COACHING PRACTICES OF ADULT CLUB LEVEL GAELIC FOOTBALL COACHES AND THE ASSOCIATED MATCH PLAY DEMANDS WITHIN MODIFIED GAMES

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Thesis submitted for the award of PhD

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Declaration

I hereby certify that this material, which I now submit for assessment on the programme of study leading to the award of PhD is entirely my own work, that I have exercised reasonable care to ensure that the work is original, and does not to the best of my knowledge breach any law of copyright, and has not been taken from the work of others and to the extent that such work has been cited and acknowledged within the text of my work.

Signed: **ID No**. 56744494 **Date:** 06/01/2024

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Definition of Terms

High catch - Taking possession of the ball in an overhead position with the hands

Chest catch - Taking possession of the ball with hands between head and waist height

Low catch - Taking possession of the ball with hands below waist height

Total catches - Sum of high, chest and low catches

Hand pass - Striking the ball with the hand/fist to transfer it to a teammate

Foot pass - Striking the ball with the foot to transfer it to a teammate

Successful Scoring attempt – Successful attempt to score during play by striking the ball by hand or foot over the crossbar and between the uprights for a point, or kicked below the crossbar and between the uprights for a goal

Unsuccessful Scoring attempt - Unsuccessful attempt to score during play by striking the ball by hand or foot

Pick-up - Lifting the ball from the ground by placing the toe of the boot beneath the ball and lifting it into cupped hands to take possession

Block - Using both hands to block the ball as an opponent attempt`s to kick the ball

Interceptions - Deflection of the ball in open play using the foot or hand to prevent an opponent gaining possession

Solo tap - The act of kicking the ball back to the hands to retain possession while solo-running

Solo hop - Hopping the ball to oneself during a solo-run

Touch - A single intentional contact with the ball

Possession – When the player has control of the ball

Team possession - When two or more players on the same team gain possession of the ball

Players per team possession – Number of different players who gain possession of the ball in a team possession

Time per team possession - Duration of each team possession

Skills per team possession – The number of skills performed by all players involved in each team possession

Drills - Exercises practiced unopposed in lines that require the repetition of skills and prescribed directional movement

Skills in isolation - Similar to drills but don't occur in lines and are often completed with little or no movement allowing the player to solely concentrate on the skill being practiced. (e.g. 3 players passing to each other randomly throughout the field with no pressure)

Applied skill practice - Activities that involve some level of opposition and where technique is exposed to pressure and elements of decision making are required with 6 or less players in formations such as (e.g. 1vs1/2vs2/3vs3/3vs2/4vs2 etc.)

Conditioning - Exercises completed without the ball that usually focuses on improving physical fitness, speed, agility etc.

Small sided games - Activities that involve games from 4 vs. 4 to 7 vs. 7 where rules or conditions may or may not be employed

Medium sided games - Activities that involve games from 8 vs. 8 to 11 vs. 11 where rules or conditions may or may not be employed

Large sided games - Activities that involve games from 12 vs. 12 to 14 vs. 14 where rules or conditions may or may not be employed

Full sided games - Game play with the full complement of players (15 vs. 15) where rules or conditions may or may not be employed

Abbreviations

AFL	Australian Football League
b.min^{-1}	Beats per minute
CL	Club level
FSG	Full sized games
GAA	Gaelic Athletic Association
GF	Gaelic football
GPS	Global positioning satellites
HR	Heart rate
HIR	High intensity running
hr	Hour
HRmax	Heart rate max
Hz	Hertz
kg	Kilogram
km·h^{-1}	Kilometres per hour
LIA	Low intensity activity
LSG	Large sized games
min	Minutes
MG`s	Modified games
MSG	Medium sized games
PE	Physical Education

PF	Playing form
PI	Principle Investigator
RPA	Relative playing area
sec	Seconds
SSG	Small sided games
TD	Total distance
TF	Training form
TGfU	Teaching games for understanding
VHIR	Very high intensity running
vs.	Versus
yrs.	Years
%time	Percentage of time

ABSTRACT

Cregg, Cathal J. Coaching Practices of Adult Club Level Gaelic Football Coaches and Match Play Demands of Modified Games

The traditional drill-to-game (DTG) approach has been the dominant coaching practice employed by club level Gaelic football (GF) coaches in Ireland. Modified games (MG`s) involves altering normal playing conditions such as the playing area, number of players per team, size and shape of pitch, rules of the game etc., and are a central tenet of the games based approach (GBA). Ideally, MG's should closely replicate competitive match play demands (MPD). This PhD compared MPD (activity profiles, individual technical skills, team play characteristics and heart rate responses) during 7 and 11-a-side senior club level GF games with 15-a-side senior championship games while maintaining all other match play conditions. The follow on study (Physical and physiological predictors of activity profiles during Gaelic football match play) could not be undertaken due to the closure of the exercise physiology laboratories in DCU due to COVID-19. A protocol paper for the study is included as Chapter VI. The final study examined coaching practices of club level GF coaches in relation to the sequencing and time allocation to training and playing form activities, and their rationale for using various modified game formats during training.

In general, player activity profiles and technical skills were significantly greater during MG's than 15-a-side games. Although a similar number of team play opportunities are offered to players competing in 7, 11 and 15 a-side games, the time per team possession and the number of skills per possession was significantly greater in the MG`s. There was very little difference in the maximal and mean HR during MG's and 15-a-side games.

Regardless of the phase of the season, coaches placed a greater emphasis on drills/isolated activities during the first part of training sessions and progressed to game-based activities at the latter part of training sessions. A greater proportion of preseason training sessions was spent in drills/isolated activities than game-based activities. In contrast, significantly more training time was allocated to game-based activities during the competitive season.

In summary, MG's involving reduced player numbers while maintaining all other match play variables closely replicates competitive MPD. Apart from offering valuable insights for senior club level GAA coaches, the research methodology offers a structured framework as a starting point for coaches when altering playing conditions (constraints) during MG`s on MPD. Finally, current coaching practice among senior club level coaches mostly aligns to the traditional DTG approach.

Chapter I

Chapter I

Introduction

Gaelic football (GF) is a popular sport in Ireland and can be described as a hybrid of soccer, rugby and basketball, although it predates all of these games[1,2,3,4]. It is one of the five games organised and promoted by the Gaelic Athletic Association (GAA), the others being hurling, camogie, handball and rounders. The GAA is a community-based organisation and is celebrated for its amateur playing status. At youth and adult level, there is a graded system of competition where the best players from each club are selected to represent their county team (high performance). Adult club level and inter-county games are 60 min and 70 min in duration, respectively.

Games are played between two teams of 15 players on a rectangular grass surface ranging from 145 x 90 m to 130 x 80 m. Teams are comprised of a goalkeeper, six defenders, two midfield players and six forwards, although changes can occur depending on the tactics employed by the team. A round ball that is slightly larger and heavier than that used in soccer can be caught and kicked from the ground or hands. A point is awarded when the ball is kicked or hand passed over the crossbar and a goal (3 points) is awarded when the ball crosses the end between the two uprights and underneath the crossbar[5].

Game-play includes irregular changes of pace and anaerobic efforts superimposed on a backdrop of light to moderate aerobic activity[5]. The high intensity

activity bouts undertaken during GF are largely unpredictable and are imposed by the pattern of play. Activity patterns can vary greatly from player to player and from one game to another. Players are required to make decisions based on continuous sensing and processing of information in their immediate environment. This requires the development of perceptual-cognitive skills such as anticipation and decision-making[6].

The traditional drill-to-game (DTG) approach has been the dominant coaching practice employed by club level GF coaches. This approach involves training sessions that include isolated drills to develop technical skills and/or athletic development drills focused on maintaining or improving various components of physical fitness. The GAA's National Coaching and Games Development Committee has since 2008 recommended that coaches at all levels of the association transition from the traditional drill-to-game model to adopting a game-based approach (GBA). In contrast to the traditional approach where opportunities for decision making during the majority of training sessions is low, the GBA focuses on creating an environment where technical skills and physical fitness can be developed through modified games (MG`s), while offering players opportunities for contextual processing and decision making. MG`s involve a smaller number of players than full-sided competitive games. Conditions (constraints) such as playing area, number of players per team, relative playing area (RPA), coach encouragement, game duration, number of games, recovery time between games, size and shape of pitch, availability of balls and the rules of the game can be manipulated[7,8,9]. Ideally, MG's should closely

replicate 15-a-side competitive match play demands (MPD), i.e., individual technical skills, team play characteristics, activity profiles and physiological responses.

The only published study to examine the impact of MG`s on MPD in adult club level GF used a 4 vs. 4 game format on three different pitch sizes as part of the conditioning component of training sessions[10]. The playing surface areas were based on a study involving intercounty GF players and failed to take account of the RPA during competitive 15-a-side match play[11]. For example, Mangan et al., (2019) kept the number of players constant during three 4 vs. 4 GF games while altering the dimensions of the playing area by approximately 10%. Based on maximal playing dimensions, the RPA during the 4 vs. 4 games equated to 21%, 32% and 43% of the area available during 15-a-side GF games. Pitch length and width can also influence MPD during MG`s. Increasing the pitch length during 5-a-side soccer games has been found to have a greater effect on activity profiles than altering the width[12]. The length to width ratio of a maximal size GF pitch is 1.0:1.6. The three pitch sizes used by Mangan et al., (2019) during the 4 vs. 4 MG's had a length to width ratio of 1:2, 1:3 and 1:4[10].

Statement of the Problem

There is a need for a more systematic approach to the design of studies focused on evaluating the efficacy of MG`s in replicating MPD of 15-a-side competitive GF games. It is generally accepted that a reduction in player numbers is a central tenet of MG`s. Understanding how MG`s involving reduced player numbers replicates MPD of full-sided

games while controlling for other match play variables will provide coaches with important information and will provide a foundation for future researchers to more effectively evaluate the efficacy of MG`s. The purpose of this PhD thesis is to assess the impact of MG`s with reduced player numbers on MPD while controlling for other match play variables. To date, no studies have examined the coaching practices of club level GF coaches in relation to the sequencing and allotted time of activities and their rationale for using various MG`s formats during training. This PhD thesis will also evaluate coaching practices among adult club level coaches.

This PhD thesis was also due to have a study which assessed physical and physiological predictors of activity profiles during GF match play. This study could not be undertaken due to the closure of the exercise physiology laboratories in DCU due to COVID-19. Chapter VI sees this study written as a protocol paper. To the authors knowledge no published data exists regarding the physical and physiological attributes that relate to the activity patterns during competitive 15-a-side GF match play. The purpose of this study is to identify the physical and physiological factors that relate to TD, RD and VHIR of club level GF players during competitive match play.

Study Aims

1. To assess intra-game variability in MPD among senior club level GF players during 15-a-side championship games

2. To assess intra-game variability among senior club level GF players during 11-a-side games
3. To assess intra-game variability among senior club level GF players during 7-a-side games
4. To compare MPD during senior club championship games with 11-a-side and 7-a-side MGs
5. To examine adult club level GF coaches estimated time spent on coaching activities during preseason and competitive season
6. To examine adult club level GF coaches sequencing of coaching activities during preseason and competitive season

Hypotheses

1. There will be no significant difference in MPD between senior club level 15-a-side championship games
2. There will be no significant difference in MPD between the 11-a-side games
3. There will be no significant difference in MPD between the 7-a-side games
4. There will be a significant difference in MPD between 15-a-side championship games and 11-a-side and 7-a-side MG's
5. There will be no significant differences among adult club level GF coaches in the estimated time spent on coaching activities during preseason and competitive season

6. There will be no significant differences among adult club level GF coaches sequencing of coaching activities during preseason and competitive season

Chapter II

CHAPTER II

REVIEW OF LITERATURE

Introduction

GF is one of four field-based sports organised by the GAA. It is played with teams of 15 players on a rectangular grass surface measuring 145 x 90 m[4,13]. Club players within each of the 32 counties represent their local community in county competitions and players are selected to represent their county team at intercounty level. Each county competes in an All-Ireland football intercounty competition involving the 32 counties of Ireland as well as New York and London with the final played annually in the GAA National stadium Croke Park in front of a full capacity in excess of 82,000 spectators[14]. GF is played over 70 min at intercounty level and 60 minutes for all club and youth intercounty games[2].

Teams consist of a goalkeeper, six defenders, two midfield players and six forwards. Traditionally, teams have set up in a 1-3-3-2-3-3 formation; goalkeeper, three full backs, three half-backs, two mid-fielders, three half-forwards and three full-forwards[5]. The evolution of tactics has resulted in teams deploying a range of different formations quite often playing with extra defenders or midfielders. The defender's primary responsibility is to stop the opposition from scoring while a forward player is mainly responsible for creating and converting scoring opportunities. The

midfielders are the link players between defence and attack. The pattern of game play is unpredictable due to differences in physical, technical, tactical and team play features.

The majority of studies that have examined the MPD and coaching practices in GF have involved intercounty level players and coaches[5,15,16,17,18,19,20,21,22]. In contrast, with the exception of three recent studies[10,23,24] relatively few studies have examined MPD and coaching practices with club level GF players and coaches. Although club coaches account for >95% of all GF coaches, no published studies exist on the coaching practices for this cohort while only one recently published study reported on intercounty GF coaches[22]. Training programmes and coaching practices of club level GF coaches have relied to a large extent on personal experience, anecdotal observations and research findings involving intercounty teams and other invasion field-based team sports such as soccer, Australian football, rugby league and rugby union[15].

Several studies involving other invasion field-based team sports[25–27,28,29,30] and one involving adult club level GF players[10] have examined the impact of MG`s on MPD. Very few of these studies have taken account of RPA, pitch length to width ratio or compared their results the competitive match play.

This review of literature will examine the literature presently available on traditional DTG and GBA coaching practices, while also detailing the information available on MPD during full and MG`s.

The traditional DTG approach and more recently the GBA appear to be the two most common coaching practices described in the literature. Anecdotally, the majority of club GF coaches have adopted the DTG approach to training where the focus is on technical skill development early in a session followed by conditioned games and athletic conditioning. Since 2008, the GAA`s Coaching and Games Development Committee recommend that coaches adopt a GBA and anecdotally there has been a shift in practices. To date, no studies have assessed the coaching practices of club level GF coaches.

Monitoring of Match Play Demands

Global Positioning System

GPS is a satellite-based navigational technology originally devised for military purposes[31] that has recently found applications in aviation, marine and recreational outdoor activities. The system uses 27 earth-orbiting satellites that emit constant coded signals at the speed of light. GPS units receive signals from at least three satellites to locate its position. Using this information, a receiver can calculate and record data on position, time and velocity[32]. The sampling rate (number of times per second) that the GPS unit and satellites interact to determine the device's location is represented in Hertz(Hz). The first GPS units used in team sports settings had a sampling rate of only 1 Hz. Current GPS units can sample at 18 Hz. GPS technology is now routinely used to quantify the physical and physiological demands of invasion field-based team sports such as Australian football[33–36], soccer[37] ,rugby league[38,39,40,41,42], rugby union[43,44,45,46], and GF[15,16,17,10,18,19,20].

The key GPS variables used across invasion field-based team sports are typically total distance (TD), relative distance (RD) ($m \cdot min^{-1}$), low intensity running (LIR), high intensity running (HIR), max velocity, and the number of high intensity efforts. These parameters provide useful information regarding training/playing load. There is however, no agreement on the movement velocity thresholds associated with the various high speed categories.

Validity and Reliability of GPS

Validity and reliability are criteria used to assess measurement quality and allow for greater interpretation and "meaningfulness" to results and findings[47]. Specifically, validity refers to the degree to which a test or test item measures what it is designed to measure, and it is the most important characteristic of testing[48]. Measures of validity include, the standard estimate of error, standard error of measurement, coefficient of variation, or the percentage of difference between the mean and criterion measures[47]. Reliability is a measure of the degree of consistency or repeatability of a test. Errors of up to 10% would be viewed as an acceptable trade-off for time efficiency and ease of use[47].

Initial studies to assess GPS in team sports found that 1 Hz GPS systems were valid for measuring TD and peak speed but were not suitable for measuring repeated sprint ability and non-linear movements[49,50,51]. Both 1 Hz and 5 Hz GPS systems were found to under report TD as well as both the mean and peak speed compared to a laboratory based VICON system with 22 cameras operating at 100 Hz[52]. Among 20 elite soccer players, Jennings et al., (2010) found that the validity of 1 Hz and 5 Hz GPS systems for measuring TD during the simulated team sport running circuit was 3.6% and 3.8%, respectively[53]. Johnston et al., (2012) found that 5 Hz GPS units were valid for measuring movement demands performed at velocities <20 km·h^{-1}, whereas velocities >20 km·h^{-1} are not as reliable[54].

GPS systems with a sampling rate of ≥10 Hz are now commonly used to assess activity patterns of player participation across invasion field-based team sports. The magnitude of error during constant velocity, acceleration and deceleration sprinting is reduced when using a 10 Hz compared to a 5 Hz GPS system[55]. The higher sample rate also improved reliability values during all phases of locomotion. Akenhead et al., (2014) found that the validity and inter-unit reliability of the 10 Hz GPS devices tested were acceleration-dependent, with accuracy decreasing as acceleration increased[56]. Beata et al., (2018) reported that 10 Hz GPS units did not underestimate the criterion distance during a 400-m trial, 128.5-m circuit, 20-m trial, and running speed [57]. Johnston et al., (2014) compared the validity and inter-unit reliability between 10 and 15 Hz GPS units and found that both were more accurate than 1 Hz and 5 Hz GPS units. A more recent study found that GPS systems with a sampling rates of 18 Hz improved validity and reliability for determining movement patterns in team sports compared to 10 Hz GPS systems[58] .

Vickery et al., (2014) evaluated the accuracy and reliability of 5, 10, and 15 Hz GPS devices in two males during 10 repetitions of drills replicating movements typical of tennis, cricket, and field-based sports[59]. Standard movement data for distance and speed was provided from a 22-camera VICON system sampling at 100 Hz. Overall, there was no significant difference to the VICON data for the majority of distance and speed measures using the 5, 10, and 15 Hz GPS devices. Neither accuracy or reliability of the GPS devices changed with higher sampling frequencies. However, the coefficient of

variation (CV) for the 5 Hz and 15 Hz devices when measuring distance and speed ranged between 3 and 33%.

GPS Summary

GPS devices have an acceptable level of validity and reliability for assessing movement patterns at lower speeds and over increased distance efforts[31]. The decreased reliability to accurately measure movement patterns during short duration, high-speed, straight-line running, and efforts requiring changes in direction may limit both accuracy and reliability for assessing these activities during team sports. GPS devices with a sampling rate of 10 Hz adequately address the limitations of 1 Hz and 5 Hz GPS units for measuring high intensity short distance running. Furthermore, there seems to be no additional benefit to increasing sample speed to 15Hz, and may in fact it may be detrimental to measures of distance and speed/velocity[47]. However, a more recent study found that sampling rates of 18 Hz enhances validity and reliability for determining movement patterns in team sports compared to 10 Hz GPS[60].

GPS is a time efficient and relatively easy way for coaches/researchers to track player's activity profiles but caution must be taken when interpreting results particularly as player velocity increases.

Adult Club GF Full Game Demands

Activity Profiles

Advances in player tracking technology has greatly facilitated activity monitoring of athletes participating in invasion field-based team sports. Indeed, activity monitoring is now routine during both training and competition[47,61]. In particular, GPS technology provides large quantities of data on the location at a specific time point from which individual velocities and distances can be quantified. These distances are typically summarised into a number of velocity-based movement categories that vary in intensity and are associated with verbal descriptors such as low, moderate or high speed running[61].

One of the earliest studies to examine activity profiles during GF match play used time motion analysis to determine the frequency and duration of high intensity activity in 55 collegiate level players. Players performed an average of 96 high intensity efforts per game with an average duration of 5.7 sec and a recovery period of 36.7 sec between efforts. The work-to-rest ratio was 1:6 with the players spending 14.4% of match time performing high intensity activity[62].

A number of studies have explored the activity profiles during club and intercounty GF games involving youth and adult players[5,16,17, 18,19,20,23,63,]. Surprisingly, only one published study has examined the activity profiles during competitive senior club level GF games[23]. Activity profiles were obtained from 58 players representing two

teams during 30 competitive senior club level GF games. Players covered an average distance of 7.1 km per game with half backs, half forwards and midfield players covering significantly more TD, jogging distance (7.0–11.9 km·h^{-1}), distance while cruising/striding (12.0–16.9 km·h^{-1}) and high speed running distance (17.0–21.9 km·h^{-1}) than full backs and full forwards. Midfield and full-forward players completed the greatest and least distance respectively, while jogging. Half forwards and midfielders covered significantly more distance sprinting than full backs and full forwards. Half forwards covered significantly more TD, distance while cruising/striding, high speed running, and sprinting distance (>22.0 km·h^{-1}) than half backs. Full backs performed significantly more accelerations than half backs and midfielders while half backs performed significantly more decelerations than full backs and midfielders[23].

Cullen et al., (2017) examined the activity profiles of 85 county and club U-18 GF players. Players representing 3 club teams and 3 county teams were monitored during 17 competitive games (8 club level and 9 county level). There was no significant difference in activity profiles between playing level. When the data was averaged across both club and intercounty players, the TD covered during match play was 5,774 m. Low intensity activity consisted of standing (10%), walking (67%) and jogging (15%) accounted for 92% of total playing time. Moderate intensity activity represented 6% of playing time and only 2% of total playing time involved HIR (0.5%) and sprinting (1.5%)[20]. A recently unpublished MSc thesis from the same laboratory found that club level U-18 GF players

covered an average TD of 6,131 m at a RD of 100 m·min^{-1} during a single competitive game[63].

Considering that adult level intercounty GF games are 70 min in duration as opposed to 60 min for club youth and adult games, the number of metres covered per minute may be a more accurate reflection of work rate. This metric is often referred to in the scientific literature as RD[10,18,23,64]. During the pre-season, intercounty players cover a TD of 6.9 km at 92.4 m·min^{-1}. However, the RD increases between 116 m·min^{-1} and 122 m·min$^{-1\ 1}$ during the competitive season[16,17]. Similar to senior and U-18 club level games, most of the distance was covered at low intensity and only 11% involved HIR[18] indicating that much of the energy required during match play is provided via aerobic pathways. Intercounty players however, perform on average 43 sprints per game at an average peak running speed of 30.3 km·h$^{-1\ 17}$, 12 accelerations per 5 min time period[19] and 2,087 m at a running speed >17 km·h$^{-1\ 19}$.

Other invasion, field-based team sports have also reported that the majority of activity during match play is low intensity in nature. For example, among AFL players 70% of the TD covered during match play involved low intensity activity and 30% was classified as moderate to high intensity[36]. Among elite soccer players 74.9 - 77.5% of the TD covered during games involved low intensity activity, 23.1 - 25.1% HIR and 7.6% - 8.4% VHIR[65,66,67]. Compared to GF, the average TD covered per game is higher in soccer[65,68,69] and Australian football[35,36], and lower in elite intercounty hurling[70,71], rugby union[44,44]

and Rugby league[40]. RD ranges from 128 m·min^{-1} to 139 m·min^{-1} in elite Australian football players[35,72], 121 m·min^{-1} during international rugby 7`s[73] and 66.7 m·min^{-1} and 71.9 m·min^{-1} for elite rugby union forwards and backs, respectively[44]. The RD completed by forwards and backs in the national rugby league is 97 m·min $^{-1}$ and 100 m·min $^{-1}$, respectively[39].

