# The Influence of pitch size on running performance during Gaelic football small sided games

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**Abstract**

*The current study examined the impact of small sided game (SSG) pitch dimensions on running performance during 4 min SSG. Twenty four elite Gaelic football players were monitored with GPS (4-Hz, VX Sport, New Zealand) over an in-season training period. Total distance (m) high speed running distance (m) ($\geq17$ km·h$^{-1}$), very high speed running distance ($\geq22$ km·h$^{-1}$) (m), total accelerations (n), acceleration distance (m) peak and mean velocity (km·h$^{-1}$) were calculated. The current results show that the manipulation of SSG pitch size has an impact on the running performance responses. The data showed that SSG played on large pitches (SSG$_{80x20m}$) had greater running demands than medium (SSG$_{60x20m}$) or small (SSG$_{40x20m}$) pitches, with significantly more distance covered in all movement categories. During SSGs the total distance covered were 515 ± 89 [426 – 594] m, 719 ± 145 [564 - 854] m and 1029 ± 189 [810 - 1128] m corresponding to a relative distance of 128 ± 22 [57 - 101] m·min$^{-1}$, 179 ± 36 [91 - 163] m·min$^{-1}$ and 257 ± 46 [139 - 231] m·min$^{-1}$ for small, medium and large pitch dimensions respectively The current data may help applied practitioners to understand further how modifying different aspects of SSG can alter the running performance responses of players. Moreover, applied practitioners now have consistent information to design and optimise their training time in mixing the physical, technical and tactical elements within specific SSG pitch dimensions.*

**Key Words:** Training analysis; High-speed running; Team sport

## 1. Introduction

Gaelic Football match play is typically characterised by repeated bouts of sustained high-intensity running with limited recovery periods superimposed upon low intensity sub-maximal periods of running (Reilly and Collins 2008; O' Donoghue and King, 2005; Collins, Solan and Doran, 2013). During match-play a range of offensive and

defensive skills are executed at high speed, with play shifting rapidly from end-to-end, rapid accelerations and decelerations, changes of direction, and unorthodox movement patterns take place to make Gaelic football match-play unlike other field games. Recently the running performance of Gaelic football match play has been analysed utilising global positioning systems technology (Malone *et al.,* 2015). Indeed, players on average completed 8160 ± 1482 m total distance, with 1731 ± 659 m covered at high speed. The observed sprint distance was 445 ± 169 m distributed across 44 sprint actions. A significant difference was observed between positional groups for both total running distances, high speed running distance and sprint distance, with midfielders covering more total and high speed running distance, compared to other positions. Given the amateur ethos of players there is a need for practitioner appreciation of time efficient methodologies of training.

Small sided games (SSG) represent a common form of conditioning in team sports (Hill-Haas *et al.,*2011; Gaudino *et al.,* 2014) functioning as an effective alternative methodology to traditional interval training methods for enhancing a players specific endurance capacity (Dellal *et al.,* 2012; Hill-Haas *et al.,* 2009b). In addition to replicating the specific movement patterns associated with match play, such methods have the advantage of concurrent physical, technical, tactical and physiological development (Kelly and Drust, 2009; Collins, Doran and Reilly, 2013). In light of their growing popularity, a comprehensive understanding of the stimulus imposed on players during these drills is required in order to optimise the training adaptation. Manipulating variables such as the playing area, number of players and rules of the game has been shown to influence the workload of SSG (Brandes *et al.,* 2012; Castellano, *et al.,* 2013; Dellal *et al.,* 2012; Hill-Haas *et al.,* 2011). For example, a larger pitch size and low number of players increases the strain incurred (Casamichana and Castellano, 2010; Dellal *et al.,* 2012; Hill-Haas *et al.,* 2011; Kelly and Drust, 2009). To date information concerning the load associated with SSG's has been predominantly assessed via heart rate (HR), blood lactate ([BLa]) and rating of perceived exertion (RPE) (Hill-Haas *et al.,* 2011; Rampinini *et al.,* 2007).

In other field sports such as soccer the influences on physical demands in SSG have been investigated thoroughly, however, within Gaelic football there is a lack of in-depth investigations of these training methodologies (Reilly and Collins, 2008). The advancement of technology now permits accurate assessment of running performance within training by global positioning systems (GPS) (Gaudino *et al.,* 2014). These systems have been shown to be accurate and valid within intermittent exercise (Buchheit *et al.,* 2014). Specifically with regard to pitch dimensions, studies have inspected the influence of small, medium or large dimensions within soccer specific SSG (Rampinini *et al.,* 2007; Kelly and Drust, 2009). The majority of studies have reported that bigger dimensions increase the physiological responses of players (Rampinini *et al.,* 2007; Kelly and Drust, 2009). Moreover, analysis by Casamichana and Castellano (2010) showed that the distance covered at high speed was greater in larger pitch dimensions. Interestingly, the SSG game type has also been shown to impact the running performance of players with Gaudino et al. (2014) recently showing that possession based SSG resulted in a greater total distances when compared to SSG with goalkeepers.

