed. This study is the first of its kind to investigate motion patterns for elite bandy players. The study shows that there are differences between offensive and defensive positions in bandy in terms of total distance, mean velocity, effective game time, and time spent in different velocity thresholds. These differences are important for the coach and the leader to take into account when setting up training sessions and in the matching of the team.

Acknowledgments
The authors would like to thank all the players that made this study possible.

Funding
This study was funded by Faculty of Health and Occupational Studies, University of Gävle, Sweden.

ORCID
Sven Blomqvist  http://orcid.org/0000-0002-2995-4428

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