The mean maximal running velocity is 8.1 m·sec^{-1} and 8.7 m·sec^{-1} for domestic and international level rugby 7`s players, respectively[73]. Among elite rugby union backs and forwards the mean maximal running velocity is 8.0 m·sec^{-1} and 7.3 m·sec^{-1}, respectively[44]. Similarly, maximal running velocities among elite intercounty hurlers ranges from 8.2 to 8.3 m·sec^{-1} [71,74].

Activity patterns during GF may also be influenced by match outcome and the phase of the season. County level GF players were found to run significantly less distance at high speed in games that resulted in losses, in comparison to games that were won[64]. Furthermore, players were found to cover greater distances in the later part of the season in comparison to other months. Finally, the percentage distance covered at high-speed increases significantly over the course of the season[75].

Activity Profiles Summary

To date, the majority of studies examining the activity profiles during GF match play have involved elite intercounty players[5,16,17,18,19,20,76] while a few recent studies have evaluated activity profiles of club level players[20,23,63]. Regardless of the level of

competition, most of the playing time is spent in low intensity, aerobic type activity. Although the time spent performing high intensity activity is relatively small, it is likely that this intensity threshold may play a key role in the outcomes of games[77].

Heart Rate Responses

The measurement of HR can be used to estimate the physiological responses during physical activity[78]. Understanding the HR intensities during match play can be used to assist coaches in designing practice activities that replicate competitive MPD. Exercise intensity and HR are linearly related. The changes in HR and the maximal HR achieved during competitive match play are influenced by environmental conditions and various individual characteristics such as current physical fitness level, relative workload and age[48]. The HR responses during various sporting activities were traditionally measured by continuous electrocardiogram (ECG) recording equipment, which was transmitted by short-range radio telemetry. However, the nature of field based sports activities (including jumps, tackles, contact with opponents, etc.) and sweat production during exercise compromised the connection of the electrodes to the skin surface[78]. The first wireless HR monitor developed in the 1980's consisted of a transmitter and a receiver. The transmitter was attached to the chest strap and the receiver was a watch like monitor. By the early 1990`s, specific data analysis software had been developed to facilitate a more detailed analysis of HR during training and competition. Current HR

monitoring systems allows simultaneous real time monitoring of all on-field players and for HR to be expressed relative to maximal values[78].

There are no recently published studies examining the HR response among senior club level players during competitive match play. The first study to examine the HR responses during Gaelic football was published 26 years ago and involved U-21 club level players playing in England[79]. The average HR of 157 $b \cdot min^{-1}$ and 158 $b \cdot min^{-1}$ during the first and second half, respectively equated to 81% maximal HR (HRmax) during the entire game. In a subsequent study involving English based players, the relative HR was 80% and 82% during competitive intercounty and club level GF games, respectively[5]. The mean HR was similar between the first and second half and between the first 10 min and the last 10 min of intercounty games. In contrast, HR tended to increase among club level players during the latter part of games.

A number of recent studies have evaluated HR response during competitive GF games. Gamble et al., (2019) reported an average HR of 162 $b \cdot min^{-1}$ (84% HRmax) among elite intercounty GF players during a pre-season competition[18]. Intercounty U-18 GF players were found to perform at 83% HRmax during 60 min of competitive match play. Similarly, Reilly et al., (2015) reported an average HR of 85% HRmax during match play involving 56 elite youth GF players[1]. In contrast, the average relative HR was lower (78%) during U-18 club level games[20]. The U-18 inter-county GF players spent significantly

more time at 90-100% HR max than club level players whereas club players spent a significantly more time at 71-80 %HR[80].

Technical and Team Play Characteristics

The majority of previous research examining match demands during GF have focused primarily on activity profiles. To date, only two published studies have examined the technical demands and team play characteristics during competitive GF games[23,24]. Mangan et al., (2019) examined the technical demands and team play characteristics during 30 competitive senior club level GF games. Playing position was found to have a significant impact on the number of possessions, shots taken, frees conceded outside the 45 m line, turnovers won and opposition kick-outs won and lost through breaking ball. Half backs, midfielders and half forwards had significantly more possessions than full backs. Both the half-forward and full-forward lines had significantly more shots than full backs, half backs and midfielders. Half backs, half forwards and midfielders had significantly more passing attempts compared to full backs and full forwards[23].

A total of 10 out of the 17 performance variables analysed during senior provincial club championship games were found to be significantly different between the winning and losing teams[24]. Winning teams recorded significantly more goals, points and total scores to losing teams. Five of the six performance variables that assessed effective use of possession were significantly different between winning teams and losing teams.

Surprisingly, the number of possessions, attacks and shots was not significantly different between winning and losing teams.

In an earlier study Mangan et al., (2017) examined the technical performance indicators in 4 elite GF teams during 52 competitive intercounty games. The average number and duration of team possessions per game was 69 and 17 sec, respectively. The ball was transferred by hand 70% of the time which resulted in a ball retention rate of 97%. Retention rates fell to 79% when the ball was kicked the other 30% of the time. Approximately 4 in every 10 team possessions resulted in a scoring attempt with 75% during open play. Possession was retained from 56% of long kick outs and 92% short kick outs[81].

In relation to attacking play during senior intercounty GF games, Bradley and O'Donoghue (2011) found that on average there were 12.1 counterattacks and 34.9 other turnover breaks per game[82]. On average 44% of counterattacks resulted in a scoring attempt with 50% resulting in a score. Team possessions between 26 sec and 35 sec in duration were the most successful in terms of resulting in a score and accounted for 48% of all successful attacks. Longer passing sequences during counter-attacks were more successful than attacks with fewer passes, which had a higher turnover rate.

Allister et al., (2018) investigated the game-related factors that differentiated winning and losing intercounty GF teams and how technical performance impacted the final score[83]. Teams that won or lost were differentiated by fouls committed, goals and

total attacks. Total attacks, shot efficiency, goals, fouls committed, and black cards determined who won games by a narrow margin. In games that had a large margin of victory, fouls committed, goals, total attacks, attack efficiency, shot efficiency, opposition kick-out win %, yellow, black and red cards were significantly different between teams.

Gamble et al., (2019) examined 83 technical and tactical variables across 26 intercounty league and championship games. With an accuracy of 87.5%, defensive counterattacks distinguished who won the games. The total score, number of scores, shots, points, points from play, and goals was significantly higher in the team that won. This led to superior shot efficiency, average attacks per score, and scores per 10 possessions[84].

Technical and Team Play Characteristics Summary

To date, only two studies have examined the technical demands and team play characteristics of adult club level GF players during competitive match play[23,24]. Playing position had a significant impact on the number of possessions, shots taken, frees conceded outside the 45m line, turnovers won, oppositions kick-outs won and lost through breaking ball. Effective use of possession was significantly different between winning teams and losing teams across most variables. More research is required to better comprehend the technical and team features of successful club level Gaelic football match play.

Modified Games

The relationship between players and their environment is dynamic and unpredictable during competitive GF games. Ideally, technical skills should be developed in and around the game environment. MG`s are played on reduced playing areas, often using modified rules and a smaller number of players than traditional football matches[9,85,86]. Player activity profiles, HR responses, various tactical and technical elements can be significantly altered to replicate the demands of competitive match play[86]. Compared to traditional drills and isolated TF activities, MG's may be a more effective approach to develop the perceptual-cognitive and technical skills that underpin superior performance[87]. Historically, TF activities have been used to prepare intercounty senior GF teams, particularly during preseason[21]. To date, only two GF published studies have examined player activity profiles, HR responses, tactical and technical elements of match play during MG`s[10,11]. Interestingly, both studies examined multiple 4 min bouts of 4 vs. 4 games with varied playing conditions.

Classification of Modified Games

Owen et al., (2014) categorized modified soccer games as small, medium and large based on the number of players relative to the 11-a-side game[86]. (Table 2.1).

Table 2.1 Classification of soccer game-based on player numbers

Sided-Game	%PP	% Range	Game Classification
11 vs. 11	100	76-100%	Large Sided Games
10 vs. 10	91		
9 vs. 9	82		
8 vs. 8	73	45-75%	Medium-Sided Games
7 vs. 7	64		
6 vs. 6	55		
5 vs. 5	45		
4 vs. 4	36	0-44%	Small-sided Games
3 vs. 3	27		
2 vs. 2	18		
1 vs. 1	9		

%PP - Percentage of players relative to the full side 11 vs. 11 game. For example, in 5-a-side games, 5 players represent 45% of the full complement of 11 players.

Activity Profiles of MG`s while Keeping Relative Playing Area Constant

With few exceptions, the majority of studies that have examined the effects of MG's on MPD have arbitrarily selected both the number of players and the pitch dimensions. As a result, the RPA has tended to be substantially less during MG`s than full-sided games. Furthermore, relatively few studies have related the MPD during MG's to the MPD in competitive match play.

Aguiar et al., (2013) found that when the RPA was kept constant, MG's ranging from 2 to 5-a-side had a significant impact on the TD covered and the number of sprints performed among professional U-19 male soccer players[27]. However, no rationale was provided for the selection of the RPA which at 150 m^2 was considerably less than during competitive 11-a-side games (324m^2). Similarly, Hill-Hass et al., (2009) reported that activity profiles were different during 2, 4 and 6-a-side youth level soccer games played on a surface area that provided a constant relative RPA equal to 150 m^2 [88]. The maximal sprint duration was significantly lower during the 2-a-side than either the 4 or 6 a-side games. The time between sprints was also longer during the 2-a-side game than either of the other two MG formats. Interestingly, the mean and maximal duration of each sprint and the distance covered increased significantly as the number of players per team increased. Soccer players were found to cover more TD and distance during low, moderate, and HIR during 2, 3, and 4 a-side games when goalkeepers are withdrawn and when keeping the same RPA than when goalkeepers are present[89].

In one of the relatively few studies to compare MPD during MG`s with full-sided competitive games, Duthie et al., (2019) found that among elite field-based hockey players running speed was significantly lower and that the number of accelerations was higher during 2, 3 and 4-a-side games than full-side games. The RPA was 150 $m^2$ during each of the MG`s and was significantly less than the 251m^2 during full 11-a-side hockey game[26].

Malone et al., (2019) examined the effect of altering the exercise-to-rest ratio during 6 x 4 min games of 4-a-side hurling played on a pitch measuring 60 x 20 m. Considering that a hurling pitch is the same dimension as for GF, the RPA of 150 m^2 was only 32% of that during a 15-a-side game. Exercise-to-rest ratios of 1:2 and 1:3 resulted in an increase in total high-speed distance, very high-speed distance, and acceleration distance but only after the third 4-min bout. In contrast, 2:1 and 1:1 exercise-to-rest ratios resulted in significant reductions in high-speed distance, very high-speed distance, and acceleration distance[90]. No rationale was provided for the pitch dimensions and no comparisons were made to 15-a-side games. In contrast, Christopher et al., (2016) found no effect of altering the exercise to rest ratio on selected activity profiles during 8 min of 6-a-side soccer games with an RPA of 133.3m^2 which is considerably less that the 324m^2 a player would have in an official soccer game[91].

HR Demands of MG`s while Keeping Relative Playing Area Constant

Despite the fact that technological advances in sensor technology has greatly facilitated the monitoring of HR during training and competitive GF match play[5,18,20,1] only one published study has examined HR responses in club GF players during three, 4 min, 4-a-side games with a RPA of 100 m^2, 150 m^2, and 200 m^2 [10]. The relative HR when averaged across the 3 game formats was 86% HRmax. Time spent at <70%, 70-85%, and >85% HRmax was not effected by altering the RPA.

Hill-Hass et al., (2009) found no significant difference in the average %HRmax during 2-a-side, 4-a-side or 6-a-side soccer games among 16-year-old males[88]. Time spent at >90% HRmax was greater in the 2 vs. 2 than the other two formats. Kluseman et al., (2012) examined the influence of playing numbers (2 vs. 2 and 4 vs. 4), court size (half and full court) and work-to-rest ratios (4 x 2.5 min quarters with 1 min recovery and 2 x 5 min halves with 30 sec recovery) on the HR response of elite junior male and female basketball players[92]. Court size had no substantial effect on the HR response. The total time spent at >90% HRmax was two-fold greater during the 2 min game followed by a 5 min recovery. Conversely, the time spent at 80–89% HRmax was substantially longer in both the 2 vs. 2 and 4 vs. 4 games that were 4 min in duration with 2.5 min recovery intervals. Christopher et al., (2016) found no difference in mean HR, %HRmax and amount of time spent >85% HRmax in 12 elite youth soccer players during 3 x 8 min, 6-a-side games with a RPA of 133.3 m^2 [91]. When maintaining a constant RPA of 150 m^2 during club level 4 vs. 4 hurling games, Malone et al., (2019) found that exercise-to-rest ratios of 2:1 and 1:1 resulted in a significantly higher relative HR than exercise-to-rest ratios of 1:2 and 1:3 [90].

Among male professional soccer players, HR was also found to be different during 2,3,4 and 5 a-side games involving 3 x 6 min bouts followed by a 1 min passive recovery period[27]. The RPA was 150 m^2. The mean HR in the 3-a-side games was significantly higher than the 4 and 5-a-side games. A greater amount of time was spent

at ≥90% HRmax in the 2 and 3-a-side formats. Interestingly, HR during the 5-a-side game was below the mean HR value reported during a competitive soccer match.

While keeping the RPA constant at 100 m^2, Koklu et al., (2015) found the %HRmax was significantly higher during 2, 3 an 4-a-side soccer games without a goalkeeper than with a goalkeeper present[89]. While keeping the RPA constant at 100 m^2, Abrantes et al., (2012) evaluated the impact of manipulating team size and game conditions on HR response during 3-a-side and 4-a-side games among high level youth soccer players. The game conditions were offence only, defence only, and combined offence and defence. Each game was 4 min in duration and was followed by a 2 min active recovery period. The 3 vs. 3 games and the combined format elicited the highest relative HR[93].

Technical Demands of MG`s while Keeping Relative Playing Area Constant

There are potential technical and tactical benefits to using MG`s in training. Whelan (2011) evaluated the possession characteristics and a number of selected technical skills performed among youth club level U-14 GF players during a 7-a-side game consisting of two 15 min periods with a 2 min half-time interval[94]. The results were compared to the first half (30 min) of a reference 60 min, 15-a-side competitive fixture. The RPA was 320 m^2 for both the 7-a-side and 15-a-side games. The goalkeeper and six outfield players who participated in the 7 a side game also participated in a 15-a-side competitive fixture.

The mean number of total catches, high catches, chest catches, total passes, hand passes, foot passes, scoring attempts, pick-ups, blocks, interceptions, solo-taps, solo hops and touches was significantly higher in the 7-a-side game than the 15-a-side game. There was no significant difference in the mean number of skills per possession, the number of players involved in each possession, or the time per possession between the 7 and 15-a-side game. The six outfield players who played both games had a significantly higher number of touches, catches, foot passes, punt kicks, scoring attempts, pick-ups, interceptions, solo taps and solo hops during the 7-a-side than the 15-a-side game.

A second study from the same PhD evaluated the possession characteristics and technical skills performed during 9-a-side GF games with a RPA of 300m^2 and 400m^2 and a 15-a-side game with an RPA of 400m^2. There was a significantly greater number of catches, passes, scoring attempts and touches during both 9-a-side game formats than the 15-a-side game[94]. Similarly, youth soccer players were found to perform a significantly greater number of technical skills during 8-a-side games than 11-a side games[92]. The RPA was however higher during the 8-a-side games (200 m^2 and 220 m^2) than the 11-a side games (160 m^2).

Using game type tactical conditions (offence only, defence only, and combined offence and defence play) and the same RPA (100 m^2), Abrantes et al., (2012) found no difference in technical actions between 3 and 4-a-side games among high level youth

soccer players. Each game consisted of 4 x 4 min bouts, interspersed with 2 min of active recovery[93].

There are an infinite number of ways to manipulate playing time and recovery duration during MG`s. Fanchini et al., (2011) found no difference in technical actions during 3-a-side soccer games that were 2, 4, and 6 min in duration and the RPA was kept constant at 191 m^2 [95]. Similarly, McLean et al., (2016) also reported no difference in semi-professional soccer players in the number of technical skills performed during MG`s (3 a-side, 6 x 2 min bouts) despite the recovery period ranging from 30 to 120 sec and the RPA remaining constant[96]. Christopher et al., (2016) manipulated the exercise to rest ratio during 3 x 8 min, 6 a-side games in youth soccer players. The games involved eight minutes of continuous play, 2 x 4 min and 4 x 2 min with 2 min rest. A significantly higher number of goals were scored during the 4 x 2 min and 2 x 4 min games than the continuous 8 min games. There were no significant differences in the total number of passes or individual possessions between the game formats[91]. In contrast, Fanchini et al., (2011) found that technical actions were not influenced by the duration of 3-a side soccer games with an RPA of 191m^2 [95].

Pitch Length to Width Ratio During MG`s

Casamichana et al., (2012) controlled for RPA and the pitch length to width ratio while comparing the activity profiles of full-sided 11-a-side games to modified soccer matches[97]. Semi-professional soccer players played 3 vs. 3, 5 vs. 5, and 7 vs. 7 games on pitches i) without goals, ii) with regulation goals and goalkeepers, and iii) with 2 small size goals and no goalkeepers. The pitch length to width ratio was 1:1.45 for both MG's and the full-side game. The RPA was 210 m^2 for all MG`s which equated to 70% of the RPA (300m^2) during the full sided games. Although the overall work rate was greater during the MG's, the frequency of repeated high-intensity efforts was higher during the 11-a-side games.

A small number of studies examining the MPD during modified soccer games maintained a constant length to width ratio but did not take into account the RPA or compare the findings to the 11-a-side game format. For example, Casamichana and Castellano (2010), found no difference in either the mean HR and %HR during 3 x 8 min, 5-a-side soccer games played on pitches with a length to width ratio of 1:1.4 and a RPA of 275 m^2 and 175 m^2. The %HR mean and %HR max was significantly higher during 5 v 5 soccer games with an RPA of 275 m^2 and 175 m^2, when compared to 75 m^2 [98]. In a subsequent study, Casamichana et al., (2018) found that compared to altering the length of a pitch, altering the width had a greater effect on the TD covered, peak speed, and the number of accelerations, decelerations, and changes of direction during 5 vs. 5 soccer

games[12]. In contrast, Vilar et al., (2014) found that altering the RPA (39.2 m², 80 m² and 135.3 m²) while keeping the length to width ratio constant resulted in fewer opportunities to maintain ball possession during 5-a-side soccer games but had no effect on the number of passes and shots at goal[99].

In summary, the majority of studies that have examined the impact of MG`s on MPD during invasion team based sports have arbitrarily selected playing conditions and have failed to relate the findings to full sided competitive games. A more systematic approach to the design of studies focused on evaluating the efficacy of MG`s in replicating MPD during invasion field based team sports is needed in order to be better able to evaluate the impact of altering one or more constraints/conditions and relate the findings to 15-a-side competitive GF games.

Laboratory and Field Testing

Running Speed

Speed can be defined as movement distance per unit time, and is typically quantified as the time taken to cover a fixed distance[48]. Maximal sprinting speed, although important, is only one aspect of the speed requirements for Gaelic games. Acceleration is the rate of change of velocity as a function of time[48]. It is calculated by subtracting the initial speed from the final speed and dividing by the time. The time required to complete 10 metres has been identified as the most significant predictor of 40 metre sprint time, highlighting the importance of rapid acceleration to overall sprint performance[100]. Brechue et al., (2010) found that maximal acceleration is attained at 9.1 metres and maintained through 18.3 m during a 36.6 m sprint in collegiate level American football players[101].

Maximum sprinting velocity over distances ranging from 5 to 40 m has been identified as a characteristic of elite players in Australian Rules football, American football, and junior rugby league[102–105]. Performance in a 40 yard sprint is one of the primary physiological characteristics that distinguish between drafted and non-drafted players across all positional categories in American football[103]. Similarly, drafted Australian Rules players have significantly better 5 m, 10 m and 20 m sprint times than non-drafted players[102]. In addition, starters in an elite American Football League (AFL) team performed significantly better than non-starters in both standing 10 m and flying 30 m sprint times[106]. Surprisingly, McIntyre (2005) found no significant difference in 15

m sprint performance between Gaelic football players, hurlers and soccer players[107]. Cullen et al., (2013) found a strong positive relation between 5 m and 20 m sprint time in elite level adolescent Gaelic football players[4].

The considerable variation in positional demands in team sports requires different fitness attributes. Positional differences in running speed have been found in a number of team sports including soccer and rugby league[104,108–110]. Sporis et al., compared positional differences in 5 m, 10 m and 20 m running speed among elite soccer players[110]. Goalkeepers had significantly slower 10 m and 20 m sprint times than other team members, and forward players were significantly faster over 5 m, 10 m, and 20 m than midfield players. However, goalkeepers compared favourably with other positions in the 5 m sprint times, and there was no difference in sprint times over 5 m, 10 m, and 20 m between forward players and defenders[110]. Considering the wing players in professional rugby league rely heavily on speed during the course of a game, it is not surprising that they have faster 15 m sprint times than forward players, and with the exception of hookers, have a faster 40 m sprint time than all other forward positions[109]. Amateur rugby league backs are faster over 40 m than forwards[108] and elite level junior level rugby league outside backs are significantly faster over 10 m, 20 m, and 40 m than players in any other position[104].

Power

Power is a measure of work performed per unit of time[111,112]. It is expressed as (F x D)/T), where F is the force generated, D is the distance through which the force is moved and T is the duration of the exercise. Many of the important activities in Gaelic football such as competing for possession, breaking a tackle, jumping to catch a kick-out, and accelerating from a stationary position requires muscular power.

A number of laboratory and field-based tests have been developed to measure muscle power. The Margaria-Kalamen test measures maximal power output during stair climbing. Power output (P) is calculated using the formula; $P = (W \times 9.8 \times D)/t$, where W is body weight in kg; 9.8 is the normal acceleration due to gravity in ms^{-2}; D is the vertical height in m between selected steps; and t is the time taken to complete the test. Test-retest reliability in the Margaria-Kalamen test is high ($\geq r = 0.95$)[113,114].

The Wingate anaerobic test involves cycling at maximal effort against a resistance equal to a percentage of body mass for a fixed duration. The test measures a number of parameters including peak power, average power and rate of fatigue[115]. The most popular protocol for the Wingate test involves cycling against a resistance equal to 7.5% body mass for 30 sec. However, protocols involving multiple 10 sec bouts interspersed with short recovery periods may be more appropriate for assessing muscle power in Gaelic football players. The Wingate test has high test-retest reliability r= 0.89 - 0.98)[116,117,118]. A major drawback of the Wingate test is that it may lack the specificity required to assess peak power in non-cyclists. The need for specialised equipment and

trained personnel has impeded the widespread use of the Wingate and Margaria - Kalamen tests in intermittent team sports[115].