However, despite extensive research within certain team sports there is still a lack of understanding as to running performance related information on SSG within Gaelic football. In particular, little is known about some crucial running performance components within drills of different player numbers and pitch size. The unpredictable and multi-factorial nature of these games involving among others a great number of explosive actions and changes in velocity, implies a greater complexity in the quantification of the workload. Therefore, novel insight as to the running performance during different pitch dimensions is warranted. Given the above information the aim of the investigation was to provide insight as to the impact that different pitch dimensions have on standardised SSG with respect of running performance for Gaelic football players. A single team method of analysis was utilised to best avoid inter-individual differences within different teams influencing the data collection so that any differences in running performance could be attributed to the pitch dimensions.

## 2. Methods

### 2.1. Player numbers and Drill Layout
Twenty-five Gaelic football players competing at inter-county level considered as the highest level of competition in Gaelic football (age $27.3 \pm 3.2$ years; height $188.9 \pm 3.2$ cm; body mass $80.5 \pm 4.5$ kg) took part in the study during the in-season competition period (February – September). A total of 1560 individual drill observations were undertaken on outfield players with a median of 28 observations per player. Three different dimension formats of SSG were observed during the study period. $SSG_{40x20m}$ (Player observations, n = 520), $SSG_{60x20m}$ (Player Observations, n = 520) and $SSG_{80x20m}$ (Player observations, n = 520). The game rules were the same for each format, where the objective was to keep possession and score in a touchdown zone at the end of each pitch. Once a team had scored they maintained possession and attacked the opposite end of the pitch. Each drill was performed in a varied order to avoid ordering effects. SSG were performed in with a continuous rhythm, under the supervision and motivation of several coaches in order to keep the running performance of players high (Rampinini *et al.,* 2007). During all SSG free play was allowed with maximal touches, in all cases multiple replacement balls was available by prompt replacement when hit out of play (Gaudino *et al.,* 2014; Castellano *et al.,* 2013). Before the study period, these SSG were frequently performed to ensure familiarisation before the experimental period. All sessions were performed on the same pitch. In addition all exercise games were performed at the same time during the day (6 pm – 8 pm) to limit to effects of circadian variations on measured variables (Drust *et al.,* 2005). All SSG were completed after a standardised warm up of 15 min. All games were standardised by time (4 min in length). All players were notified of the aims and objectives of the study, research methods, requirements, benefits and risks before giving written informed consent. The research was carried out with approved ethical consideration from the local institutes' research ethics committee.

### 2.2. Data collection
The participants wore an individual GPS unit (VXsport, New Zealand, Issue: 330a, Firmware: 3.26.7.0) sampling at 4-Hz and containing a triaxial accelerometer and magnetometer in all training sessions. The GPS unit (mass: 76 g; 48 mm x 20 mm x 87

mm) was encased within a protective harness between the player's shoulder blades in the upper thoracic-spine region. Fifteen minutes before the commencement of training, the GPS device was fixed to the player, to establish a satellite lock training (Maddison and Ni Mhurchu, 2009). Proprietary software provided instantaneous raw velocity data at 0.25 s intervals, which was then exported and placed into a customised Microsoft Excel spreadsheet (Microsoft, Redmond, USA). The spreadsheet allowed analysis of distance covered (m) and speed calculated ($km.h^{-1}$) in the following categories; total distance; high speed running distance ($\geq 17$ $km \cdot h^{-1}$); very high speed running distance ($\geq 22$ $km \cdot h^{-1}$); max speed ($km \cdot h^{-1}$); average speed ($km \cdot h^{-1}$). The software allowed for the calculation of accelerations lasting 1 second ($\Delta t = 1s$) were considered and were categorised based on the number of efforts. Consequently, the following two categories were selected: moderate ($2$–$3$ $m \cdot s^{-1}$), and high acceleration ($> 3$ $m \cdot s^{-1}$) (Hodgson *et al.,* 2014).