Power Assessment - Field Based Tests

A number of simple counter movement jump tests (CMJ) measure vertical displacement to calculate lower limb muscular power and may be a suitable alternative to the Wingate test and Margaria–Kalamen test. The CMJ tests are performed from a stationary position and can be performed with hands placed on the hips throughout the duration of the jump or with a co-ordinated arm swing (Figure 2.1)[119]. A CMJ performed with arm swing is commonly referred to as a vertical jump (VJ). Both versions of the jump test are simple to execute, practical, valid[115,120] ,and are reliable measures of lower-body power[121,122,123]. The height attained is higher in both men and women when the CMJ is performed with arm swing[121,124]. This is due in part to raising the centre of mass and increasing the velocity at take-off[124].

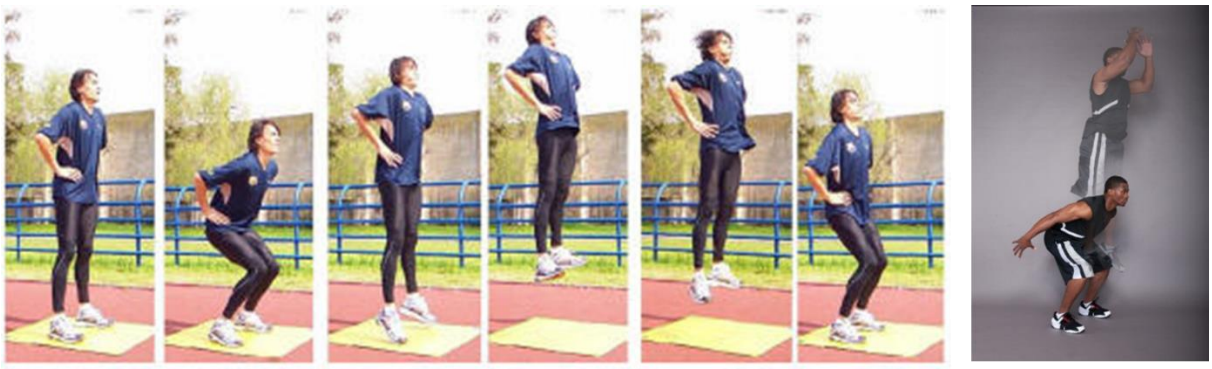

Figure 2.1: Countermovement jump without and with arm swing

VJ height ranges from 50 to 65 cm among collegiate level and elite inter-county GF players[125–128]. Among elite collegiate level Gaelic football players, midfielders produce

greater power during the VJ as well as greater vertical displacement than all other positions[125]. This is perhaps not surprising considering that midfield players are required to compete for aerial possession more frequently than players in any of the other positions. Performance in the VJ test is similar in collegiate level defenders and forwards and elite inter-county players[125,126].

Aerobic Fitness

Senior club level GF players cover an average distance of 7.1 km per game[23] and most of the playing time is spent in low intensity, aerobic type activity that rely on aerobic metabolism. Maximal aerobic capacity ($\dot{V}O_2max$) defines the upper limits of the cardiopulmonary system[129] and is an integrative measure of the maximal capacity to transport and utilize oxygen. Kelly et al (2021) reported GF club players to have a $\dot{V}O_2max$ of 52. 7 ± 5.4 ml $kg^{-1}min^{-1}$ [130]. To date, no published studies have examined the relationship between $\dot{V}O_2max$ and Gaelic football performance. Among elite junior soccer players, TD covered, work intensity, number of sprints and involvements with the ball were greater in players with a higher $\dot{V}O_2max$[131]. Furthermore, successful professional soccer teams have a higher aerobic fitness levels than teams that are less successful[132].

The high intensity activity bouts undertaken during GF are largely unpredictable and are imposed by the pattern of play and vary greatly from player to player and from one game to another. Intramuscular phosphagen is the most rapidly available source of energy to rephosphorylate adenosine diphosphate and does not require the presence of

molecular oxygen. Indeed, muscle phosphagen levels can decrease by almost 90% during high intensity exercise[133,134,135]. The adenosine triphosphate (ATP) required for restoration of phosphagen stores is provided by the aerobic metabolic system. A high $\dot{V}O_2$max should greatly facilitate the replenishment of phosphagen stores between bouts of high intensity activity and greatly assist in performing repeated bouts of short duration high intensity exercise bouts. Professional basketball players were found to have a higher $\dot{V}O_2$max than amateur players and were able to perform repeated bouts of short duration, high intensity exercise more often than their amateur counterparts[136]. Similarly, soccer players with higher $\dot{V}O_2$max scores make a greater number of sprints and cover a larger distance than players with a lower maximal aerobic capacity[131].

The unpredictable nature of GF match play may result in periods during match play when the recovery interval between high intensity exercise bouts may be inadequate for the partial or complete restoration of muscle phosphagen. Under these conditions, there will be an increased reliance on anaerobic glycolysis to meet the increased energy demands. The pyruvate formed from breakdown of carbohydrates during anaerobic glycolysis is subsequently reduced to lactate and the subsequent decrease in intracellular pH can impair muscle function[137]. The ability to clear lactate from the exercising muscle can be improved significantly with training and is an area that requires investigation, particularly among invasion team based field sport athletes.

Coaching Approaches

GF players are constantly making decisions during match-play. Each decision is based on the ability to perceive essential information from the playing environment, correctly interpret this information and then select the appropriate response[138]. Each decision is followed by an appropriate action that enable the player to achieve the action goal. Anecdotally, club level GF coaches tend to use the "traditional" drill-to-game (DTG) approach as their primary coaching strategy. This traditional DTG approach is characterised by conventional, highly structured coaching sequences which start with the introduction of technical skills in isolation from the competitive performance environment. Sessions conclude with a game or performance activity where players attempt to apply the motor skills/tactics practiced in isolation[139].

This approach assumes that physical fitness and technical skills should be developed in isolation and that this is best accomplished through TF activities[140]. This approach focuses on the practice of technical skills often in overly simplistic and unpressurized situations that are unrelated to the demands of real game play[141]. Research studies on the coaching practices from other field based sports have also found that coaches employ a primarily "traditional" DTG approach[141,142,143].

In contrast to the traditional approach where opportunities for decision making during training sessions is low, the GBA focuses on creating a learning environment where technical skills, tactical development and physical fitness can be developed through MG`s. The GBA is based on creating a learning environment through the

manipulation of MG's rather than solitary, technically focused drills. Coaches are encouraged to use questioning in order to promote critical thinking, reflection and dialogue among players. The GBA also requires the coach to create an environment where players are motivated to expresse their talents, to be imaginative, to take calculated risks and to let the game be their teacher.

Constraints Led Approach

The constraints led approach is one such alternative to the traditional technical based, structured, skill acquisition approach and is underpinned by non-linear pedagogy and ecological dynamics. This approach recognises that skills cannot be learnt in isolation, but that the task, environment and individual constraints must be taken into account to acquire a particular skill. Manipulating one or more constraints such as the nature of the task, the environment or the individual is believed to facilitate self-organization to solve problems in specific and realistic settings[144] (Figure 2.2). Ideally, players are placed in game like situations to facilitate the transfer of learning to improve performance in competition.

The constraints-led approach is learner-centred and assumes that effective motor learning depends on the dynamic interaction between the individual, the task, and the environment. Individual constraints refer to the physiological and emotional state of the individual and influence how and when and individual moves[145]. Individual constraints include body size (height, weight, lean body mass), functional capacities (speed, strength, endurance, balance, agility), mental skills (concentration, confidence,

emotional control or motivation perceptual), cognitive skills (e.g., recognising patterns of play, anticipation by reading the movement of opponents) and personality factors (risk aversion, risk taker). Task constraints are factors related to the performance and includes the number of players, pitch size, equipment, etc. Environmental constraints refer to either physical or socio-cultural characteristics outside of the body and include ground surface, ambient temperature, natural light etc. The three primary constraints often overlap and are interactive, making this learning approach complex.

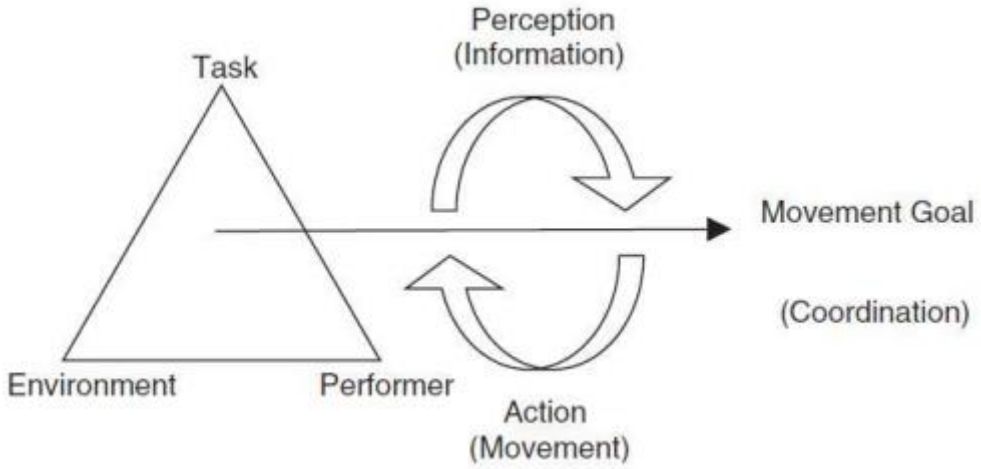

Figure 2.2: The constraints-led approach to coaching[146]

Games Teaching: A New Approach

In the 1960`s, a general dissatisfaction with how motor skills were taught in schools, particularly in relation to the lack of opportunity for developing cognitive and decision making skills resulted in a shift from the DTG approach to a GBA in the physical education settings[146]. British soccer coach Allen Wade (1967) proposed a MG's framework for the combined purpose of teaching technical and tactical attack and

defensive skills in soccer[147]. In time, MG's became a central feature of the teaching games for understanding (TGfU) model developed by Bunker and Thorpe[148]. The principle of learning through playing meaningful games is the cornerstone of the TGfU approach and is underpinned by the skill acquisition theory of a constraints led approach[146] to enhance skills, techniques and tactics, which then transfers practice into match like situations. By adopting a GBA, the TGfU model emphasizes the tactical understanding of match play. The model emphasizes the logic of play imposed by the rules of the game, and that the appreciation of the need to develop the tactical structure of play prior to highly structured technique teaching[148].

Teaching Games for Understanding

The TGfU model (Figure 2.3) as outlined below outlines a 6 step process, whereby the coach helps the player to achieve a new level of skilful performance. While levels of performance will vary, each and every player is able to participate in decision-making based upon tactical awareness thereby retaining an interest and involvement in the game [149].

(1) Game Focus - While the full adult version of the game offers coach's direction and presents a long-term goal to aspire to, it is essential to expose players to a variety of game forms in accordance with their experience level and age. Constraints like the playing area, player number, equipment, and rules must be carefully taken into account in order to provide players with challenges to solve when playing games. Fundamentally, the game should look somewhat similar to the adult version of the game.

(2) Game Appreciation – The game's rules must be understood by all participants because they define how the game will be played. The rules will set limitations on the game, specify how teams score, and specify the range of skills required. It is understood that changes to a game's rules will affect the tactics used.

(3) Tactical Awareness – To develop problem solving, coaches must give consideration to the tactics used in the game. Principles of play, common to all games, form the basis for a tactical approach to the game. Players are introduced to tactics through a gradual introduction to the principles and complexity of scenarios.

(4) Decision Making - The player's consideration of “what to do” and “how to do it” in various situations is the decision-making factor. Players demonstrate a better understanding of when and how to perform skills as they get more knowledge of the game form, game appreciation, and tactical awareness elements thus permitting both the player and coach to recognise and attribute shortcomings in decision making.

(5) Skill Execution - describes the actual production of the required movement as envisaged by the coach and seen in the context of the player while recognising the player’s limitations. It should be seen as separate from "performance". It may include some qualitative aspect of both the mechanical efficiency of the movement and its relevance to the particular game situation. Skill execution is thus always seen in the context of the learner and the game.

(6) Performance - This is the observed outcome of the previous processes measured against criteria that are independent of the learner. It is that by which we would classify

players as good or bad regardless of playing level and should be a measure of appropriateness of response as well as efficiency of technique.

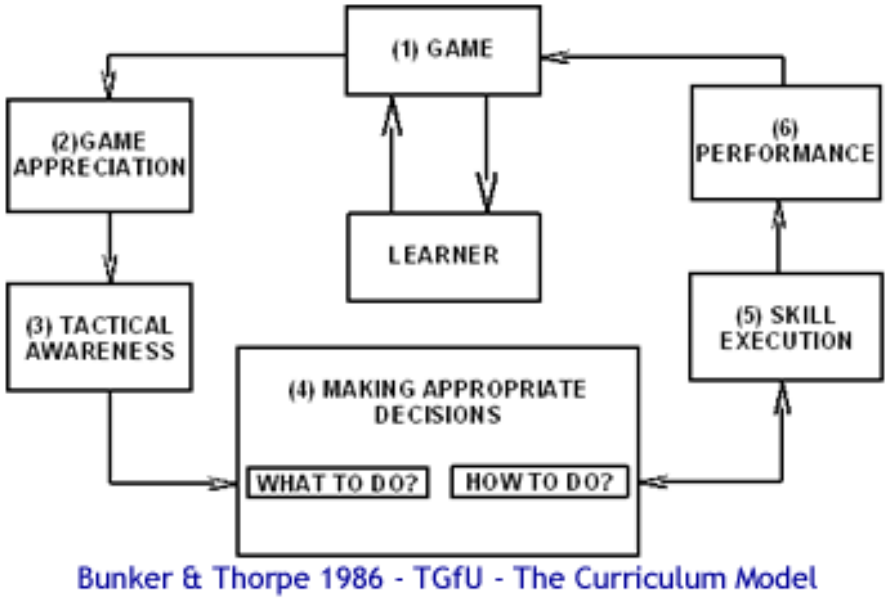

Figure 2.3: Teaching Games for Understanding Model

Tactical Development with a Games Based Approach

Competent sports performance, particularly during team sports, is not only dependent on the execution of technical skills, but also perceptual-cognitive skills concerned with obtaining and using information present within the game environment[150]. Players are required to make decisions based on continuous sensing and processing of information in their immediate environment. MG's may offer players the opportunity to develop their technical and perceptual-cognitive skills under similar conditions to those encountered during 15-a-side games, thereby increasing the likelihood of transfer to the competitive environment[87]. Thus, to develop tactical-

decision making and cognitive skills in sport, the greatest possible number of tactical experiences must be promoted and constructed[151].

A small number of studies have looked at this area. Harvey et al., (2010) used the TGfU model over 8 sessions to show positive changes in American high school interscholastic soccer players defensive off the ball adjustments and covering using a 3 vs. 3 assessment game[152]. Similarly, Praxedes et al., (2016) showed that a TGfU model intervention showed better decision making in the pass and dribble actions following 21 sessions with youth soccer players over a 18 week period[151].

Miller et al., (2016) showed that players in GBA-focused netball sessions over 9 weeks showed positive changes in decision making with significant difference in support play but not for skill execution[150].

Technical Development with a Games Based Approach

In the area of technical development limited evidence exists with the exception of two published studies available to date. Pizarro et al., (2017) showed significantly higher values in both the decision-making, passing and dribbling actions following 22 TGfU sessions with U12 footballers over a 15-week period [153]. Praxedes et al., (2016) also showed that a TGfU model intervention disclosed better execution in the pass actions following 21 sessions with youth soccer players over an 18-week period[153].

In a PhD thesis significant improvements were shown in overall decision making, as well as in each of the three individual decision-making scores (passing, shooting and carrying)following an intervention programme with U14 & 15 intercounty GF players[21].

The U14 players also showed a significant improvement in overall skill execution, however, within the individual skill execution scores, only carrying showed a significant improvement relative to baseline while U15 players showed significant improvements in ball control, but did not show any improvements in any of the skill execution scores.

It is challenging to specifically pinpoint technical or skill improvements without breaking down games into its individual sections due to the holistic nature of GBAs, which necessitates the complex interaction of skill, decision-making, and tactical awareness. This challenge may underlie the limited evidence to date for the development of technical skills through GBA[154].

Physical Fitness Development with a Games Based Approach

Miller et al., (2016) showed that players in GBA-focused netball sessions had significantly higher intensity levels than those who participated in "traditional" sessions[150] while Nathan et al., (2017) presented that field hockey players had significantly higher HR measurements than those involved in traditional skills practice[155]. Sierra-Rios et al., (2020) revealed that TGfU sessions for under-12 male soccer players promoted significantly higher levels of light physical activity and lower levels of sedentary physical activity compared to traditional coaching sessions[156]. From a tactical perspective when studying tactical principles (attacking the goal, penetrating the defence and keeping possession) results revealed that when keeping possession, significantly less time was spent in sedentary activity and more time was spent in moderate to vigorous activity during TGfU sessions compared to the instructional sessions.

The majority of research that examines MG`s for physical fitness development does so by quantifying MPD of these games but this does so without the use of other aspects of a GBA such as questioning, dialog and building a supportive sociomoral environment for players.

Player Autonomy with a Games Based Approach

The fourth aspect of Light's GBA framework is creating a supportive sociomoral environment, which requires the coach to offer a safe learning environment where athletes are motivated to take calculated risks, use their imaginations, and learn via doing so[21]. A number of studies have looked at the affective domain (fun, motivation and emotion) and personnel development (cooperation, responsibility, ownership and fair play). Evans & Light (2007) showed that using a GBA(Game Sense) increased players motivation by making training more relevant to match conditions[157]. The coach player relationship improved while all of the players interviewed reported having a strong sense of improved player autonomy, with many of them claiming to have gained decision-making authority inside the team setting. While using the same approach Phil (2016) also reported an improved coach player relationship and players recognized a change from their prior coaching experiences. Although most of the players liked it, a small number felt that additional skill workouts were needed and one thought the coach was being too friendly[158]. Harvey (2009) showed that while using a 12-week Game Sense programme a positive transfer to match situations occurred, an enhanced engagement between the coach and players, improved teamwork and communication[22].

In a basketball PE context, GBA proved useful in keeping players task-focused and ensured increased motivation and interest[159] . Players felt they had more involvement, improved understanding of the game, learnt more as a result of playing the games and had better decision-making.

Koekoek et al., (2014) while implementing a TGfU model revealed that the young soccer players were able to take responsibility for their own learning. The players had explicit views about the MG`s in terms of what they had learned , what they were supposed to learn and why the practice was designed in the way it was, indicating that the MG`s were suitable for making players responsible for their own learning[160]. Atkinson and Harvey (2017) used the Tactical Games Model, which enhanced communication and teamwork by having more players participate in discussions. This also improved player positioning on the field and increased cognitive awareness[161].

Overall, the reviewed studies demonstrate increased motivation, ownership, understanding, communication, teamwork and a positive relationship between the coach and these should be considered key strengths of GBA.

Coaching Approaches Summary

Since the development of the TGfU model[154] several other GBA`s have emerged, each with a slight variation on the original model[154]. These other models include Game Sense, Tactical Games Model, Play Practice, Ball School, the Tactical Decision Learning Model, the Integrated Technical-Tactical Model, the Invasion Games Competence Model

and the Games Concept Approach[154]. In trying to bring about some uniformity around GBAs, Light (2013) proposed four common features[154]:

(1) The design and manipulation of practice games and activities.

(2) The use of questioning

(3) The provision of opportunities for dialogue

(4) Building a supportive sociomoral environment

Despite the fact that there aren't a large number of published studies, the information available indicates promising results, with greater motivation, ownership, comprehension, communication, teamwork, and a favourable relationship with the coach being shown.

Coaching Practices

Activity Type – Training Form and Playing Form Activities

The traditional DTG approach and the GBA can be distinguished by the primary activity type and timing of activities within a coaching session. Activity types may be broadly classified as training form (TF) and playing form (PF) for DTG and GBA, respectively. TF is the more traditional approach involving both isolated skill practice and athletic conditioning. Activities focus on developing skills using drills and isolated activities performed in a non-pressurised environment. This type of training may lead to the acquisition of technical skills at the expense of perceptual-cognitive skills, such as anticipation and decision-making.

In contrast PF involves game-based activities involving a high degree of decision making[22]. Compared to TF activities, this approach is likely to lead to the more effective development of the perceptual-cognitive and technical skills underpinning superior performance during competitive match play[87]. The use of games in training is based on the premise that greater improvements in match performance will occur when the demands such as activity profiles, HR response, technical and team play characteristics replicate the demands of the sport. There is a concern that the PF approach may reduce the volume of individual skill practice and limit skill development[162]. However, Berry et al., (2005) found no difference in the skill execution performance among Australian footballers following 10-weeks of game-based training compared to a more traditional direct instructional approach[163].

A recent study that collected data in elite GF players during 78 training sessions and 13 games over an entire season showed there was a strong correlation between PF activities and competitive games across all GPS variables with position-specific similarities existing across all the playing lines[164]. TF activities such as skills based training had lower running demands and running/conditioning based training had significantly higher running demands than that found in competitive games.

In the only study to directly quantify training activities among GF coaches, Kinnerk et al., (2020) found that on average, elite intercounty level coaches spent 57% and 43% of preseason practice time in TF and PF activities, respectively. The proportion of practice time spent performing PF activities increased to 63% during the competitive

season[22]. Youth soccer coaches involved with U-9, U-13 and U-16 age groups, were found to spend 65% and 35% of training sessions in TF and PF activities, respectively. The percentage of the session duration spent in PF activities increased with advancing age from 31% for U-9 teams to 34% for U-16 teams[141]. Partington and Cushion (2013) also found that professional youth soccer coaches working within an English Football Association premier league Centre of Excellence spent a considerable proportion of the sessions (47%) in PF activities[142].

The proportion of session time engaged in TF and PF form activities may be influenced by the sport. Female elite rugby coaches were found to spent on average 59% of session time in PF activities[165]. The proportion of session time devoted to PF activities increased to 84% in close proximity to the team's annual international championship. Professional soccer coaches were reported to spend 22% and 41% of training time in PF and TF activities, respectively[166]. The remaining time was spent transitioning between session activities (6%) or being inactive (31%). In contrast, adolescent cricket players spend on average 69% of session time in TF activity and only 19% in PF, with the remainder of the time transitioning between activities[143].

Sequence of Activities

The traditional DTG coaching method involves linear sequencing of activities beginning with technical skills practice followed by game-related practice and or athletic development activities. In contrast, coaches who employ GBA utilise a game-based activity as the starting point or "organising centre" of the session from which the rest of

the session is constructed. Indeed, the GBA is often described as game centred[22]**.** Surprisingly, only two studies have investigated how activities are sequenced during invasion, field-based sports training sessions. Kinnerk et al., (2020) found that regardless of the period in the season, a high proportion of elite GF coaches self-reported sequencing their coaching sessions by selecting TF activities in the first half of their training sessions before progressing to PF activities in the second half of the sessions[21]

Elite soccer coaches self-reported that they prescribed more TF activities early in the session and progressed to PF activities later in the session[166].

Coaching Practices Summary

There is currently a dearth of information on coaching practices used by coaches in all sports. According to the current evidence, coaches primarily align to a DTG approach. Much more research across all field-based sports and age groups is necessary in order to draw strong findings.

Chapter III

CHAPTER III

RESEARCH STUDY 1

Variability in Match Play Demands Among Senior Club Level Gaelic Football Players During 15-a-Side Championship Games

Rationale

GF is a dynamic invasion team based field sport that requires players to continuously retrieve and process information, execute technical skills under pressure and possess the physical fitness levels required for optimal performance[5]. In recent years, elite level GF coaches having discarded the traditional rigid positional configuration of 6 defenders, 2 midfielders and 6 attacking players, and adopted tactics that facilitate a more flexible approach to team play. A number of recent studies have characterized the MPD during competitive intercounty GF games[5,15,16,17,18,19,20,75,76].

In comparison to elite level intercounty GF, there is a paucity of scientific literature describing MPD among adult club level GF players. Currently, only two published studies have documented MPD during senior club level championship games[23,24]. The lack of objective data on MPD specific to senior club level GF teams is currently a major limitation in the design of technical, tactical, and athletic development programmes for this large cohort of players.

Physiological monitoring is crucial to understanding individual player responses during competitive games. Current technological developments in wearable, sensor-based telemetry systems and associated analysis software allows HR to be used as a non-invasive, time-efficient and cost-effective way to simultaneously obtain an insight into the physiological response during competitive match play. The measurement of HR during GF match play is almost not existent. Indeed, there are currently no published studies examining the HR response among senior club level players during competitive match play. The purpose of this study was to assess the physical activity profiles, individual possessions, technical skills, team play characteristics and heart rate during senior club level 15-a-side championship games.

Study Aims

1. To compare player activity profiles between four 15-a-side senior club level championship games
2. To compare the number of individual possessions and technical skills performed between four senior club level 15-a-side championship games
3. To compare the team-play characteristics between four senior club level 15-a-side championship games
4. To compare the heart rate response between four senior club level 15-a-side championship games

Hypotheses

1. There will be no significant difference in player activity profiles between four 15-a-side senior club level championship games
2. There will be no significant difference in the number of individual possessions and technical skills performed between four senior club level 15-a-side championship games
3. There will be no significant difference in the team-play characteristics between four senior club level 15-a-side championship games
4. There will be no significant difference in the heart rate response between four senior club level 15-a-side championship games

METHODS

Overview of the Study Design

Match play demands involving physical activity profiles, individual possessions, technical skills, team play characteristics and heart rate were assessed during four senior club level 15-a-side championship games played between May and August 2017. The dimensions of the playing area, RPA and length to width ratio, temperature and humidity during the four 15-a-side games are summarized in Table 3.1. Participants were fitted with a portable 10 Hz GPS unit and a HR monitor prior to each game. Data from the first half of each game (approx. 30 min) were used in the analysis.

Table 3.1: Pitch dimensions, RPA and length to width ratio, temperature and humidity of 15-a-side games

	Games			
Variable	**1**	**2**	**3**	**4**
Pitch dimensions (m)	139 x 85	134 x 79	145 x 88	138 x 83
Relative paying area (m^2)	422	378	456	409
Pitch length to width ratio	1:1.6	1:1.7	1:1.6	1:1.7
Temperature (°C)	12	16	18	16
Humidity (%)	50	85	64	71

Participants

Male members (n=19) of a senior, club level GF panel (mean ± SD; age = 26.27 ± 5.59 yrs., height = 176.92 ± 8.50 cm, weight = 76.53 ± 7.05 kg and estimated $\dot{V}O_2max$ = 50.57 ± 2.80 ml $kg^{-1}min^{-1}$) participated in the study. The experimental procedures were approved by the Dublin City University Research Ethics Committee. Participants were

provided with a plain language statement outlining the nature and demands of the study as well as the inherent risks. Written informed consent was obtained prior to participation. Participants were advised that they could withdraw from the study at any time.

Anthropometrics

Participants removed their shoes, and their height was measured to the nearest 0.1 cm using a portable scale (Seca 707 Balance Scales, GmbH, Hamburg, Germany). Weight was measures to the nearest kilogram (kg) using calibrated Seca weighing scales (Seca Ltd., Hamburg, Germany). BMI was calculated as body mass (kg) divided by height in metres^2.

Yo-Yo Intermittent Recovery Test

The Yo-Yo intermittent recovery test level 1 was used to estimate $\dot{V}O_2max$[167]. The test involves repeated pairs of 20 m runs at progressively increasing speeds controlled by audio beeps. The rest interval between runs was 10 sec in duration, during which time participants completed a 10 m walk. Participants were instructed to commence each shuttle from a stationary position. The time required to complete each shuttle run was progressively decreased. Failure to complete a shuttle run in the required time resulted in a verbal warning, and a second offence resulted in termination of the test. The distance covered (m) was recorded and represented the test score.

Global Positioning System

GPS technology was used to measure activity profiles. The STATSports Viper Pod GPS (STATSports, Elite Electronics, Enniskillen, Northern Ireland) units sampled at 10 Hz and incorporated a 100 Hz tri-axial accelerometer, 3-D gyroscope and 3-D digital compass. The devices (mass 50 g, 88 mm x 33 mm x 16 mm) were inserted in a custom-made vest placed between the shoulder blades and worn under the player's shirt. The placement of the units between the shoulder blades ensured there was no restriction of the player's movement. The GPS units were turned on 30 min prior to the pre-match warm-up to allow acquisition of satellite signals in accordance with the manufacturer's instructions. In accordance with best practice and to avoid inter-unit variability, players wore the same GPS device for each match[47].

Physical performance was analysed by measuring both the distance covered and percentage of total distance while in standing, walking, jogging, running, high speed running and maximal speed running zones. The locomotor speeds ($m \cdot s^{-1}$) used to classify standing (≥0.00 – <0.19), walking (≥0.19 – <2.00), jogging (≥2.00 – <4.00), running (≥4.00 – <5.50), high speed running (≥5.50 – <7.00), and maximal speed running (≥7.00), were based on activity profiles and thresholds reported previously in hurling[168], and soccer[65,68,169]. The starting speed for each activity zone represented the end point for the preceding zone, ensuring that all data was included in the analysis. Other measures included; low intensity activity (LIA, <4.0 $m.s^{-1}$), high intensity running (HIR, >4.0 $m.s^{-1}$),

very-high intensity running (VHIR, >5.5 m.s-1)[65,68]. Accelerations was defined as actions >1.5 $m \cdot s^{-1}$ and >3.5 $m \cdot s^{-1}$ and decelerations defined as actions >1.5 and >3.5 $m \cdot s^{-1}$ were also measured. Post-game GPS movement activity data was downloaded using STATSports software. All data were exported into Microsoft Excel (Microsoft, USA) for further interpretation.

Heart Rate

Radio-telemetry (Polar T31, Kempele, Finland) was used to continuously measure HR during both the Yo-Yo intermittent recovery test level 1 and match play. HRmax was determined as the highest HR attained during the Yo-Yo intermittent recovery test level 1 or match play. HR was expressed relative to the maximal value and classified into the following categories; < 60% HRmax, 61 - 70% HRmax, 71 - 80% HRmax, 81-90% HRmax, and 91-100% HRmax. Post-game HR response data was downloaded using STATSports software. Data were exported into Microsoft Excel (Microsoft, USA) for further interpretation.

Video Analysis

The Gaelic football games were video recorded (SONY HDR-CX220E, Sony Corporation, Japan) and technical skills were subsequently tagged using SportsCode software (Avenir Sports, Galway, Ireland). A specially designed tagging panel was used to record the following technical skills for each player; possessions, catches, foot passing, hand passing, interceptions, touches, pickups, scoring attempts, blocks, solo taps and

solo hops (Appendix A). The tagging panel was also used to establish the team play characteristics by tagging the time, the number of skills performed and the number of players involved in each team possession.

Statistical Analysis

Descriptive statistics were calculated for all numerical variables and reported as mean ± SD. Normality of distribution for all variables was assessed using the Shapiro-Wilk test. Where the assumption of normality was met a one-way ANOVA test was used to compare differences in mean values across the different games. Where statistically significant differences were found, post hoc analysis was undertaken using the Tukey test. In cases where Levene's test indicated that the assumption of homogeneity of variance was violated, Welch's ANOVA test was used to compare mean differences across the different games. Where statistically significant differences were found, post hoc analysis was carried out using the Games-Howell test.

For variables that did not meet the assumption of normality, the Kruskal-Wallis test was used to assess differences across the games. Pairwise comparisons with a Bonferroni correction was used to determine whether there was a statistically significant difference between the different games. A Chi Square goodness of fit test was used to assess whether there were differences in the count of team possessions across the different games. A p value of <0.05 was considered statistically significant. Data analyses

were performed using the Statistical Package for Social Science (SPSS) software version 27 IBM (IBM, Chicago, IL, USA).

RESULTS

Anthropometrics

Anthropometric data and estimated $\dot{V}O_2$max for the participating team is summarized in table 3.2. The estimated $\dot{V}O_2$max is very similar to the laboratory based measurement recently reported for club level GF players (2021)[130].

Table 3.2: Anthropometric data and estimated $\dot{V}O_2$max for the 15 a-side team

	Games
Variable	**15 vs 15**
Age (yr)	26.27 ± 5.59
Height (cm)	176.92 ± 8.50
Weight (kg)	76.53 ± 7.05
Estimated $\dot{V}O_2$max (mL $kg^{-1}min^{-1}$)	50.57 ± 2.80

Values are mean ± SD

Game Time

Total game time, time of ball in play and out of play during each 15-a-side game and the mean (± SD) values combined across the four games are summarized in table 3.3. There were no significant difference in total game time or the time that the ball was in play and out of play during the four 15-a-side games.

Table 3.3: Total game time, ball in play time and out of play time during each 15-a-side game and combined across the four games

Variable	Games				
	1	2	3	4	Combined*
Total time (sec)	2119	2144	1933	1931	2031.75 ± 115.636
Time in play (sec)	1014	944	841	1006	951.25 ± 79.88
Time out of play (sec)	1105	1200	1092	925	1080.50 ± 114.30
Time in play (%)	48	44	44	52	46.87 ± 3.99
Time out of play (%)	52	56	56	48	53.13 ± 3.99

*Values are mean ± SD

Activity Profiles

Total Distance, Relative Distance and Distance in Each Speed Zone

The TD, RD, and distance in each speed zone during each 15-a-side game and the mean (± SD) values combined across the four games are summarized in table 3.4. There were no significant differences in TD, RD, walking , jogging , running, high speed and max speed running between the four 15-a-side games. There were no significant differences in the average maximal velocity between game 1 (mean ± SD; 7.69 ± 0.67 $m \cdot s^{-1}$), game 2 (7.78 ± 0.67 $m \cdot s^{-1}$), game 3 (7.91 ± 0.52 $m \cdot s^{-1}$) and game 4 (8.01 ± 0.46 $m \cdot s^{-1}$).

Percentage Time in Each Speed Zone

The percentage of game time spent in each activity zone during each 15-a-side game and the mean (± SD) values combined across the four games are summarized in table 3.5. There were no significant differences in the proportion of time spent walking,

jogging, running, high speed running and maximal speed running between the four 15-a-side games.

Table 3.4: Total distance, relative distance, distance in each zone and max speed during each 15-a-side game and combined across the 4 games

Variable	Games				
	1	**2**	**3**	**4**	**Combined**
Total distance (m)	3746.90 ± 722.93	3455.94 ± 569.58	3460.82 ± 725.17	3601.44 ± 643.75	3561.45 ± 656.14
Relative distance ($m \cdot min^{-1}$)	101.99 ± 19.65	96.04 ± 15.84	101.39 ± 21.17	108.60 ± 19.41	102.02 ± 19.06
Walking (m)	1476.94 ± 172.77	1383.37 ± 210.32	1417.83 ± 212.97	1314.63 ± 200.83	1394.85 ± 203.42
Jogging (m)	1206.64 ± 351.90	1189.11 ± 407.14	1075.48 ± 429.72	1319.16 ± 382.50	1199.56 ± 393.15
Running (m)	721.48 ± 373.82	611.24 ± 200.02	635.41 ± 325.27	669.68 ± 254.83	657.56 ± 286.17
High speed (m)	295.40 ± 97.91	233.90 ± 75.31	274.04 ± 86.62	250.31 ± 94.51	262.00 ± 89.18
Max speed (m)	46.44 ± 43.77	38.31 ± 32.72	58.05 ± 59.57	47.67 ± 37.52	47.47 ± 43.52

Values are mean ± SD

Table 3.5: Percentage of game time in each activity zone during each 15-a-side game and combined across the four games

Variable	Games				
	1	**2**	**3**	**4**	Combined
Walking (%)	40.85 ± 8.92	41.05 ± 9.30	42.76 ± 10.93	37.51 ± 7.88	40.49 ± 9.24
Jogging (%)	31.79 ± 4.09	33.69 ± 8.33	30.20 ± 6.82	36.09 ± 4.98	33.04 ± 6.54
Running (%)	18.33 ± 6.09	17.39 ± 3.65	17.48 ± 5.50	18.18 ± 4.28	17.84 ± 4.79
High speed (%)	7.82 ± 2.07	6.77 ± 1.94	7.85 ± 1.54	6.90 ± 2.24	7.31 ± 1.98
Max speed (%)	1.21 ± 1.09	1.10 ± 0.95	1.70 ± 1.59	1.32 ± 1.05	1.33 ± 1.18

Values are mean ± SD

Actions in Speed Zones

The number of actions performed in the running, high speed running and maximal speed running zones during each 15-a-side game and the mean (± SD) values combined across the four games are summarized in table 3.6. There were no significant differences in the number of actions performed in each of the activity zones between the four 15-a-side games.

Distance Covered in the Low, High and Very High Intensity Zones

The distance covered in low, high and very high intensity zones during each 15-a-side game and the mean (± SD) values combined across the four games are summarized in table 3.7. There were no significant differences in distance covered in low, high and very high intensity zones between the four 15-a-side games.

Percentage of Playing Time in the Low, High and Very High Intensity Zones

The percentage of playing time in the low, high and very high intensity zones during each 15-a-side game and the mean (± SD) values combined across the four games are summarized in table 3.8. There were no significant differences in the proportion of game time in low, high and very high intensity zones between the four 15-a-side games.

Table 3.6: Number of actions* performed in running zones during each 15-a-side game and combined across the four games

Variable	Games				
	1	**2**	**3**	**4**	**Combined**
Running (n)	30.00 ± 13.07	31.57 ± 9.17	27.15 ± 12.40	30.79 ± 9.74	29.92 ± 10.92
High speed (n)	16.00 ± 2.83	15.07 ± 4.07	15.62 ± 4.66	14.50 ± 4.94	15.26 ± 4.16
Max speed (n)	3.25 ± 2.60	2.50 ± 1.79	4.23 ± 2.86	3.00 ± 2.25	3.23 ± 2.41

Values are mean ± SD; *Any movement that peaks within the designated running zone is referred to as an action.

Table 3.7: Total distance covered in low, high and very high intensity zones during each 15-a-side game and combined across the four games

Variable	Games				
	1	**2**	**3**	**4**	**Combined**
Low intensity (m)	2683.58 ± 334.96	2572.49 ± 377.98	2493.31 ± 377.81	2633.78 ± 404.13	2594.41 ± 371.70
High intensity (m)	1063.32 ± 437.99	883.45 ± 239.04	967.50 ± 396.14	967.66 ± 295.18	967.04 ± 341.88
Very high intensity (m)	341.84 ± 136.94	272.21 ± 94.65	332.09 ± 114.73	297.99 ± 118.01	309.47 ± 116.21

Values are mean ± SD

Table 3.8: Percentage of game time at low, high and very high intensity during each 15-a-side game and combined across the four games

Variable	Games				
	1	**2**	**3**	**4**	Combined
Low intensity (%)	72.64 ± 6.71	74.73 ± 3.80	72.96 ± 5.93	73.60 ± 4.67	73.52 ± 5.23
High intensity (%)	27.36 ± 6.71	25.27 ± 3.80	27.04 ± 5.93	26.40 ± 4.67	26.47 ± 5.23
Very high intensity (%)	9.03 ± 3.08	7.87 ± 2.56	9.55 ± 2.56	8.22 ± 2.95	8.64 ± 2.79

Values are mean ± SD

Actions Performed in the High and Very High Intensity Zones

The number of actions performed in the high and very high intensity zones during each 15-a-side game and the mean (± SD) values combined across the four games are summarized in table 3.9. There were no significant differences in the number of actions performed in the high and very high intensity zones between the four 15-a-side games.

Accelerations and Decelerations

The number of accelerations and decelerations performed during each 15-a-side game and the mean (± SD) values combined across the four games are summarized in table 3.10. There were no significant differences in the number of accelerations and decelerations between the four 15-a-side games.

Heart Rate

The HR responses during each 15-a-side game and the mean (± SD) values combined across the four games are summarized in table 3.11. There were no significant differences in any of the measured HR variables between the four 15-a-side games.

Table 3.9: Number of actions* performed in the high and very high intensity zone during each 15-a-side game and combined across the four games

Variable	Games				
	1	**2**	**3**	**4**	**Combined**
High intensity zone (n)	49.25 ± 14.86	49.14 ± 11.09	47.00 ± 14.47	48.29 ± 10.34	48.42 ± 12.39
Very high intensity zone (n)	19.25 ± 4.48	17.57 ± 4.86	19.85 ± 4.72	17.50 ± 5.95	18.49 ± 5.02

Values are mean ± SD*Any movement that peaks within the designated running zone is referred to as an action.

Table 3.10: Number of accelerations and decelerations performed during each 15-a-side game and combined across the four games

Variable	Games				
	1	**2**	**3**	**4**	**Combined**
Accelerations > 1.5 m/sec (n)	94.92 ± 15.09	88.50 ± 17.76	80.15 ± 9.65	86.93 ± 13.85	87.49 ± 14.93
Accelerations > 3.5 m/sec (n)	8.75 ± 3.05	8.14 ± 4.753	7.54 ± 3.31	5.79 ± 2.19	7.51 ± 3.55
Decelerations > 1.5 m/sec (n)	84.33 ± 16.46	85.93 ± 21.11	79.00 ± 8.72	84.86 ± 14.16	83.58 ± 15.61
Decelerations > 3.5 m/sec (n)	13.42 ± 4.36	12.79 ± 4.81	13.62 ± 3.62	12.57 ± 4.29	13.08 ± 4.20

Values are mean ± SD

Table 3.11: Heart rate responses during each 15-a-side game and combined across the four games

Variable	Games				
	1	2	3	4	Combined
Heart rate max ($b \cdot min^{-1}$)	190.80 ± 7.77	191.46 ± 6.32	189.44 ± 5.81	190.73 ± 6.15	190.70 ± 6.35
Average HR ($b \cdot min^{-1}$)	165.07 ± 9.85	166.91 ± 6.70	166.44 ± 8.07	167.34 ± 6.27	166.49 ± 7.49
Percentage HRmax (%)	86.48 ± 2.59	87.20 ± 2.67	87.84 ± 2.70	87.76 ± 2.60	87.31 ± 2.60
Time spent in HR zone 1 (%)	0.78 ± 2.46	0.69 ± 1.69	0.56 ± 0.85	1.60 ± 3.01	0.92 ± 2.14
Time spent in HR zone 2 (%)	6.37 ± 6.61	3.95 ± 6.55	4.95 ± 3.66	4.07 ± 2.33	4.75 ± 5.14
Time spent in HR zone 3 (%)	24.50 ± 12.33	18.96 ± 8.23	14.96 ± 8.73	15.97 ± 8.10	18.65 ± 9.75
Time spent in HR zone 4 (%)	32.61 ± 7.69	37.20 ± 8.19	35.58 ± 7.98	35.84 ± 11.22	35.44 ± 8.76
Time spent in HR zone 5 (%)	35.42 ± 13.75	38.83 ± 18.82	43.62 ± 17.48	42.29 ± 16.10	39.92 ± 16.47

Values are mean ± SD

Individual Technical Skills

Number of Individual Possessions and Selected Technical Skills

Individual possessions and selected technical skills performed during each 15-a-side game and the mean (± SD) values combined across the four games are summarized in table 3.12. There were no significant differences in the number of individual possessions between the four 15-a-side games. Except for pick-ups and hand passes there were no significant differences in any of the selected technical skills performed between the four 15-a-side games. The number of pickups was lower ($p \leq 0.05$) in game 4 than game 1. A higher number of hand passes were performed during games 1 ($p \leq 0.05$) and 4 ($p \leq 0.05$) than game 3.

Table 3.12 Individual possessions and selected technical skills performed during each 15-a-side game and combined across the four games

Variable	Games				
	1	2	3	4	Combined
Possessions (n)	9.25 ± 5.26	7.00 ± 4.35	6.08 ± 4.44	8.29 ± 3.60	7.62 ± 4.45
Blocks (n)	0.08 ± 0.29	0.14 ± 0.36	0.00 ± 0.00	0.07 ± 0.27	0.08 ± 0.27
Interceptions (n)	0.58 ± 0.90	0.43 ± 0.85	0.08 ± 0.28	0.36 ± 0.50	0.36 ± 0.68
Pick-ups (n)	1.08 ± 1.00 *	0.43 ± 0.65	0.69 ± 0.86	0.07 ± 0.27	0.55 ± 0.80
Solo hops (n)	1.50 ± 1.45	2.00 ± 1.71	1.23 ± 1.30	3.21 ± 2.26	2.02 ± 1.86
Solo taps (n)	3.00 ± 4.02	1.29 ± 1.20	1.38 ± 1.94	1.79 ± 2.08	1.83 ± 2.49
Foot passes (n)	2.00 ± 2.30	1.36 ± 1.39	1.85 ± 2.19	1.43 ± 1.70	1.64 ± 1.87
Hand passes (n)	5.50 ± 3.15ǂ	4.29 ± 2.40	2.77 ± 1.42	5.43 ± 2.44ǂ	4.49 ± 2.59
Total catches (n)	7.42 ± 4.32	5.79 ± 3.77	4.46 ± 3.26	7.21 ± 3.22	6.21 ± 3.73
Chest catches (n)	5.50 ± 3.15	4.86 ± 3.11	3.23 ± 3.30	5.86 ± 2.80	4.87 ± 3.16
High catches (n)	0.83 ± 1.40	0.36 ± 0.75	0.54 ± 0.52	1.00 ± 1.47	0.68 ± 1.11
Low catches (n)	1.08 ± 1.08	0.57 ± 0.85	0.69 ± 0.75	0.36 ± 0.63	0.66 ± 0.85
Total scoring attempts (n)	1.00 ± 1.54	0.43 ± 0.94	0.54 ± 1.20	0.86 ± 1.29	0.70 ± 1.23
Successful scoring attempts (n)	0.58 ± 1.00	0.29 ± 0.61	0.23 ± 0.60	0.50 ± 0.86	0.40 ± 0.77
Unsuccessful scoring attempts (n)	0.42 ± 0.67	0.14 ± 0.36	0.33 ± 0.89	0.36 ± 0.63	0.31 ± 0.64

Values are mean ± SD;*p≤0.05 vs. Game 4; ǂp≤0.05 vs. Game 3

Team Possession Characteristics

Team possession characteristics during each 15-a-side game and the mean (± SD) values combined across the four games are summarized in table 3.13. There were no significant differences in any of the possession characteristics between the four 15-a-side games.