## 2.3. Statistical Analysis

Data are presented as mean ± standard deviation with 95% confidence intervals (mean ± SD [95%CI]). A repeated measures ANOVA was performed in order to understand the main effect of format type ($SSG_{40x20m}$, $SSG_{60x20m}$ or $SSG_{80x20m}$) on the running parameters between SSG drills. The dependant variables across the range of analysis were, total distance (m), high speed distance (m; $\geq 17$ $km \cdot h^{-1}$), sprint distance (m; $\geq 22$ $km \cdot h^{-1}$), mean velocity ($km.h^{-1}$), peak velocity ($km \cdot h^{-1}$) and number of accelerations (n) with pitch dimensions (e.g, first and second half) independent variables. Significant main effects and interaction between factors were followed up with a least significant difference (LSD) post hoc analysis (Perneger, 1998). Statistical significance was set at $p \leq 0.05$. Effect sizes (ES) were interpreted as <0.2, trivial; 0.2-0-6, small; 0.6-1.2, moderate; 1.2-2.0, large; >2.0, very large differences in physical performance variables between SSG pitch dimensions (Hopkins *et al.,* 2009)

## 3. Results

Running performance for each pitch dimensions is reported in table 1. The larger pitch dimensions showed higher running performance for all variables measures. During SSG the total running distance covered were 515 ± 89 [426 – 594] m, 719 ± 145 [564 - 854] m and 1029 ± 189 [810 - 1128] m corresponding to a relative distance of 128 ± 22 [57 - 101] $m.min^{-1}$, 179 ± 36 [91 - 163] $m.min^{-1}$ and 257 ± 46 [139 - 231] $m.min^{-1}$ for small, medium and large pitch dimensions respectively. Similar trends were observed for high speed running distance ($SSG_{80 \times 20m} > SSG_{60 \times 20m} > SSG_{40 \times 20m}$; p = 0.003; ES = 1.2) and very high speed running distance ($SSG_{80 \times 20m} > SSG_{60 \times 20m} > SSG_{40 \times 20m}$; p = 0.004; ES = 1.1) respectively for larger pitch dimension resulting in higher running performance (see table 1). Finally, the total distance covered in acceleration ranges were both higher on large (total acceleration = 151 ± 65 [6–167] m) and medium pitches (total acceleration = 91 ± 45 [4–110] m) when compared to smaller pitch dimensions (total acceleration = 67 ± 35 [6-66] m). Further analysis of acceleration categories showed that larger pitch dimensions resulted in higher distances in both moderate ($SSG_{80 \times 20m} > SSG_{60 \times 20m} > SSG_{40 \times 20m}$; p = 0.002; ES = 1.3) and large acceleration categories ($SSG_{80 \times 20m} > SSG_{60 \times 20m} > SSG_{40 \times 20m}$; p = 0.004; ES = 3.1).

## 4. Discussion

The current investigation sought to characterise the running performance of elite Gaelic football players across different pitch dimensions in SSG training. The study is the first to quantify these variables within Gaelic football providing a detailed analysis of these drills is pivotal in the contemporary game as it enables an in depth understanding of the workload imposed on each player, which consequently has practical implications for the prescription of the adequate type and amount of stimulus during training. Additionally, the investigation quantified the acceleration demands of SSG thus providing an explanation for the well documented efficacy of this training methodology in team sports for eliciting improvements in fitness of team sport players (Hill-Haas *et al.,* 2009b). In line with other studies (Rampinini *et al.,* 2007; Corvino *et al.,* 2014), the current investigation found that for the same game format of SSG an increase in relative playing area resulted in a linear concomitant increase in the running performance of players. This was reflected in small pitch dimensions ($SSG_{40x20m}$) being characterised by reduced running performance highlighted by reduced distances, maximal velocity and acceleration responses. Furthermore, medium pitch dimensions ($SSG_{60x20m}$) appear to further increase the running performance profile of players; providing increased absolute and relative running demands. Interestingly, large pitch dimensions ($SSG_{80x20m}$) are characterised by a high running performances however these dimensions appear best to replicate the match play scenario. These data have important implications for coaches and practitioners utilising SSG as a conditioning stimulus in Gaelic football as the data is the first to report consistent information on SSG demands in a Gaelic football specific training environment.