Table 3.13: Team possession characteristics during each 15-a-side game and the mean (± SD) values combined across the four games

	Games				
Variable	**1**	**2**	**3**	**4**	**Combined**
Team possessions (n)	25	19	23	22	22.25 ± 2.50
Players per possession (n)	4.36 ± 2.00	3.95 ± 1.96	3.30 ± 1.30	4.14 ± 1.91	3.94 ± 1.82
Time per possession (sec)	17.12 ± 8.21	17.03 ± 11.54	14.33 ± 5.90	18.14 ± 11.86	16.63 ± 9.48
Skills per possession (n)	11.76 ± 5.94	11.32 ± 8.17	7.74 ± 5.29	12.68 ± 9.88	10.79 ± 9.80

Values are mean ± SD

Discussion

The lack of objective data on MPD specific to senior club level GF teams is a major limitation in the design of technical, tactical, and athletic development programmes for this large cohort of players. This study is the first to simultaneously assess the physical activity profiles, individual possessions, technical skills, team play characteristics and heart rate during senior club level 15-a-side championship games. External situational variables such as match location, team quality ,playing time, and tactical approaches may influence MPD's during competitive GF games[170]. This study is also the first to assess the intergame variability in selected MPD during competitive GF games.

When relativized to a full 60-min game, the average TD and RD were 7,122 m and 102 m·min^{-1}, respectively. To date, only one published study has examined the activity profiles and technical demands during competitive senior club level GF games[23]. Data was collected from 58 players involving two teams during 30 senior club level GF games. Players covered an average TD of 7,145 m and a RD of 109 m·min^{-1} per game which is very similar to the findings in the present study. The number of hand passes, kick passes and total shots per game were also very similar between the two studies. The total number of team possessions when average across the four games (n=44) was similar to the value (n=41) reported by McGuigan et al., (2018) during competitive senior club level GF games[24]. At intercounty level RD ranged from 116 m.min^{-1} to 122 m.min^{-1} during the competitive season[16,17]. Using the same speed zones, Gamble et al., (2019) stated among

intercounty players that 69% of activity was performed at low intensity, 31% at high intensity and 11% at very high intensity[18]. This is very similar to the 74%, 26% and 9% reported in the current study. The same study from Gamble reported an average HR of 162 b.min^{-1} (84% HRmax) while it was 166 b.min^{-1} (87% HRmax) during the current study.

Despite the fact that fewer games were analysed in the present study compared to other studies that have measured physical activity characteristics, technical demands and team possessions during competitive senior club level GF, the findings were similar. This is perhaps not surprising considering that defensive counterattacking football is the predominant tactical approach adopted by most club level GF teams and this approach does not seem to vary much from game to game or from team to team. The majority of club level GF games involves opposing teams mirroring each other's defensive setup with the majority of players retreating deep inside their defensive 45 m line to deny a scoring opportunity or create a turn-over that can be effectively exploited. A recent study involving 13 intercounty teams found that defensive counterattacking, contributed to outcome an differentiated winners from losers during 26 league and championship games with a cross-validation accuracy of 87.5%.

It was hypothesised that there would be little or no significant difference in MPD between any of the four 15-a-side games. With the exception of hand passes and pickups there were no significant differences in any of the measured MPD between the four 15-a-side games, indicating that MPD involving physical activity profiles, individual

possessions, technical skills, team play characteristics and heart rate are relatively consistent from game to game. No study has assessed the intergame variability for adult club level GF. With the exception of the pick-up, Whelan (2011)[94] also found no significant differences in the number of technical skills performed during three, 15-a-side GF games involving male U-14 players. There was also no significant difference in any of the team possession characteristics between the three games[94]. This study did not investigate the activity profiles or HR characteristics during the 15-a-side games.

There is evidence that large variations in HIR exist in some invasion team-based field sports[171,172,173] due in part to factors such as the quality of opposition[68] and possession characteristics[174]. Among soccer teams, Rampinini et al., (2007) found that HIR was higher against opposition placed higher in the league table compared to weaker teams[68]. During English Premier league games, the volume of high-speed running was found to be higher when the team were in possession of the ball[174]. Carling et al., (2016) found large variability across the majority of high speed running variables when assessing 12 elite soccer players over a season[173].

Among professional AFL players Kempton et al., (2015) reported that match-to-match variability for RD and TD were relatively stable, while high-speed activities and technical measures exhibited a large degree of inter-game variability[175]. Large inter-game variability in physical activity patterns and the number of technical skills and their execution has also been reported among soccer players playing in the English Premier

League[176]. Match location, match result, and opposition standard had limited influence on match-to-match variability for either technical or physical parameters. Liu et al., (2016) found that technical performances among Spanish professional soccer across various field positions during 380 matches was significantly different between the 'strong' teams compared to the 'weaker' teams[177]. The relative consistency of the intra game MPD in the present study indicates that the average game values can be used and compared with other game formats in this thesis.

Chapter IV

CHAPTER IV

RESEARCH STUDY 2

Variability in Match Play Demands Among Senior Club Level Gaelic Football Players during 11-a-side and 7-a-side Modified Games

Rationale

Modified games involve replicating the basic principles of team play while imposing conditions relative to the playing rules, number of players, playing area, etc. The concept of specificity has been used to justify the use of MG`s in the preparation of players involved in invasion field-based team sports. It is believed that MG`s can replicate or exceed many of the MPD of competitive matches and are therefore an ideal way to prepare teams[10].

The majority of previous studies investigating the efficacy of MG have arbitrarily altered the pitch dimensions and player numbers and have failed to take account of how these changes impact the RPA relative to competitive match play. For example, the only published study to examine the impact of MG`s on MPD in adult club level GF used a 4 vs. 4 game format on three different pitch sizes as part of the conditioning component of training sessions[10]. The study failed to take account of the changes in RPA or equate the RPA to 15-a-side match play (approx.466 m^2).

There is currently relatively little evidence based research to assist senior club level GF coaches in designing and implementing MG`s. A systematic approach to the design of MG's will allow researchers and coaches to better evaluate independent modifications and how it may impact on the MPD during 15-a-side competitive GF games. The purpose of this study was to assess intra-game variability in selected MPD during MG`s with reduced player numbers while controlling for other match play variables including the RPA.

Study Aims

1. To compare player activity profiles between three 11-a-side and between three 7-a-side senior club games while controlling for other match play variables including the RPA.
2. To compare the number of individual possessions and technical skills performed between three 11-a-side and between three 7-a-side senior club level games while controlling for other match play variables including the RPA.
3. To compare the team-play characteristics between three 11-a-side and between three 7-a-side senior club level games while controlling for other match play variables including the RPA.
4. To compare the heart rate response between three 11-a-side and between three 7-a-side senior club level games while controlling for other match play variables including the RPA.

Hypothesis

1. There will be no significant difference in player activity profiles between three 11-a-side and between three 7-a-side senior club games while controlling for other match play variables including the RPA.
2. There will be no significant difference in the number of individual possessions and technical skills performed between three 11-a-side and between three 7-a-side senior club level games while controlling for other match play variables including the RPA.
3. There will be no significant difference in team-play characteristics between three 11-a-side and between three 7-a-side senior club level games while controlling for other match play variables including the RPA.
4. There will be no significant difference in heart rate response between three 11-a-side and between three 7-a-side senior club level games while controlling for other match play variables including the RPA.

METHODS

Design Considerations of GF Modified Games

Modified GF games involving reduced player numbers can range from 1 vs. 1 to 14 vs. 14. In GF, a 4 vs. 4 MG allows for the positioning of an attacking and defensive nuances of an official game (1 goalkeeper, defender, midfield and forward). Any game like activities ≤7 players i.e.,3 vs 3, 4 vs 1, 3 vs 2, 2 vs 2 etc., have been classified as isolated skills practice[21,22]. Owen et al., (2014) previously categorized soccer games (see Table 2.1) based on the proportion of players relative to the 11-a-side game. Similar proportions (relative to the 15-a-side game) were adopted in this PhD thesis to classify games as small sided games (SSG), medium sided games (MSG) and large sided games (LSG). (Table 4.1). Team formation was taken into consideration when deciding on the number of players in both the SSG and MSG categories. A minimum of 7 players facilitated the deployment of a goalkeeper and a player in each of the 5 outfield playing lines - full back, half back, midfield, half forward and full forward. (Figure 4.1).

Table 4.1 Classification of Gaelic football game-based on player number (Adopted from Owen et al., (2014) [86])

Sided-Game	%PP	% Range	Activity Type
15 vs. 15	100	100%	Full sided game
14 vs. 14	93	76-93%	Large sided games
13 vs. 13	87		
12 vs. 12	80		
11 vs. 11	73	51-75%	Medium sided games
10 vs. 10	67		
9 vs. 9	60		
8 vs. 8	53		
7 vs. 7	47	26-50%	Small sided games
6 vs. 6	40		
5 vs. 5	33		
4 vs. 4	27		
3 vs. 3	20	0-25%	Isolated skills practice

%PP - Percentage of players relative to the full side 15 vs. 15 game. For example, in 7-a-side games, 7 players represent 47% of the full complement of 15 players.

Figure 4.1: GF team formations for full and modified games

15 vs 15 Game

Position Line	Number in Line	Pitch Formation
Full Forward Line	3	● ● ●
Half Forward Line	3	● ● ●
Midfield	2	● ●
Half backline	3	● ● ●
Full backline	3	● ● ●
Goal Keeper	1	●

11 vs 11 Game

Position Line	Number in Line	Pitch Formation
Full Forward Line	2	● ●
Half Forward Line	2	● ●
Midfield	2	● ●
Half backline	2	● ●
Full backline	2	● ●
Goal Keeper	1	●

7 vs 7 Game

Position Line	Number in Line	Pitch Formation
Full Forward Line	1	●
Half Forward Line	1	●
Midfield	1	●
Half backline	1	●
Full backline	1	●
Goal Keeper	1	●

Overview of Study Design

The pitch dimensions, RPA and length to width ratio of the 7 and 11-a-side games are summarized in Table 4.2. Participants played three 11-a-side and three 7-a-side games. All MG`s were played on separate days at two different venues and consisted of 30 min of continuous match play. Ambient temperature and humidity ranged from 10 - 16 °C and 77 - 94%, respectively. These games were played between 20:00 and 21.30 hr.

Table 4.2: Pitch dimensions, RPA and length to width ratio of 7 and 11-a-side games

	Game Size	
Variable	**7-a-side**	**11-a-side**
Pitch dimensions (m)	95 x 59	124 x 75
Relative surface area per player (m^2)	466	466
Pitch length: width	1:1.6	1:1.6

Participants

Male members (n=24) of a senior, club level GF championship panel participated in the study. A total of 21 members participated in the 7 a-side games (mean ± SD; age = 23.91 ± 4.65 yrs., height = 179.93 ± 5.80 cm , weight = 73.75 ± 7.10 kg and estimated $\dot{V}O_2max$ = 52.13 ± 2.86 ml $kg^{-1}min^{-1}$), while 24 participated in the 11 a-side games (mean ± SD; age = 24.30 ± 4.46 yrs., height = 180.45 ± 5.57 cm , weight = 75.35 ± 8.59 kg and estimated $\dot{V}O_2max$ = 51.99 ± 2.95 ml $kg^{-1}min^{-1}$).

Anthropometrics

As previously described in the methods section of Chapter 3 (Page 62)

Yo-Yo Intermittent Recovery Test

As previously described in the methods section of Chapter 3 (Page 62)

Global Positioning System

As previously described in the methods section of Chapter 3 (Page 63)

Heart Rate

As previously described in the methods section of Chapter 3 (Page 64)

Video Analysis

As previously described in the methods section of Chapter 3 (Page 64)

Statistical Analysis

Descriptive statistics were calculated for all numerical variables and reported as mean ± SD. Normality of distribution for all variables was assessed using the Shapiro-Wilk test. Where the assumption of normality was met a one-way ANOVA test was used to compare differences in mean values across the different games. Where statistically significant differences were found, post hoc analysis was carried out using the Tukey test. In cases where Levene's test indicated that the assumption of homogeneity of variance

was violated, Welch's ANOVA test was used to compare mean differences across the different games. Where statistically significant differences were found, post hoc analysis was carried out using the Games-Howell test.

For variables that did not meet the assumption of normality, the Kruskal-Wallis test was used to assess differences across the games. Pairwise comparisons with a Bonferroni correction was used to determine whether there was a statistically significant difference between the different games. A Chi Square goodness of fit test was used to assess whether there were differences in the count of team possessions across the different games.

A p value of <0.05 was considered significant. Data analyses were performed using the Statistical Package for Social Science (SPSS) software version 27 IBM (IBM, Chicago, IL, USA).

RESULTS

Anthropometrics

Anthropometric data and estimated $\dot{V}O_2$max for the teams participating in each MG is summarized in table 4.3. The was no significant difference in age, height, weight or estimated $\dot{V}O_2$max between the teams competing in the 7, 11 and 15-a-side games. The estimated $\dot{V}O_2$max is very similar to the laboratory based measurement recently reported for club level GF players (2021)[130].

Table 4.3: Anthropometric data and estimated $\dot{V}O_2$max for the teams participating in each game format

	Games	
Variable	**11 vs 11**	**7 vs 7**
Age (yr)	24.20 ± 4.46	23.91 ± 4.65
Height (cm)	180.45 ± 5.57	179.93 ± 5.80
Weight (kg)	75.35 ± 8.59	73.75 ± 7.10
Estimated $\dot{V}O_2$max (mL $kg^{-1}min^{-1}$)	51.99 ± 2.95	52.13 ± 2.86

Values are mean ± SD

7-a-side Intra Game Variability

Game Time

The total game time, ball in play and out of play demands are summarized in table 4.4. There were no significant differences between any of the variables across the three 7-a-side games.

Table 4.4: Total game time, time of ball in play and out of play demands during each 7-a-side game

	Games		
Variable	**1**	**2**	**3**
Total time (sec)	1869	1821	1835
Time in play (sec)	1143	1010	1214
Time out of play (sec)	726	811	621
Time in play (%)	61	55	66
Time out of play (%)	39	45	34

Values are mean ± SD;

Activity Profiles

Total Distance, Relative Distance and Distance in Each Speed Zone

The TD, RD and distance covered in each speed zone during the three 7-a-side games are summarized in table 4.5. There were no significant differences in TD, RD and distance covered in each speed zone between each of the 7-a-side games. There were no significant differences in the average maximal velocity between game 1 (mean ± SD; 7.78 ± 0.32 $m \cdot s^{-1}$), game 2 (7.98 ± 0.55 $m \cdot s^{-1}$) and game 3 (8.06 ± 0.31 $m \cdot s^{-1}$)

Table 4.5: Total distance, relative distance and the distance covered in each zone during each of three 7-a-side games

	Games		
Variable	**1**	**2**	**3**
Total distance (m)	4034.85 ± 452.96	3772.24 ± 386.18	4066.30 ± 299.78
Relative distance ($m \cdot min^{-1}$)	129.07 ± 14.49	126.73 ± 11.49	130.85 ± 9.08
Walking (m)	1207.70 ± 119.77	1220.63 ± 157.22	1269.43 ± 98.67
Jogging (m)	1335.96 ± 182.45	1309.12 ± 365.50	1475.23 ± 250.80
Running (m)	972.37 ± 207.23	806.26 ± 163.02	816.60 ± 127.41
High speed (m)	459.36 ± 95.61	379.77 ± 98.13	424.38 ± 65.42
Max speed (m)	59.46 ± 36.63	56.46 ± 54.20	80.65 ± 36.14

Values are mean ± SD

Percentage Time in Each Speed Zone

The percentage of game time in each activity zone during each 7-a-side game are summarized in table 4.6. There were no significant differences in the proportion of time spent walking, jogging, high speed running and maximal speed running between the three 7-a-side games. Participants spent a significantly higher proportion of time running in game 1 than game 3. ($p \leq 0.05$)

Table 4.6: Percentage of time spent in each speed zone during each 7-a-side game

	Games		
Variable	**1**	**2**	**3**
Walking (%)	30.14 ± 3.38	32.55 ± 4.51	31.41 ± 3.58
Jogging (%)	33.14 ± 2.89	34.33 ± 7.10	36.09 ± 3.79
Running (%)	23.95 ± 3.50	21.32 ± 3.17	20.04 ± 2.43*
High speed (%)	11.35 ± 1.73	10.24 ± 2.96	10.46 ± 1.66
Max speed (%)	1.42 ± 0.74	1.56 ± 1.56	2.00 ± 0.94

Values are mean ± SD; *p≤0.05 vs. Game 1

Actions in Speed Zones

The number of actions performed in the running, high speed running and maximal speed running zones during each 7-a-side game are summarized in table 4.7. There were no significant differences in the number of actions performed in each of the activity zones between the three 7-a-side games.

Table 4.7: Number of actions* performed in running zones during each 7-a-side game

	Games		
Variable	**1**	**2**	**3**
No of actions in running (n)	40.55 ± 7.41	36.33 ± 8.11	37.42 ± 4.40
No of actions in high speed (n)	25.27 ± 4.22	23.58 ± 4.66	23.33 ± 2.64
No of actions in maximal speed (n)	5.18 ± 2.40	4.08 ± 3.48	5.17 ± 2.37

Values are mean ± SD *Any movement that peaks within the designated running zone is referred to as an action.

Distance Covered in the Low, High and Very High Intensity Zones

The distance covered in the low, high and very high intensity zones during each of the three 7-a-side games are summarized in table 4.8. There were no significant differences in distance covered in low and VHIR between the three 7-a-side games.

Participants covered less distance (p≤0.05) in the high intensity zone in game 2 than game 1.

Table 4.8: Total distance covered in the low, high and very high intensity zones during each 7-a-side game

	Games		
Variable	**1**	**2**	**3**
Low intensity (m)	2543.66 ± 222.80	2529.75 ± 349.34	2744.67 ± 226.06
High intensity (m)	1491.19 ± 283.12	1242.49 ± 120.78 *	1321.63 ± 129.43
Very high intensity (m)	518.82 ± 128.19	436.23 ± 132.91	505.03 ± 63.09

Values are mean ± SD; *p≤0.05 vs. Game 1

Percentage of Playing Time in the Low, High and Very High Intensity Zones

The percentage of time performed at low, high and very high intensity during each 7-a-side game is summarized in table 4.9. There were no significant differences in the percentage of game time spent in VHIR between the three 7-a-side games. Significantly less time was spent in the low and high intensity zone in Game 2 and 3 vs Game 1.

Table 4.9: Percentage of time performed at low, high and very high intensity during each 7-a-side game

	Games		
Variable	**1**	**2**	**3**
Low intensity (%)	63.28 ± 3.71	66.88 ± 3.34 *	67.49 ± 2.31*
High intensity (%)	36.72 ± 3.71	33.12 ± 3.34 *	32.51 ± 2.31 †
Very high intensity (%)	12.77 ± 2.29	11.80 ± 3.98	12.46 ± 1.68

Values are mean ± SD; *p≤0.05 vs. Game 1; †p≤0.01 vs. Game 1

Actions Performed in the High and Very High Intensity Zones

The number of actions performed in the high and very high intensity zones are summarized in table 4.10. There were no significant differences in any of the variables between the three 7-a-side games.

Table 4.10: Number of actions* performed in the high and very high intensity zones during each 7-a-side game

	Games		
Variable	**1**	**2**	**3**
High intensity zone (n)	71.00 ± 10.79	64.00 ± 6.24	65.92 ± 4.32
Very high intensity zone (n)	30.45 ± 5.35	27.67 ± 5.79	28.50 ± 3.03

Values are mean ± SD *Any movement that peaks within the designated running zone is referred to as an action.

Accelerations and Decelerations

The number of accelerations and decelerations performed are summarized in table 4.11. There were no significant differences in any of the acceleration and deceleration variables between the three 7-a-side games.

Table 4.11: Number of accelerations and decelerations during each 7-a-side game

	Games		
Variable	**1**	**2**	**3**
Accelerations > 1.5 m·sec^{-1} (n)	106.36 ± 11.37	101.42 ± 9.28	106.17 ± 6.28
Accelerations > 3.5 m·sec^{-1} (n)	8.91 ± 4.32	10.25 ± 4.07	9.83 ± 3.43
Decelerations > 1.5 m·sec^{-1} (n)	112.36 ± 16.41	103.92 ± 9.05	103.25 ± 7.99
Decelerations > 3.5 m·sec^{-1} (n)	21.82 ± 7.55	20.58 ± 4.68	20.33 ± 6.33

Values are mean ± SD

Heart Rate

The HR responses during the 7-a-side games are summarized in table 4.12. There was no difference in any of the measured HR variables between the three 7-a-side games.

Table 4.12: Heart rate response during the 7-a-side games

	Games		
	1	**2**	**3**
Heart rate max ($b.min^{-1}$)	193.10 ± 6.19	192.92 ± 6.73	194.08 ± 7.27
Average HR ($b.min^{-1}$)	173.46 ± 10.44	166.78 ± 9.21	172.90 ± 12.82
Percent HR max (%)	89.61 ± 4.38	86.56 ± 4.93	88.90 ± 4.53
Time spent in HR zone 1 (%)	1.43 ± 1.15	5.58 ± 7.12	5.39 ± 7.85
Time spent in HR zone 2 (%)	4.35 ± 6.72	4.98 ± 6.43	3.07 ± 2.94
Time spent in HR zone 3 (%)	21.18 ± 18.80	29.12 ± 19.66	14.56 ± 16.95
Time spent in HR zone 4 (%)	59.81 ± 21.13	58.33 ± 28.03	55.34 ± 28.23
Time spent in HR zone 5 (%)	13.14 ± 22.05	1.90 ± 3.36	21.54 ± 32.34

Values are mean ± SD

Individual Technical Skills

Number of Individual Possessions and Selected Technical Skills

The number of individual possessions and selected technical skills performed during each 7-a-side game are summarized in table 4.13. With the exception of foot passes There were no significant differences in the number of individual possessions and the number of selected technical skills performed between the three 7-a-side games. There was a significantly ($p \leq 0.05$) greater number of foot passes in game 3 than game 1.

Table 4.13: Individual possessions and selected technical skills performed during each 7-a-side game

	Games		
Variable	**1**	**2**	**3**
Possessions (n)	19.36 ± 9.96	17.25 ± 10.75	20.42 ± 8.98
Blocks (n)	0.00 ± 0.00	0.17 ± 0.39	0.17 ± 0.39
Interceptions (n)	1.27 ± 1.10	0.67 ± 1.23	0.50 ± 1.17
Pick Ups (n)	1.73 ± 1.10	1.83 ± 2.08	1.25 ± 0.62
Solo hops (n)	6.64 ± 3.83	9.08 ± 9.67	10.33 ± 7.45
Solo taps (n)	10.55 ± 8.90	5.50 ± 6.29	9.17 ± 8.66
Foot passes (n)	3.64 ± 2.50	4.33 ± 4.01	9.67 ± 6.57*
Hand passes (n)	12.36 ± 6.42	8.67 ± 6.17	6.33 ± 6.39
Chest catches (n)	11.73 ± 7.94	11.33 ± 7.91	16.00 ± 7.51
High catches (n)	1.10 ± 1.22	1.00 ± 1.35	2.58 ± 3.82
Low catches (n)	3.00 ± 2.41	2.50 ± 2.02	2.08 ± 1.51
Total catches (n)	15.82 ± 8.75	18.17 ± 13.10	20.67 ± 10.83
Successful scoring attempts (n)	2.09 ± 1.97	2.50 ± 2.84	2.25 ± 1.71
Unsuccessful scoring attempts (n)	1.18 ± 1.17	0.67 ± 0.98	0.83 ± 0.83
Total scoring attempts (n)	3.27 ± 2.87	3.17 ± 3.51	3.08 ± 2.07

Values are mean ± SD; *p≤0.05 vs. Game 1

Team Possession Characteristics

Team possession characteristics during each 7-a-side game are summarized in table 4.14. There were no significant differences in any of the possession characteristics between the three 7-a-side games.

Table 4.14: Team possession characteristics during each 7-a-side game

	Games		
Variable	**1**	**2**	**3**
Team possessions (n)	55	46	52
Players per possession (n)	3.67 ± 1.12	3.85 ± 1.33	4.08 ± 1.47
Time per possession (sec)	20.11 ± 9.98	21.11 ± 11.37	22.88 ± 15.55
Skills per possession (n)	13.31 ± 6.83	13.72 ± 8.19	15.69 ± 11.27

Values are mean ± SD; Team possessions are count data (accumulation of two teams involved in each game)

11-a-side Inter Game Variability

Game Time

The total game time, time of ball in play and out of play demands are summarized in table 4.15. There were no significant differences between any of the variables across the three 11-a-side games.

Table 4.15: Total game time, time of ball in play and out of play demands during each of the 11-a-side games

	Games		
Variable	**1**	**2**	**3**
Total time (sec)	1800	1801	1800
Time in play (sec)	1163	1292	1220
Time out of play (sec)	637	509	580
Time in play (%)	65	72	68
Time out of play (%)	35	28	32

Activity Profiles

Total Distance, Relative Distance and Distance in Each Speed Zone

The TD, RD and distance covered in each speed zone during each 11-a-side game are summarized in table 4.16. There were no significant differences in TD, RD and distance covered in each speed zone between each of the 11-a-side games. There were no significant differences in the average maximal velocity achieved between game 1 (mean $\pm$ SD; 7.89 $\pm$ 0.41 $m \cdot s^{-1}$), game 2 (8.00 $\pm$ 0.44 $m \cdot s^{-1}$) and game 3 (7.91 $\pm$ 0.35 $m \cdot s^{-1}$).

Table 4.16: Total distance, relative distance and distance covered in each zone during each 11-a-side game

Variable	Games		
	1	2	3
Total distance (m)	3603.96 ± 425.36	3534.97 ± 459.63	3539.29 ± 529.51
Relative distance ($m \cdot min^{-1}$)	118.17 ± 13.95	114.45 ± 14.90	116.99 ± 17.52
Walking (m)	1283.32 ± 130.12	1243.93 ± 91.17	1277.94 ± 107.20
Jogging (m)	1147.14 ± 244.31	1150.11 ± 237.81	1146.19 ± 237.74
Running (m)	724.88 ± 178.06	716.42 ± 193.18	720.49 ± 216.12
High speed (m)	398.83 ± 95.24	357.54 ± 116.83	329.16 ± 75.07
Maximal speed (m)	49.79 ± 29.41	66.97 ± 40.30	65.51 ± 38.34

Values are mean ± SD

Percentage Time in Each Speed Zone

The percentage of time spent in each speed zone are summarized in table 4.17. There were no significant differences in the proportion of time spent walking, jogging, running and maximal speed running between the three 11-a-side games. Participants spent a higher proportion of time in high speed running in game 1 than game 3 ($p \leq 0.05$).

Table 4.17: Percentage of time spent in each speed zone during each 11-a-side game

Variable	Games		
	1	2	3
Walking (%)	35.87 ± 3.78	35.77 ± 5.50	36.73 ± 5.13
Jogging (%)	31.79 ± 5.06	32.32 ± 3.64	32.22 ± 4.15
Running (%)	19.90 ± 3.04	19.95 ± 3.22	19.93 ± 3.44
High speed (%)	11.05 ± 2.19	9.99 ± 2.52	9.28 ± 1.40 *
Max speed (%)	1.39 ± 0.85	1.97 ± 1.25	1.84 ± 0.93

Values are mean ± SD; *p≤0.05 vs. Game 1

Actions in Speed Zones

The number of actions performed in the running, high speed running and maximal speed running zones during each 11-a-side game are summarized in table 4.18. There were no significant differences in the number of actions involving, running, high speed running and maximal speed running between the three 11-a-side games.

Table 4.18: Number of actions* performed in running zones during each 11-a-side game

	Games		
	1	**2**	**3**
No of actions in running (n)	29.00 ± 8.67	33.19 ± 6.42	34.39 ± 8.15
No of actions in high speed (n)	21.53 ± 6.57	20.75 ± 6.45	17.89 ± 5.74
No of actions in max speed (n)	4.53 ± 2.14	4.63 ± 2.42	4.44 ± 1.95

Values are mean ± SD. *Any movement that peaks within the designated running zone is referred to as an action.

Distance Covered in the Low, High and Very High Intensity Zones

The distance covered in the low, high and very high intensity zones during each 11-a-side game are summarized in table 4.19. There were no difference in the distance covered in the low, high and very high intensity zones between the three 11-a-side games.

Table 4.19: Total distance covered in the low, high and very high intensity zones during each 11-a-side game

	Games		
Variable	**1**	**2**	**3**
Low intensity (m)	2430.46 ± 263.61	2394.04 ± 238.63	2424.13 ± 273.16
High intensity (m)	1173.50 ± 253.37	1140.94 ± 276.03	1115.16 ± 296.08
Very high intensity (m)	448.62 ± 101.24	424.52 ± 107.62	394.67 ± 97.94

Values are mean ± SD

Percentage of Playing Time in the Low, High and Very High Intensity Zones

The percentage of time performed at low, high and very high intensity during each 11-a-side game are summarized in table 4.20. There were no significant differences in the percentage of game time spent in LIR, HIR or VHIR between the three 11-a-side games.

Table 4. 20: Percentage of time performed at low, high and very high intensity during each 11-a-side game

	Games		
Variable	**1**	**2**	**3**
Low intensity (%)	67.67 ± 4.35	68.09 ± 4.37	68.95 ± 4.20
High Intensity (%)	32.33 ± 4.36	31.91 ± 4.37	31.05 ± 4.20
Very high intensity (%)	12.44 ± 2.36	11.96 ± 2.26	11.12 ± 1.91

Values are mean ± SD

Actions Performed in the High and Very High Intensity Zones

The number of actions performed in the high and very high intensity zones during the three 11-a-side games are summarized in table 4.21. There were no significant differences in any of the variables between the three 11-a-side games.

Table 4.21: Number of actions* performed in the high and very high intensity zones during each 11-a-side game

	Games		
Variable	**1**	**2**	**3**
High intensity (n)	55.05 ± 8.71	58.56 ± 9.10	56.72 ± 11.39
Very high intensity (n)	26.05 ± 6.40	25.38 ± 6.09	22.33 ± 5.90

Values are mean ± SD *Any movement that peaks within the designated running zone is referred to as an action.

Accelerations and Decelerations

The number of accelerations and decelerations performed during the three 11-a-side games are summarized in table 4.22. There were no significant differences in any of the acceleration and deceleration variables between the three 11-a-side games.

Table 4.22: Number of accelerations and decelerations during each 11-a-side game

	Games		
Variable	**1**	**2**	**3**
Accelerations > 1.5 m·sec^{-1} (n)	85.68 ± 11.27	95.75 ± 15.25	90.72 ± 14.92
Accelerations > 3.5 m·sec^{-1} (n)	7.11 ± 3.23	8.94 ± 2.46	9.28 ± 2.74
Decelerations > 1.5 m·sec^{-1} (n)	85.68 ± 10.34	92.19 ± 16.46	90.11 ± 16.16
Decelerations > 3.5 m·sec^{-1} (n)	14.37 ± 3.93	15.88 ± 4.40	14.89 ± 5.80

Values are mean ± SD

Heart Rate

The HR responses during the three 11-a-side games are summarized in table 4.23. There were no difference in any of the HR variables between the three 11-a-side games.

Table 4.23: Heart rate responses during each 11-a-side game

	Games		
Variable	**1**	**2**	**3**
Heart rate max ($b \cdot min^{-1}$)	194.53 ± 6.23	193.44 ± 5.89	192.22 ± 11.54
Average HR ($b \cdot min^{-1}$)	164.94 ± 12.81	164.02 ± 9.54	166.42 ± 11.06
Percentage HRmax (%)	84.76 ± 6.62	84.97 ± 5.02	85.07 ± 5.01
Time spent in HR zone 1 (%)	6.98 ± 9.47	4.70 ± 4.53	4.13 ± 5.26
Time spent in HR zone 2 (%)	9.92 ± 7.05	11.41 ± 8.11	9.97 ± 7.47
Time spent in HR zone 3 (%)	25.50 ± 11.24	31.31 ± 13.28	30.40 ± 18.36
Time spent in HR zone 4 (%)	47.59 ± 16.47	46.08 ± 19.44	46.13 ± 15.94
Time spent in HR zone 5 (%)	9.91 ± 20.51	6.42 ± 11.63	9.27 ± 17.15

Values are mean ± SD

Individual Technical Skills

Number of Individual Possessions and Selected Technical Skills

The number of individual possession and selected technical skills performed during each 11-a-side game are summarized in table 4.24. There were no significant differences in the number of individual possessions and the number of selected technical skills performed between the three 11-a-side games.

Table 4.24: Individual possession and selected technical skills performed during each 11-a-side game

	Games		
Variable	**1**	**2**	**3**
Possessions (n)	13.42 ± 6.97	15.63 ± 7.65	12.33 ± 7.95
Blocks (n)	0.16 ± 0.38	0.19 ± 0.54	0.11 ± 0.32
Interceptions (n)	0.32 ± 0.48	0.75 ± 1.00	0.28 ± 0.67
Pick-ups (n)	1.05 ± 0.97	1.44 ± 1.09	0.78 ± 0.94
Solo hops (n)	5.11 ± 4.25	5.50 ± 3.27	4.28 ± 5.13
Solo taps (n)	3.05 ± 2.82	6.56 ± 5.07	6.44 ± 6.20
Foot passes (n)	3.00 ± 3.42	4.25 ± 4.88	3.50 ± 4.31
Hand passes (n)	9.00 ± 3.79	9.88 ± 4.65	7.78 ± 4.82
Total catches (n)	11.84 ± 6.21	13.94 ± 7.01	10.89 ± 7.20
Chest catches (n)	9.84 ± 5.32	11.81 ± 5.97	9.56 ± 6.60
High catches (n)	0.58 ± 0.84	0.56 ± 0.73	0.11 ± 0.32
Low catches (n)	1.42 ± 1.30	1.56 ± 1.26	1.22 ± 1.11
Scoring attempts (n)	1.47 ± 1.74	1.75 ± 2.27	1.12 ± 1.27
Successful scoring attempts (n)	1.11 ± 1.49	1.25 ± 1.88	0.56 ± 0.86
Unsuccessful scoring attempts (n)	0.37 ± 0.50	0.50 ± 0.63	0.50 ± 0.71

Values are mean ± SD

Team Possession Characteristics

Team possession characteristics during each 11-a-side game are summarized in table 4.25. There were no significant differences in any of the possession characteristics between the three 11-a-side games.

Table 4.25: Team possession characteristics during each of the three 11-a-side games

	Games		
Variable	**1**	**2**	**3**
Team possessions (n)	45.00	52.00	43.00
Players per possession (n)	3.67 ± 1.12	3.85 ± 1.33	4.08 ± 1.47
Time per possession (sec)	20.11 ± 9.98	21.11 ± 11.37	22.88 ± 15.55
Skills per possession (n)	13.31 ± 6.83	13.72 ± 8.19	15.69 ± 11.27

Values are mean ± SD. Team possessions are count data (accumulation of two teams involved in each game)

Discussion

MG`s played on altered playing areas with reduced player numbers are now routinely used in training as part of a GBA to replicate the demands of 15-a-side games. In addition, to the playing area and the number of players per team, other constraints that can be manipulated during MG's include game conditions/rules, availability of footballs, coach encouragement, game duration, number of games, recovery time between games, shape of pitch etc. There is currently no evidence-based research to assist senior club level GF coaches in the design and implementation of MG`s as part of preparation for club championship fixtures. This study is the first to evaluate the effect of MG,s with reduced player numbers on selected MPD (activity profiles, technical skills, individual possessions, team possession characteristics and HR) while maintaining RPA, pitch shape and using standard goal posts and uprights placed on the end lines. In addition, all games were officiated by a qualified referee using the official GF rule book.

With the exception of the percentage of playing time spent in the high-speed zone there was no difference in any of the MPD between the three 11-a-side games. In contrast, the was significant intergame variability in the percentage of time spent in the running zone, distance in high intensity zone, percentage of time in low and high intensity between the three 7-a-side games. The number of foot passes was the only technical skill that varied significantly between the three 7-a-side games. Gaelic football games can be very unpredictable in nature and so variability is to be expected. Despite the fact

that the RPA was the same in the 7-a-side and 11-a-side games, the larger reduction in player number resulted in greater variability in a number of the measured activity parameters. Since teams consisting of 11 players have only a 27% reduction in player number compared to a 15-a-side game it is more likely that their activity patterns will consistently replicate the 15-a-side game compared to a team with 7 players who have a 53% reduction in player number.

To the authors knowledge only one previous study has investigated the effect of altering RPA on selected MPD during modified GF games[94]. The study examined the variability in MPD among youth players during three 9-a-side games with a RPA of 400m^2 and three 9-a-side games with a RPA of 300m^2 and found no significant intra game variability for any of the individual technical skills or team play possessions[94]. In contrast, Bredt et al., (2016) found a high degree of variability in most of the measured variables related to tactical demands during 3 vs. 3 games with a RPA of 163 m^2 in U17 professional soccer players[178]. Similarly, Clemente et al,. (2019) reported large intergame variability in technical demands during 3 and 6-a-side soccer games with a RPA of 50m^2 and 55m^2 respectively[179].

When considering activity profiles and HR responses similar results to the present study have been found in a number of studies. Stephen et al., (2016) showed reliability values were higher for HR and TD compared to high intensity activities during 6-a-side soccer games[180]. This was also found when Aquino et al., (2019) reported high-intensity

efforts to have larger variability in 6-a-side soccer players[181] and Younesi et al., (2021) reported TD to have less variability than all high intensity variables irrespective of game format or conditions in 3,4 and 6-a-side games[182]. When comparing the studies mentioned above caution must be taken as game length, RPA and pitch W:L ratio were not matched to the full sided game as with the current study.

The relative consistency of the intra game MPD in the current study indicates that the average game values can be used as representative of the various MG`s game formats used in the present thesis.

Chapter V

CHAPTER V

STUDY 3

Comparison of the Match Play Demands Between 15-a-side, 11-a-side and 7-a-side Senior Club Level Gaelic Football Games

Rationale

The relation between players and their environment is dynamic and unpredictable during competitive GF games. Ideally, technical skills such as catching, passing, blocking, soloing, and shooting should emerge in and around the game environment. MG's may offer players the opportunity to develop their technical and perceptual-cognitive skills under similar conditions to those encountered during 15-a-side games, thereby increasing the likelihood of transfer to the competitive environment[87]. Furthermore, by altering one or more constraints, MG`s can also potentially replicate the physical activity patterns and HR responses during competitive match play.

There is currently relatively little evidence-based research to assist senior club level GF coaches in designing and implementing MG's to replicate the possession characteristics, technical skills, activity profiles and HR response demands of 15-a-side games. The majority of previous studies investigating MPD during MG in other field-based invasion team sports used arbitrarily selected playing areas and failed to take

account of the RPA during competitive match play. Furthermore, these studies were for the most part not designed to determine the independent effects of alterations in one or more constraints on MPD and surprisingly failed to make comparisons to the MPD of competitive match play. The purpose of this study was to compare MPD between 11 and 7-a-side games with reduced player numbers, while controlling for other match play variables including the RPA.

Study Aims

1. To compare activity profiles among senior club level GF players during 7, 11 and 15-a-side games
2. To compare HR responses among senior club level GF players during 7, 11 and 15-a-side games
3. To compare the number of individual possessions and technical skills among senior club level GF players during 7, 11 and 15-a-side games
4. To compare team play characteristics among senior club level GF players during 7, 11 and 15-a-side games

Hypotheses

1. There will be significant differences in activity profiles between 7, 11, and 15-a-side games
2. There will be significant differences in HR response between 7, 11, and 15-a-side games

3. There will be significant differences the number of individual possessions and technical skills between 7, 11, and 15-a-side games
4. There will be significant differences in team play characteristics between 7, 11, and 15-a-side games

Methods

Overview of Study Design

The pitch dimensions, RPA and length to width ratio, temperature and humidity during the 7, 11, and 15-a-side games are summarized in Table 3.1 and 4.2. A single senior club GF team participated in four 60 min official championship fixtures played between May and August 2017. Data from the first half of each game were used in the analysis. Participants from another senior club team played three 11-a-side and three 7-a-side games. All MG`s were played on separate days at two different venues and consisted of 30 min of continuous match play. Participants were fitted with a portable 10 Hz GPS unit and a HR monitor prior to each game.

Participants

Male members (n=19) of a senior, club level GF panel participated in the 15-a-side games. A separate senior, club level GF team participated in the 7-a-side games (n=21) and 11 a-side games(n=24). The anthropometric data and estimated $\dot{V}O_2$max for all participants are summarised in Table 5.1. Participants were provided with a plain language statement outlining the nature and demands of the study as well as the inherent risks. Written informed consent was obtained prior to participation. Participants were advised that they could withdraw from the study at any time.

Yo-Yo Intermittent Recovery Test

As previously described in the methods section of Chapter 3 (Page 62)

Global Positioning System

As previously described in the methods section of Chapter 3 (Page 63)

Heart Rate

As previously described in the methods section of Chapter 3 (Page 64)

Video Analysis

As previously described in the methods section of Chapter 3 (Page 64)

Statistical Analysis

Descriptive statistics were calculated for all numerical variables and reported as mean ± SD. Normality of distribution was assessed using the Shapiro-Wilk test. Where the assumption of normality was met a one-way ANOVA test was used to compare differences in mean values across the 3 different game formats. Where statistically significant differences were found, post hoc analysis was undertaken using the Tukey test. In cases where Levene's test indicated that the assumption of homogeneity of variance was violated, Welch's ANOVA test was used to compare mean differences across the 3 different game sizes. Where statistically significant differences were found, post hoc analysis was undertaken using the Games-Howell test.

For dependent variables that did not meet the assumption of normality, the Kruskal-Wallis test was used to assess differences across the game sizes. Pairwise comparisons with a Bonferroni correction were used to determine whether there was a statistically significant difference between the game formats. A Chi Square goodness of fit test was used to assess whether there were differences in the count of team possessions across the different games.

A p value of <0.05 was considered significant. Data analyses were performed using the Statistical Package for Social Science (SPSS) software version 27 IBM (IBM, Chicago, IL, USA).

RESULTS

Anthropometrics

Anthropometric data and estimated $\dot{V}O_2max$ for the teams participating in each game format is summarized in table 5.1. The were no significant difference in age, height, weight or estimated $\dot{V}O_2max$ between the teams competing in the 7, 11 and 15-a-side games. The estimated $\dot{V}O_2max$ is very similar to the laboratory based measurement recently reported for club level GF players (2021) [130].

Table 5.1: Anthropometric data and estimated $\dot{V}O_2max$ for the teams participating in each game format

	Games		
Variable	**15 vs 15**	**11 vs 11**	**7 vs 7**
Age (yr)	26.27 ± 5.59	24.20 ± 4.46	23.91 ± 4.65
Height (cm)	176.92 ± 8.50	180.45 ± 5.57	179.93 ± 5.80
Weight (kg)	76.53 ± 7.05	75.35 ± 8.59	73.75 ± 7.10
Estimated $\dot{V}O_2max$ (mL $kg^{-1}min^{-1}$)	50.57 ± 2.80	51.99 ± 2.95	52.13 ± 2.86

Values are mean ± SD

Game Time

Total game time, time of ball in play and out of play during each game format is summarized in table 5.2. There were no significant differences in total time between any of the game formats. The total time for ball in play was higher ($p<0.01$) in the 11-a-side than the 15-a-side games. The percentage of time in play was higher during the MG`s than the 15-a-side game (7-aside = $p<0.01$, 11-aside = $p<0.001$). The total time that the ball was out of play and the percentage of time the ball was out of play was lower in the MG`s (7-aside = $p<0.01$, 11-aside = $p<0.001$) than the 15-a-side games.

Table 5.2: Total game time, time of ball in play and out of play during each game format

	Games		
Variable	**15 vs 15**	**11 vs 11**	**7 vs 7**
Total Time (sec)	2031.75 ± 115.636	1800.33 ± 0.58	1841 .67 ± 24.69
Time in play (sec)	951.25 ± 79.88	1225.00 ± 64.65 †	1122.33 ± 103.56
Time out of play (sec)	1080.50 ± 114.30	575.33 ± 64.13 ‡	719.33 ± 95.18 †
Time in play (%)	46.87 ± 3.99	68.04 ± 3.57 ‡	60.93 ± 5.35 †
Time out of play (%)	53.13 ± 3.99	31.96 ± 3.57 ‡	39.07 ± 5.35 †

Values are mean ± SD; †p≤0.01 vs. 15 vs 15; ‡p≤0.001 vs.15 vs 15

Activity Profiles

Total Distance, Relative Distance and Distance in Each Speed Zone

The TD, RD and distance achieved in each speed zone during each game format is summarized in table 5.3. The TD covered ($p<0.001$) and distance covered in the jogging ($p<0.05$) and running zones ($p<0.001$) was significantly higher during the 7-a-side than the 11-a-side and 15-a-side games. The RD ($m \cdot min^{-1}$) and the distance covered at high

speed running was higher (p<0.001) and the walking distance was lower (p<0.001) in both MG`s formats than the 15-a-side game. Compared to the 7-a-side games, the TD covered (p<0.001), RD (p<0.001) and the distance covered jogging (p<0.001), running (p<0.01) and high speed zones (p<0.05) were lower in the 11-a-side games. The were no significant difference in the distance covered in the max speed zone between any of the game formats. There were no significant differences in the max running velocity ($m \cdot s^{-1}$) between the 7-a-side (mean $\pm$ SD; 7.94 $\pm$ 0.41), 11-a-side (7.82 $\pm$ 0.40) and 15-a-side (7.86 $\pm$ 0.58) game formats.