Table 1. The distance, speed and physiological parameters calculated during different pitch dimensions of SSG. Results are presented as mean ± SD.

| SSG - 4 v 4 | 40 x 20 m | 60 x 20 m | 80 x 20 m | Follow up Tests (LSD) |
|---|---|---|---|---|
| Relative Player Area ($m^2$) | 100 | 150 | 200 | |
| Total Distance (m) | 515 ± 89 | 719 ± 145 | 1029 ± 189 | 80 x 20 > 60 x 20 > 40 x 20[**] |
| High Speed Running Distance (m) | 186 ± 26 | 298 ± 93 | 425 ± 100 | 80 x 20 > 60 x 20 > 40 x 20[*] |
| Very High Speed Running Distance (m) | 41 ± 10 | 85 ± 14 | 145 ± 35 | 80 x 20 > 60 x 20 > 40 x 20[*] |
| Max Speed ($km·h^{-1}$) | 28.2 ± 2.5 | 30.1 ± 3.5 | 34.1 ± 2.6 | 80 x 20 > 60 x 20 > 40 x 20[**] |
| Total Accelerations (n) | 15 ± 8 | 25 ± 15 | 55 ± 24 | 80 x 20 > 60 x 20 > 40 x 20[*] |
| Total Acceleration distance (m) | 67 ± 35 | 91 ± 45 | 151 ± 65 | 80 x 20 > 60 x 20 > 40 x 20[*] |
| Moderate Acceleration distance (m) | 40 ± 17 | 61 ± 20 | 110 ± 30 | 80 x 20 > 60 x 20 > 40 x 20[**] |
| Large Acceleration distance (m) | 27 ± 18 | 30 ± 25 | 41 ± 35 | 80 x 20 > 60 x 20 > 40 x 20[*] |

HSRD - High Speed Running Distance (m; >17 $km·h^{-1}$); VHSRD - Very High Speed Running Distance (m; >22 $km·h^{-1}$); Moderate Accelerations (m; >2–3 $m.s^{-1}$); High Accelerations (m; > 3 $m.s^{-1}$)*Significant difference between pitch dimensions ($p <0.001$) **Significant difference between pitch dimensions ($p <0.05$).
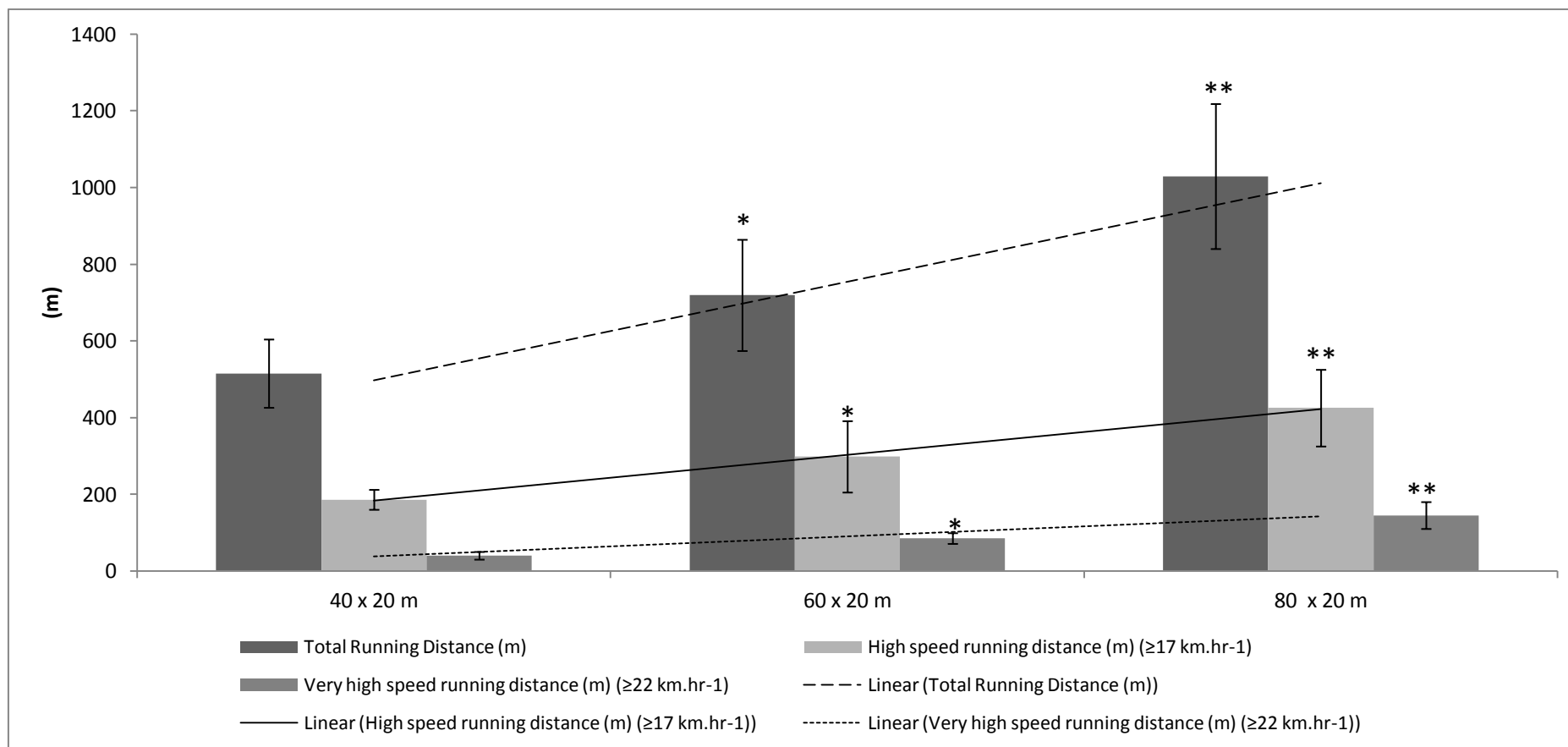
Figure 1. The total distance (m), high speed running distance (m) and very high speed running distance covered during different dimensions of SSG. (*Significant difference between small and medium pitch dimensions ($p<0.05$); **Significant difference between small and large pitch dimensions ($p<0.001$))