Table 5.3: Total distance, relative distance and distance achieved in each speed zone during each game format

	Games		
Variable	**15 vs 15**	**11 vs 11**	**7 vs 7**
Total distance (m)	3561.45 $\pm$ 656.14	3561.17$\pm$ 465.06	3955.60 $\pm$ 394.83 ‡ [c]
Relative distance ($m \cdot min^{-1}$)	102.02 $\pm$ 19.06	116.65 $\pm$ 15.30 ‡	128.88 $\pm$ 11.58 ‡ [c]
Walking (m)	1394.85 $\pm$ 203.42	1269.60 $\pm$ 110.95 ‡	1233.30 $\pm$ 126.87 ‡
Jogging (m)	1199.56 $\pm$ 393.15	1147.71 $\pm$ 235.44	1374.50 $\pm$ 280.95 * [c]
Running (m)	657.56 $\pm$ 286.17	720.84 $\pm$ 192.41	862.01 $\pm$ 179.57 ‡ [b]
High speed (m)	262.00 $\pm$ 89.18	362.70 $\pm$ 98.96 ‡	420.08 $\pm$ 90.93 ‡ [a]
Max speed (m)	47.47 $\pm$ 43.52	60.32 $\pm$ 36.22	65.70 $\pm$ 43.47

Values are mean $\pm$ SD; *p≤0.05 vs. 15 vs 15; ‡p≤0.001 vs.15 vs 15; [a]p≤0.05 vs. 11 vs 11; [b]p≤0.01 vs. 11 vs 11; [c]p≤0.001 vs. 11 vs 11

Percentage Time in Each Speed Zone

The percentage of game time spent in each activity zone during the three-game formats is summarized in figure 5.1. The were no significant difference in the proportion of time spent in the jogging or maximal speed zones between the 15-a-side games and either of the MG formats. The percentage of time spent walking was higher during the 15-a-side game than both the 11-a-side ($p<0.01$) and the 7-a-side ($p<0.001$) games. The percentage of time spent running and high speed running was significantly lower in the 15-a-side game than either MG format. Compared to the 7-a-side games, the percentage of time spent walking was higher($p<0.001$) and the percentage of time spent jogging was lower ($p<0.05$) during the 11-a-side games.

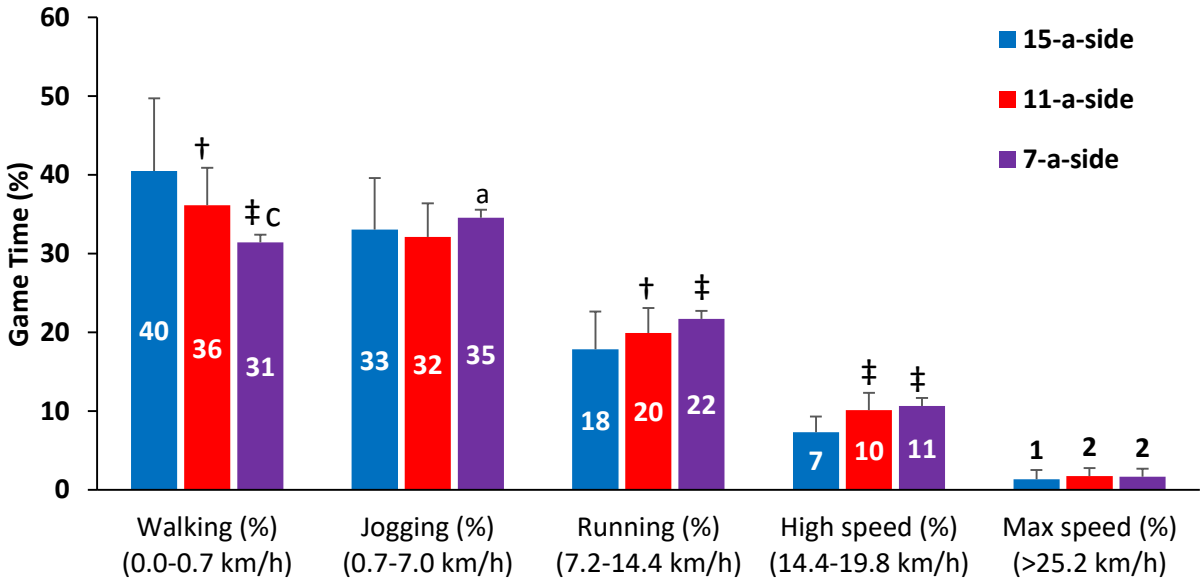

Figure 5.1. Percentage of game time performed in each of the activity zones during each game format. Values are mean ± SD; *p≤0.05 vs. 15 vs 15; †p≤0.01 vs. 15 vs 15; ‡p≤0.001 vs.15 vs 15; [a]p≤0.05 vs. 11 vs 11; [b]p≤0.01 vs. 11 vs 11; [c]p≤0.001 vs. 11 vs 11

Actions in Speed Zones

The number of actions performed in the running, high speed and max speed zones during each game format is summarized in table 5.4. The number of actions performed in the running zone was higher ($p<0.001$) during the 7-a-side games than the 15-a-side games. The number of actions performed in the high-speed zone was higher ($p<0.001$) during both MG formats than the 15-a-side games. The were no significant difference in the number of actions in the max speed zone between either MG format and the 15-a-side games. The number of actions performed in the running ($p<0.001$) and high speed ($p<0.01$) zones were lower in the 11 than the 7-a-side games.

Table 5.4: Number of actions performed in running zones during each game format

	Games		
Variable	**15 vs 15**	**11 vs 11**	**7 vs 7**
Running (n)	29.92 ± 10.92	32.09 ± 8.08	38.08 ± 6.85 ‡ [c]
High speed running (n)	15.26 ± 4.16	20.06 ± 6.35 ‡	24.03 ± 3.91 ‡ [b]
Max speed running (n)	3.23 ± 2.41	4.53 ± 2.13	4.80 ± 2.77

Values are mean ± SD; ‡$p\leq0.001$ vs.15 vs 15 [b]$p\leq0.01$ vs. 11 vs 11;
[c]$p\leq0.001$ vs. 11 vs 11

Distance Covered in the Low, High and Very High Intensity Zones

The distance covered in low, high and the very high intensity activity zones during each game format is summarized in table 5.5. The distance covered in the low intensity zone was higher ($p<0.05$) in the 11 than the 15-a-side games. The distance covered in the high intensity zone (11-a-side ($p<0.05$), 7-a-side ($p<0.001$)) and the very high intensity zone ($p<0.001$) was significantly higher in both MG formats than the 15-a-side games. The distance covered in the low intensity zone was lower ($p<0.01$) whereas the distance in the high ($p<0.001$) and the very high intensity ($p<0.05$) zones were higher in the 7-a-side than the 11-a-side games.

Table 5.5: Total distance covered in low, high and very high intensity zones during each game format

	Games		
Variable	**15 vs 15**	**11 vs 11**	**7 vs 7**
Low intensity (m)	2594.41 ± 371.70	2417.31 ± 255.19 *	2607.81 ± 284.09 [b]
High intensity (m)	967.04 ± 341.88	1143.86 ± 271.05 *	1347.79 ± 211.00 ‡ [c]
Very high intensity (m)	309.47 ± 116.21	423.02 ± 102.68 ‡	485.77 ± 114.83 ‡ [a]

Values are mean ± SD; *p≤0.05 vs. 15 vs 15; ‡p≤0.001 vs.15 vs 15 [a]p≤0.05 vs. 11 vs 11; [b]p≤0.01 vs. 11 vs 11; [c]p≤0.001 vs. 11 vs 11

Percentage of Game Time Spent in the Low, High and Very High Intensity Zones

The percentage of game time spent in the low, high and very high intensity activity zones during each game format is summarized in figure 5.2. The percentage of time spent in low intensity was lower ($p<0.001$) and the percentage of time spent in the high and very high intensity were higher ($p<0.001$) during MG formats than the 15-a-side games.

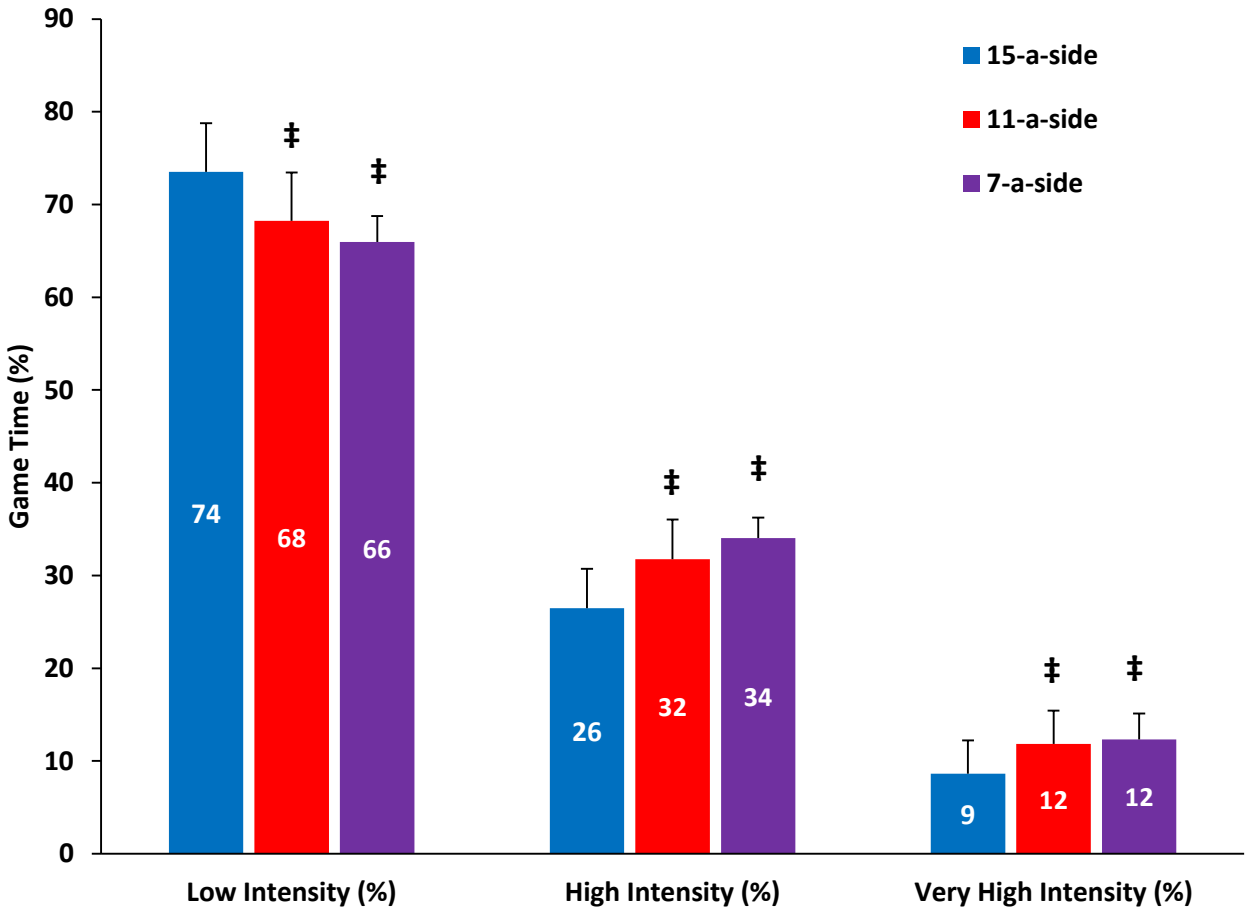

Figure 5.2: Percentage of game time performed in low, high and very high intensity during each game format. ‡p≤0.001 vs.15 vs 15

Actions Performed in the High and Very High Intensity Zones

The number of actions performed in the high and very high intensity activity zones during each game format is summarized in table 5.6. The number of actions performed in the high intensity and very high intensity zones was higher ($p<0.001$) during the MG`s than the 15-a-side games. The number of actions performed in the high intensity zone ($p<0.001$) and in the very high intensity zone ($p<0.01$) were lower in the 11 than the 7-a-side games.

Table 5.6: Number of actions performed in high and very high intensity zones during each game format

	Games		
Variable	**15 vs 15**	**11 vs 11**	**7 vs 7**
High intensity (n)	48.42 ± 12.39	56.68 ± 9.73 ‡	66.86 ± 7.84 ‡ [c]
Very high intensity (n)	18.49 ± 5.02	24.58 ± 6.24 ‡	28.83 ± 4.86 ‡ [b]

Values are mean ± SD; ‡p≤0.001 vs.15 vs 15; [b]p≤0.01 vs. 11 vs 11; [c]p≤0.001 vs. 11 vs 11

Accelerations and Decelerations

The number of accelerations and decelerations during each game format is summarized in table 5.7. There was a greater number of accelerations >1.5 m·sec^{-1} ($p<0.001$), >3.5 m·sec^{-1} ($p<0.05$), decelerations >1.5 m·sec^{-1} and >3.5 m·sec^{-1} ($p<0.001$) during the 7-a-side games than during the 15-a-side games. The number of accelerations >1.5 m·sec^{-1} ($p<0.001$), decelerations >1.5 m·sec^{-1} and decelerations >3.5 m·sec^{-1}($p<0.001$) was lower during 11-a-side than 7-a-side games.

Table 5.7: Number of accelerations and decelerations during each game format

	Games		
Variable	**15 vs 15**	**11 vs 11**	**7 vs 7**
Accelerations > 1.5 m·sec^{-1} (n)	87.49 ± 14.93	90.43 ± 14.17	104.60 ± 9.17 ‡ ^{c}
Accelerations > 3.5 m·sec^{-1} (n)	7.51 ± 3.55	8.40 ± 2.96	9.70 ± 3.87 *
Decelerations > 1.5 m·sec^{-1} (n)	83.58 ± 15.61	89.15 ± 14.42	106.34 ± 11.98 ‡ ^{c}
Decelerations > 3.5 m·sec^{-1} (n)	13.08 ± 4.20	15.00 ± 4.72	20.89 ± 6.10 ‡ ^{c}

Values are mean ± SD; *p≤0.05 vs. 15 vs 15; ‡p≤0.001 vs.15 vs 15; ^{c}p≤0.001 vs. 11 vs 11

Heart Rate

The HR responses during each game format is summarized in table 5.8. There were no significant differences in HRmax between the two MG formats and the 15-a-side games. The proportion of time spent in HR zone 1 (11-a-side ($p<0.001$), 7-a-side ($p<0.05$)) and HR zone 4 was greater ($p<0.001$) during the MG`s than the 15-a-side games. The proportion of time spent in HR zone 5 ($p<0.001$) was less during the MG`s than the 15-a-side games. A greater proportion of time was spent in HR zones 2 and 3 ($p<0.001$) and

the percentage HRmax was lower ($p<0.05$) during the 11-a-side than the 15-a-side games. The average HR and percentage HRmax was lower ($p<0.05$) and proportion of time spent in zone 2 ($p<0.001$) was higher during 11-a-side than 7-a-side games.

Table 5.8: Heart rate responses during each game format

	Games		
Variable	**15 vs 15**	**11 vs 11**	**7 vs 7**
Heart rate max ($b.min^{-1}$)	190.70 ± 6.35	193.42 ± 8.24	193.38 ± 6.59
Average HR ($b.min^{-1}$)	166.49 ± 7.49	165.12 ± 11.00	170.95 ± 11.08 [a]
Percentage HRmax (%)	87.31 ± 2.60	84.93 ± 5.4 *	88.24 ± 4.66 [a]
Time spent in HR zone 1 (%)	0.92 ± 2.14	5.27 ± 6.74 ‡	4.36 ± 6.49 *
Time spent in HR zone 2 (%)	4.75 ± 5.14	10.44 ± 7.41 ‡	4.08 ± 5.33 [c]
Time spent in HR zone 3 (%)	18.65 ± 9.75	29.07 ± 14.50 ‡	21.41 ± 18.84
Time spent in HR zone 4 (%)	35.44 ± 8.76	46.60 ± 16.97 ‡	57.61 ± 25.54 ‡
Time spent in HR zone 5 (%)	39.92 ± 16.47	8.53 ± 16.52 ‡	12.45 ± 23.90 ‡

Values are mean ± SD; *p≤0.05 vs. 15 vs 15; †p≤0.01 vs. 15 vs 15; ‡p≤0.001 vs.15 vs 15
[a]p≤0.05 vs. 11 vs 11; [b]p≤0.01 vs. 11 vs 11; [c]p≤0.001 vs. 11 vs 11

Individual Technical Skills

Number of Individual Possessions and Selected Technical Skills

The average number of individual possessions and selected technical skills during each game format is summarized in table 5.9. The number of individual possessions was higher ($p<0.001$) during both MG formats than during the 15-a-side game. The total number of individual possessions was higher ($p<0.05$) during the 7-a-side than during the 11-a-side games. The number of hand passes and foot passes was significantly higher in both MG formats than the 15-a-side game.

The total number of catches and the number of chest catches, low catches and pick-ups was significantly higher in both MG formats compared to the 15-a-side games. Compared to 11-a-side games, the total number of catches and the number of high and low catches was higher ($p<0.05$) during the 7-a-side games. The number of solo taps and solo hops was significantly higher in both MG formats than the 15-a-side games. The total number of solo hops was significantly lower ($p<0.01$) during the 11-a-side than the 7-a-side games.

The total number of scoring attempts and successful scoring attempts was significantly higher during both MG formats than the 15-a-side game. The total number of scoring attempts and the number of successful scoring attempts was higher ($p<0.01$) during the 7-a-side than the 11-a-side games. The number of unsuccessful scoring attempts was higher ($p<0.01$) in the 7-a-side than the 15-a-side games.

Table 5.9. Individual possessions and selected technical skills performed during each game format

Variable	Games		
	15 vs 15	**11 vs 11**	**7 vs 7**
Possessions (n)	7.62 ± 4.45	13.72 ± 7.50 ‡	19.00 ± 9.72 ‡ [a]
Blocks (n)	0.08 ± 0.27	0.15 ± 0.41	0.11 ± 0.32
Interceptions (n)	0.36 ± 0.68	0.43 ± 0.75	0.80 ± 1.18
Pick-ups (n)	0.55 ± 0.80	1.08 ± 1.02 *	1.60 ± 1.40 ‡
Solo hops (n)	2.02 ± 1.86	4.94 ± 4.27 ‡	8.74 ± 7.41 ‡ [a]
Solo-taps (n)	1.83 ± 2.49	5.26 ± 5.10 ‡	8.34 ± 8.10 ‡
Foot passes (n)	1.64 ± 1.87	3.55 ± 4.15 †	5.94 ± 5.34 ‡
Hand passes (n)	4.49 ± 2.59	8.85 ± 4.42 ‡	9.03 ± 6.62 ‡
Total catches (n)	6.21 ± 3.73	12.15 ± 6.79 ‡	18.29 ± 10.95 ‡ [a]
Chest catches (n)	4.87 ± 3.16	10.34 ± 5.94 ‡	13.06 ± 7.86 ‡
High catches (n)	0.68 ± 1.11	0.42 ± 0.69	1.57 ± 2.51 [a]
Low catches (n)	0.66 ± 0.85	1.40 ± 1.21 ‡	2.51 ± 1.98 ‡ [a]
Total Scoring attempts (n)	0.70 ± 1.23	1.44 ± 1.78 *	3.17 ± 2.79 ‡ [b]
Successful scoring attempts (n)	0.40 ± 0.77	0.96 ± 1.45*	2.29 ± 2.18 ‡ [b]
Unsuccessful scoring attempts (n)	0.31 ± 0.64	0.45 ± 0.61	0.89 ± 0.99 †

Values are mean ± SD; *p≤0.05 vs. 15 vs 15; †p≤0.01 vs. 15 vs 15; ‡p≤0.001 vs.15 vs 15
[a]p≤0.05 vs. 11 vs 11; [b]p≤0.01 vs. 11 vs 11;

Team Possession Characteristics

The team play possession characteristics during each game format are summarized in table 5.10. The were no significant difference in the total number of team possessions between any of the three game formats. The time per team possession and the number of skills per team possession was significantly higher during both MG formats than the 15-a-side games. The number of players per team possession during the 11-a-side was significantly higher ($p<0.05$) than both the 15-a-side games and 11-a-side games ($p<0.001$).

Table 5.10: Team play characteristic during each game format

	Games		
Variable	**15 vs 15**	**11 vs 11**	**7 vs 7**
Team possessions (n)	22.25 ± 2.50	23.33 ± 2.58	25.50 ± 3.27
Players per possession (n)	3.94 ± 1.82	4.67 ± 1.98 *	3.86 ± 1.31 [c]
Time per possession (sec)	16.63 ± 9.48	24.55 ± 15.40 ‡	21.35 ± 12.50 †
Skills per possession (n)	10.79 ± 9.80	16.17 ± 10.58 ‡	14.66 ± 9.68 ‡

Values are mean ± SD; *p≤0.05 vs. 15 vs 15; †p≤0.01 vs. 15 vs 15; ‡p≤0.001 vs.15 vs 15
[c]p≤0.001 vs. 11 vs 11

Discussion

Training based MG`s are commonly used in the belief that they replicate or exceed the activity patterns and physiological responses encountered during 15-a-side games. In addition, there is a consensus that the perceptual-cognitive skills and technical skills performed in MG`s in training should ideally transfer to 15-a-side competitive games. Although a number of studies have examined the effect of MG`s on activity profiles, physiological responses, individual skills performed and possession characteristics in invasion team-based field-sports, the majority arbitrarily selected the playing area and the number of players per team and failed to provide a rationale for the nature of the modifications to playing rules/conditions or to make comparisons with competitive match play. The primary objective of the present study was to compare selected MPD between 15-a-side competitive GF games and MG's involving reduced player numbers. The RPA and pitch shape used in the MG`s were based on the maximal playing size of a GF pitch. In addition, standard goal posts and uprights were placed on the end lines and all games were officiated by a qualified referee who adhered to the official rules of GF.

The average TD covered during the 15-a-side games is almost identical to that reported in the only previous study to examine activity profiles among adult club level GF players[23]. Almost three-quarters (74%) of 15-a-side championship match play involved low intensity activity involving walking and jogging with HIR and VHIR

accounting for 26% and 9%, respectively. Using the same speed zones, Gamble et al., (2019) reported similar findings among intercounty players during a preseason competition where 69% of activity was performed at low intensity, 31% at high intensity and 11% at very high intensity[18].

The MG's were 30 min in duration which is equivalent to one half of play during competitive 15-a-side GF games. On a pro-rata basis, the TD covered was similar between the 11-a-side and 15-a-side games. In contrast, the TD covered was 11% higher during the 7-a-side games than both the 11-a-side and 15-a-side games. Although TD provides information on the volume of activity undertaken during match play it does not take into account the intensity of effort. In contrast, RD measures the average distance travelled in metres per min and provides information on the average exercise intensity throughout a game. The average RD during the 15-a-side games was 7% lower than previously reported for club level GF players[23]. Despite a similar TD covered during the 11-a-side and 15-a-side games, the RD was 14% higher during the 11-a-side game. Interestingly, there was no difference in maximal speed running (>7.0 $m.sec^{-1}$) between the 15-a-side and the two MG formats.

Overall players spent less time in low intensity activity and more time in high and very high intensity activity during both MG's than the 15-a-side game. Importantly, these changes occurred while keeping the RPA and all other match play variables identical do to the 15-a-side game. Both TD and RD were approximately 10% greater during the 7-a-

side than the 11-a-side games. The-11-aside games resulted in significantly less low intensity running than the other 2 game formats while distances covered in the high intensity and very high intensity categories were significantly higher in both MG formats compared to the 15 a-side games. These findings indicate that when controlling for RPA and all other game variables both the 7-a-side and 11-a-side game formats replicate or exceed the MPD of 15 a-side games.