Specific analysis of running performance revealed that large pitches result in higher running volume with large to very large main effects reported between small to large pitch dimensions for total distance (ES: 3.2), high speed running distance (ES: 2.5) and very high speed running distance (ES: 3.1). Additionally players covered more distance during acceleration movements in larger dimensions (101 ± 65 m) when compared medium (81 ± 45 m) and small (47 ± 25 m) pitch dimensions. These data support previous findings in soccer (Rampinini *et al.,* 2007) and handball (Corvino *et al.,* 2014) that show as player area is increased players cover more distance during SSG however it should be noted that not all SSG studies show these results. With respect to maximum velocity, the lowest values were reported on smaller pitch dimensions, something that needs to be taken into account when proposing training drills. The current data supports previous findings in soccer that have shown that relative pitch area is an important factor for consideration by applied practitioners to best allow players to express maximal velocity characteristics during SSG (Casamichana and Castellano, 2010; Castellano *et al.,* 2013).

Considering the potential importance of acceleration movements as an indicator of fatigue in team sports (Akenhead *et al.,* 2013; Osgnach *et al.,* 2010), the data suggest SSGs might provide an adaptive training stimulus; imposing relative demands on acceleration abilities in excess of those experienced during full match play. The data provided may explain as to why this training method has proved to be equal to or superior than traditional interval training in the available research (Helgerud *et al.,* 2001; Hill-Haas *et al.,* 2009a; Impellizzeri *et al.,* 2006). During the current investigation total acceleration distance for both moderate and higher accelerations were significantly higher for players when competing in larger pitch dimensions, therefore it may be suggested that this larger pitch dimension could be utilised as a specific 'density' type stimulus for Gaelic football players during pre-season and in-season periods. Interestingly when the aim is taxing maximal acceleration and maximal speed, these components are more pronounced in larger SSG pitches than in smaller pitches. The current observation indicates that big spaces and ''opened nature'' games are required in order to address the aforementioned characteristics. However, the number of times team sport players reach the peak intensity during changes in velocity is quite reduced as only 34% of the sprint efforts during soccer games were preceded by maximal acceleration, while the 85% of maximal accelerations had a final velocity over 4.17 $m \cdot s^{-1}$ (Varley and Aughey, 2013).

Whilst the use of 4-Hz GPS systems has attached with it a degree of error for capturing the movement demands in confined spaces such as those utilised in SSG (Buchheitt *et al.,* 2014). Thus whilst the current study provides novel information to coaches there still remains scope to more accurately quantify the running demands imposed on Gaelic football players in training. Future studies should aim to assess the internal physiological profile associated with SSG for elite Gaelic football players. In addition with technical, tactical and physical activity profiles during match play being inextricably linked in the football codes. A limitation of the current study is that technical skill efficiency of the SSG analysed could not be assessed. Future studies should examine the complex relationships between these factors so that the relationships of running performance to overall SSG performance are better understood.

## 5. Conclusion

In conclusion, the current study provides novel data on the running demands of Gaelic football SSG. The distances covered during running movements within SSG are relatively higher than match play for Gaelic football players, supporting the use of SSG as a training tool in the sport. As the playing area was increased players covered more distance during acceleration type movements with players covering more distance on large pitch dimensions when compared to other dimensions. The data from the current study explains how effects of manipulating pitch dimensions of SSG might enhance opportunities for acquiring specific movement profiles an important consideration for practitioners who focus solely on SSG as a training tool. A large pitch dimension ($SSG_{80x20m}$) appears optimal in that it imposes physical demands to that of match play. Practitioners can use the data presented here to more accurately prescribe appropriate Gaelic football specific training stimuli.

## 6. Acknowledgements

## 7. References

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