Similar to other invasion, field-based team sports, GF involves repeated bouts of short-duration, high and very high-intensity activity interspersed with low intensity activities such as standing and walking[36,65,66,67]. The number and duration of high and very high intensity activities are largely unpredictable, due to the fact that they are imposed by the pattern of play and can vary greatly from player to player, and from one game to another. There was an average of 48 bouts of high intensity activity and 18 bouts of very high intensity activity during the 15-a-side games. Importantly, many of the high and very high intensity activities undertaken by players during competitive match play tend to involve important aspects of individual and team play that are crucial to determining match outcome. Participation in the 11-a-side and 7-a-side games resulted in a 17% and 38% higher number of actions performed at high intensity respectively, and a 33% and 56% higher number of actions performed at very high intensity respectively, compared to the 15-a-side game. These findings indicate that the MG formats used in the present study are ideal for providing players with opportunities to perform a large number of high and very high intensity actions that are important for

determining match outcome. Furthermore, many club teams, particularly those from rural areas may have relatively small squad sizes that precludes them from playing 15 vs. 15 games in training. Playing MG's with reduced player number and with a similar RPA as 15-a-side games will adequately replicate the high and very high intensity activities involved during competitive match play.

Accelerations and decelerations are important locomotive movements that can contribute to enhanced performance outcomes in many game-related tasks that require rapid changes in velocity. Considering that accelerations and decelerations impose the greatest physiological and mechanical loading demands on players of any running metric [183], there frequency during 15-a-side games should therefore be replicated or exceeded during MG`s. There was no difference in any of the measured accelerations or decelerations between the 11-a-side and 15-a-side game indicating the 11-a-side MG format was effective in replicating these locomotive movements. In contrast, accelerations > 1.5 and 3.5 m/sec were 20% and 29% higher during the 7-a-side than 15-a-side game, respectively. Decelerations > 1.5 and 3.5 m/sec were 27% and 60% higher respectively, during the 7-a-side than 15-a-side game.

Coaches need to be aware of the deleterious effects on muscle function of having poorly conditioned club level players perform an excessive number of decelerations. Deceleration involves the rapid forcible lengthening of a contracting muscle in the presence of high force. Compared to concentric or isometric contractions, eccentric

muscle actions generate greater forces for a given angular velocity[184] require less motor unit activation and use different neural control strategies[185]. The combination of high levels of force production and reduced recruitment of fibre number during eccentric contractions causes a high mechanical stress on the involved structures that may lead to muscle damage and a decline in muscle function[186]. When using MG`s, particularly in pre-season or during intense periods of the competitive season, club level coaches should adopt an incremental loading strategy to mitigate the deleterious effects of excessive decelerations on muscle function. Decreasing the number of players in the MG`s while keeping the RSA and pitch shape constant is an effective approach to exposing players to the activity patterns experienced during 15-a-side competitive match play.

Team Play Interactions

Elite performers in team-based sports have a superior ability to rapidly process contextual information, make decisions and execute technical skills with and without possession of the ball. For example, skilled basketball players are superior to their less skilled counterparts at remembering and identifying information related to organized sequences of play that reflected real match-play scenarios[187]. Similarly highly skilled soccer players were found to have superior recall, recognition and anticipation ability than low skilled soccer players[188]. Research from the area of analogical problem solving found that skilled performers are able to recognise patterns of play based upon structural

relations and the higher-order predicates they convey (e.g. tactical and strategic significance of these relations between players), whereas less-skilled players depend almost exclusively on more superficial structural features[6,189].

MG's have been promoted as a way to provide greater opportunities to develop both perceptual-cognitive skills and technical skills under similar conditions to those encountered in 15-a-side games. There were on average 22 team possessions lasting 16.6 sec in duration15-a-side games as a benchmark. Each possession involved 4 players who performed 11 technical skills. On a pro-rata basis, the 22 team possessions in 30 min of play are very similar to the 41 team possession per 60 min game for both winning and losing teams reported in the only published study that has examined team play characteristics during senior club level GF games[24].

Although there was no difference between the mean number of team possessions across the 3 game formats, when expressed as a percentage of the total number of players on a team, each team possession involved a higher proportion of the players in the 11-a-side (42%) and 7-a-side (55%) compared to the 15-a-side games (26%). Furthermore, the number of individual skills performed during each team possession was 36% higher in the 7-a-side and 50% higher in the 11-a-side games than the 15-a-side games resulting in significantly longer time per possession in the MG's. Effective use of team possessions was previously found to be significantly different between winning and losing club level GF teams[24]. Each ball contact requires a player to contextually process

game related information and make one or more decisions prior to executing a skill. At an individual level, the players had 1.8 and 2.5 times more ball possessions during the 11 and 7-a-side games than the 15-a-side games. This equated to a ball possession every 1.6, 2.2 and 4.5 min of play during the 7,11 and 15-a-side games, respectively. The increased number of possessions offers players more opportunities to identify patterns of play, anticipate offensive and defensive movements and make decisions in game situations. In addition, it facilitates the development of cognitive-perceptual skills that are flexible and adaptive[6].

Although both MG formats were more effective than the 15-a-side games in providing opportunities for individual ball possessions, the number of individual ball possessions was significantly higher during the 7-a-side than the 11-a-side games. Furthermore, the number of catches (low and high) and scoring attempts was also significantly higher during the 7-a-side than the 11-a-side games. Considering the importance of catching and scoring in GF, coaches can use this information to design MG's that promote these important skills. Only one previous study has compared possession characteristics during MG involving reduced player numbers and 15-a-side match play[94]. There were no significant differences in any of the team possession characteristics between 7 and 15-a-side games involving U-14 male players and between 9 and 15 a-side games involving U-14 male players. The RPA was the same during the MG and the 15 a-side games.

Individual Technical Skills and The Development of Cognitive-Perceptual Skills

The continuous contextual processing of information in a game environment is important in determining when and how to perform a specific GF skill. For example, the type of foot pass executed may differ depending on the defensive shape of the opposition, the stature of the receiving player relative to the opposition player(s), the location of the receiving player on the field of play, whether the receiving player is moving towards or away from the kicker, the running speed of the receiving player, the position of the opposition player(s) relative to the kicker and receiver etc. For the most part, the drill based approach to skill/technique development involves little of no contextual processing thereby reducing the transfer of skills to the game environment[190]. A consistent finding in the present study was that compared to 15-a-side games, MG`s provides players with a greater opportunity to continually process contextual information prior to executing a skill.

No previous studies have compared technical skills between MG`s and full-sided games in other sports when the RSA and pitch shape were kept constant. A small number of studies involving soccer have compared differences between MG`s with varying player numbers while keeping RSA constant across the games but unrelated to the 11-a-side game. These studies found no difference in technical skills when manipulating tactical constraints[93], playing time and recovery periods[25,95,96]. In contrast, the findings of the

present study indicated that varying player numbers while keeping RSA identical to the 15-a-side game has a significant impact on the number of technical skills performed.

Foot passing is one of the fundamental technical skills of GF. It is the fastest method for transferring the ball over long distances (>20 m) and is now commonly used to counteract 'blanket' defences. Compared to 15-a-side games, the number of foot passes doubled during the 11-a-side games and increased 3.6 fold during the 7-a-side games. In addition, a higher percentage of players on a team had the opportunity to execute kick passes in a game environment. Indeed, the proportion of players who performed >1-foot pass per game (30 min of play) increased from 34% in the 15-a-side game to 65% and 86% in 11 and 7-a-side game, respectively. The ratio of hand to foot passes was similar between the 11-a-side game (2.5 hand passes to 1-foot pass) and 15-a-side game (2.7 hand passes to 1-foot pass). This then decreased in the 7-a-side game (1.5 hand passes to 1-foot pass) due to a larger number of foot passes in the 7-a-side than both the 11 and 15-a-side games. The increase in the number of foot passes during the 7-a-side games occurred despite no change in the playing rules or game conditions. This information can be used by coaches when developing foot passing skills.

When using MG's with a smaller number of players, coaches usually reduce the pitch size with little thought been given to either the design of the playing area or the RPA. Anecdotally, MG's in which the RPA is reduced and the pitch shape is changed from a rectangle to a square tend to promote hand passing while discouraging kick passing.

Kick passing is promoted during MG's when both RPA and the width to length ratio of the pitch are similar to 15-a-side games. Future studies should investigate how changes in pitch shape and RPA effects both individual and team possessions and the number of offensive and defensive skills performed.

The primary objective of GF is to outscore the opposition. Presently, the scoring efficiency from 21 attempts during club level GF games ranges from 46.5% (losing teams) to 59.6% (winning teams) with an average of 53%[24]. There was a total of 21 scoring attempts in the 15-a-side games with 57% of attempts resulting in a score. These findings are similar to a recently published study that assessed scoring opportunities during club level GF games[24]. The relatively low percentage scoring efficiency may be due in part to the fact that modern GF teams often withdraw some or all of their attacking players to create a defensive screen positioned approximately 45 m from their goal making it difficult for players to find space and time to execute a shot. Tactics involving mass-defences increase the importance of offensive players knowing when to attempt a shot and having the ability to select and execute the correct shot option. This requires game-based contextual processing and subsequent technical execution.

Both MG formats provided players with both a greater number of scoring opportunities and a higher percentage of successful scoring attempts than 15-a-side games. Compared to 15-a-side games, the mean number of scoring attempts doubled during the 11-a-side games and increased 4.5 fold during the 7-a-side games.

Furthermore, the percentage of successful scoring opportunities was 10% and 15% higher during the 11 and 7-a-side games, respectively compared to the 15-a-side games. In contrast to isolated shooting drills that require very little contextual processing and whose transfer to a game is questionable, MG`s provide players with a higher number of game-based scoring opportunities. Each scoring opportunity involves game-based contextual processing that informs both the timing of the shot and the shot selection. This approach may increase the likelihood of transfer to the 15-a-side game.

Until quite recently, forwards and midfield players were primarily responsible for most scoring attempts during match play. However, modern managers and coaches have discarded the traditional rigid team configuration and have adopted formations and tactics that encourages defensive players to contribute to the overall team score. In the present study 62% and 80% of outfield players had at least one scoring attempt during the 11 and 7-a-side games, respectively. Extended participation in sport-specific play offered through the use of MG's, provide players with the opportunity to experiment and innovate with different skills, strategies, and tactics and to improvise and react to game situations.

International level field hockey, netball, and basketball players accumulated a greater number of hours in sport-specific practice compared to experienced intermediate level athletes[138]. Similarly, high performing soccer players spent more hours in soccer-specific practice as well as non-coach-led play than low performing

players[191]. The only previous study to examine the effect of MG on possession characteristics and technical skills in GF involved U-14 players[94]. Similar to the present study, the number of individual touches and technical skills increased significantly during both 7-a-side and 9-a-side games compared to 15-a-side games. In both MG formats, the RPA was identical to the 15-a-side games.

Coaches need to be cognisant of the fact that significantly reducing the number of players during MG`s may however, alter the playing environment to such a degree that it may no longer replicate the demands of 15-a-side match play.

Heart Rate

The measurement of HR can be used to estimate the physiological responses during physical activity[78]. Despite the fact that current HR telemetry monitoring systems facilitate real time monitoring of players during field-based invasion team-based sports, there is little contemporary information on the HR responses during GF games at either club or county level of competition. There was no difference in the maximal HR achieved across the three game formats. The percentage of estimated maximal HR (220-age) achieved during 7, 11 and 15-a-side games was within 0% - 4% of the max HR achieved during the MG`s, full sided games or Bangsbo test. There was however, large inter individual variability in HR responses. The average HR of 166 bpm during the 15-a-side games was higher than the values (157-158 bpm) published more than 20 years ago in studies involving adult club level GF players in England[79]. The average relative HR was

similar to values recently reported for elite intercounty GF players[18] during a pre-season competition and elite youth players[1] . Approximately 75% of game time was spent at a HR between 81-100% HR max. To date, no published research papers involving either adult club or intercounty GF players have categorised HR data during match play into zones.

Despite the fact that the RD and the time spent in high intensity and VHIR zones was significantly higher during the 7 and 11-a-side games than the 15-a-side game, there was no difference in the average %HR max between the 3 game formats. Surprisingly, the average %HR max was significantly lower in the 11-a-side games than both the 7 and 15-a-side games. This was a surprising finding considering that it was hypothesised that the relative HR would increase significantly as the number of players per team decreased. In addition, it is difficult to reconcile the fact that players spent more time in zone 5 (90-100% HR max) during the 15-a-side games than the 7 and 11-a-side games given that players performed more efforts in the high and very high intensity zones during both MG formats.

During match play, HR is recorded on a receiver that is strapped to the chest. The physical nature of GF increases the likelihood that the strap and receiver may become dislodged during match play resulting in no HR recording. Almost one fifth (17%) of the HR data could not be used as it did not record properly due to HR belts slipping from the

chest area during the games. As a result of this missing data it could be assumed that not enough files were recorded to give an accurate breakdown by HR zone.

In addition to physical fitness levels, the HR response during exercise can be influenced by environmental factors and psychological stress[192,193,194,195]. Championship fixtures are the most important games played throughout the year. It is possible that the addition stress associated 15-a-side championship games may bring additional stress and pressure for players compared to the more relaxed MG`s.

Chapter VI

CHAPTER VI

STUDY 4

Physical and Physiological Predictors of Activity Profiles during Gaelic Football Match Play

Protocol Version

Version 1

Protocol Summary

Eight senior level adult club GF teams will be randomly selected to participate in four 15-a-side GF games and make two separate visits to the Human Performance Laboratory at DCU. During the four 15-a-side games participants will be fitted with a portable 10 Hz GPS unit prior to each game. During the first laboratory visit participants will have their height, weight and body composition assessed and undergo a treadmill exercise test to assess maximal aerobic capacity ($\dot{V}O_2max$). During the second visit, participants will perform a number of laboratory and field-based tests to assess lower limb power, 5 and 20 m running speed and muscle strength.

Surprisingly, there is currently no published data regarding the physical and physiological attributes that relate to the activity patterns during competitive 15-a-side GF match play. The purpose of this study is to identify the physical and physiological

factors that relate to TD, RD and VHIR of club level GF players during competitive match play.

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List of Abbreviations

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Introduction

There is a general belief that a GBA using MG`s is an ideal environment to develop the tactical, technical skills, activity patterns and decision making required for optimal performance in invasion team-based sports. From a biological perspective, MG's should closely replicate the highly variable energy demands during competitive 15-a-side match play along with the physiological responses required to meet these demands. Real-time measurements of bioenergetics and associated physiological responses among invasion team-based sports athletes during competitive match play is not possible or practical. In contrast, individual factors such as body composition, sprint speed, muscle strength, aerobic and anaerobic capacity, running economy and blood lactate levels can be objectively measured and subsequently used to indirectly estimate the contribution of various physical and physiological factors to activity patterns during competitive match play.

Among professional male soccer players, total body mass and muscle mass were found to be positively correlated with TD covered during match play[196] whereas TD, HIR and sprinting were inversely related to the sum of skinfolds[197]. The TD covered and HIR among professional male soccer players was found to be associated with a number of physiological and field-performance test measures including circulating levels of blood lactate[198,199], $\dot{V}O_2max$[200] and Yo-Yo Intermittent Level 1 scores[201]. A 6% improvement in $\dot{V}O_2max$ has been shown to increase the distance covered, the number of sprints, and

the number of actions with the ball during competitive games[202]. Furthermore, a high aerobic capacity facilitate recovery following short periods of high-intensity intermittent activity, which is characteristic of all field based team sports[203].

Surprisingly, there is currently no published data regarding the physical and physiological attributes that relate to the activity patterns during competitive 15-a-side GF match play. The purpose of this study is to identify the physical and physiological factors that relate to TD, RD and VHIR of club level GF players during competitive match play.

Study Aims

1. To examine the relation between the TD covered during competitive 15-a-side games and selected laboratory based and field-based physical and physiological tests
2. To examine the relation between the RD covered during competitive 15-a-side games and selected laboratory based and field-based physical and physiological tests
3. To examine the relation between the volume of VHIR performed during competitive 15-a-side games and selected laboratory based and field-based physical and physiological tests

Hypotheses

1. There will be a significant relation between the TD covered during competitive 15-a-side games and selected laboratory based and field-based physical and physiological tests
2. There will be a significant relation between the RD covered during competitive 15-a-side games and selected laboratory based and field-based physical and physiological tests
3. There will be a significant relation between the volume VHIR during competitive 15-a-side games and selected laboratory based and field-based physical and physiological tests

Overview of Study Design & Setting

Eight senior level adult club GF teams participating in their respective club championships will be invited to take part in the study. Each team will participate in four 15-a-side GF games and make two separate visits to the Human Performance Laboratory at DCU. The two laboratory visits will be scheduled prior to the participants taking part in the 15-a-side games and will be separated by at least 7 d. During the first laboratory visit, participants will have their height, weight and body composition assessed and undergo a treadmill exercise test to assess maximal aerobic capacity ($\dot{V}O_2max$). During the second visit, participants will perform a number of laboratory and field-based tests to assess lower limb power, 5 and 20 m running speed and muscle strength. On both visits to the laboratory, the test that produces the least amount of fatigue will be undertaken first with the most intensive test scheduled last. Participants will be asked not to take part in any strenuous exercise for 48 h prior to the laboratory visits. The participants will be instructed to continue their normal dietary but refrain from alcohol and caffeine for 24 h prior to each laboratory visit.

The 15-a-side games will involve official championship fixtures played between July and October. Participants will be fitted with a portable 10 Hz GPS unit prior to each game. The GPS units will be placed between the shoulder blades to limit any restriction of the player's movement. The GPS units will be turned on 30 min prior to the pre-match warm-up to allow acquisition of satellite signals in accordance with the manufacturer's

instructions. Players will wear the same GPS device for each match[47]. Normal team preparation including sleep and dietary practices will be followed along with a standardised warm up prior to each game.

Sample Size

At an alpha of 0.05 (beta 0.95), 34 players would be required to detect a statistically significant correlation coefficient of 0.5 between RD and $\dot{V}O_2$max.

Sampling Procedure

Each senior club in the province will be contacted and sent a letter outlining the study that is taking place. The clubs will be given a date to respond with an expression of interest in taking part in the study. Eight clubs will be randomly selected to take part in the study from those clubs that have expressed an interest.

Participants

A total of 40 outfield senior club level Gaelic football team players within the Connacht GAA region will be recruited to participate in the study. Eligible participants will be; ≥ 18 years of age and have played in a senior football championship fixture within the Connacht GAA region in the previous 24 months. They will have no current injury or any other serious medical condition that would preclude them from participating in the study. One player will be randomly selected from each line (FB, HB, MF, HF, FF) on each of the eight teams taking part in the study to give a total sample of 40 players.

Measured Variables

Anthropometrics

Participants will remove their shoes and their height will be measured to the nearest 0.1 cm using a portable scale (Seca 707 Balance Scales, GmbH, Hamburg, Germany). Weight will be measured to the nearest kilogram (kg) using calibrated Seca weighing scales (Seca Ltd., Hamburg, Germany). BMI will be calculated as body mass (kg) divided by squared body height in metres. Harpenden skin fold callipers (Baty International Ltd, West Sussex, UK) will be used to measure double thickness subcutaneous adipose tissue on the right side of the body. The following anatomical sites will be measured: triceps, pectoralis, subscapular, abdomen, midaxillary, suprailiac and thigh. A minimum of two measurements will be taken at each site. If the measurements vary by more than 2 mm a third measurement will be taken. Body density will be calculated using the Jackson and Pollock equation[204] and body fat will be determined using the Siri equation[205].

Vertical Jump

The vertical jump will be performed using an electronic jump mat (Jump Mat, FSL Electronics, Cookstown, Ireland). Participants will be instructed to jump as high as possible while using their arms to propel their body upwards and to land on the mat. Three trials will be performed with a 20 sec rest period between each trial. The best score will be recorded.

Countermovement Jump

The countermovement jump will be performed using an electronic jump mat (Jump Mat, FSL Electronics, Cookstown, Ireland). Participants will be instructed to jump as high as possible and to land on the mat while keeping their hands on their hips. Three trials will be performed with a 20 sec rest period between each trial. The best score will be recorded.

Margaria-Kalamen

The Margaria-Kalamen test will be used to calculate power output during stair climbing at maximal speed. Timing gates will be placed on the third and ninth steps. The starting position will stand on a line 6 m in front of the first step. On their own violation each participant will sprint to and up the flight of steps, taking three steps at a time (stepping on the 3rd, 6th and 9th steps), attempting to go up the steps as fast as possible. The timing commences when the foot lands on the third step and ends when the foot lands on the ninth step. A 5-10 min warm up involving a gradual progression from low to high intensity running and including dynamic stretching of the major muscle groups will be undertaken prior to the test. This will be followed by two familiarization practice runs. Each participant will perform 3 trials interspersed with a 2 min recovery period. Power will be calculated from the formula $P = (M \times D) \times 9.8/t$ where P = power (W), M = body mass (kg), D = vertical distance, between steps 3 and 9 (m), t = time (sec) and 9.8 is the constant of gravity.

Muscle Strength

A Biodex Multi-joint System-3 dynamometer (Biodex Medical Instruments, Shirley, NY) will be used to assess muscle strength (peak torque) of both the dominant and non-dominant leg. Isokinetic quadriceps and hamstring strength will be first determined at three different angular velocities ($60°\cdot sec^{-1}$, $180°\cdot sec^{-1}$ and $300°\cdot sec^{-1}$). Maximum volitional isometric contraction force will subsequently be determined for the quadriceps femoris muscle only. To permit graphical visualisation on the monitor during testing, the dynamometer data will be transferred to a second computer using Biodex Advantage Software (Version 3.30, Biodex Medical Systems, Shirley, NY).

Participants will undertake a 5 min submaximal warm-up at a self-regulated intensity against zero resistance on a stationary bike. The warm-up will be followed by a 3 min recovery period during which participants will complete a pre-planned dynamic stretching routine. There will be 10 min rest period between each test. Standardised verbal instruction will be provided throughout each test.

5 m and 20 m sprint

Wireless electronic timing gates (Fusion Sport International, Coopers Plains, Australia) will be used to measure 5 m and 20 m running speed. The timing gates will be placed at the starting line and at 5 and 20 m. Participants will be encouraged to run as fast as possible through the timing gates. Split times will be recorded at 5 m and 20 m. A

total of 3 trials will be performed with a 2 min rest period between each trial. The best time will be recorded.

Wingate test

The Wingate test will be performed on a Monark cycle ergometer. The ergometer will be calibrated prior to each test. Participants will undertake a 5 min sub-maximal warm-up at a self-selected cadence against 5W. The warm up will be followed by a 3 min recovery period during which time participants can dismount the cycle ergometer and stretch.

Participants will be instructed to remain seated throughout the test. During the first 5 sec of the test, they will cycle at 90 rpm against zero resistance. Following a 5 sec countdown, a resistance equal to 7.5% of each participant's body mass will be applied and they will pedal maximally for 10 sec. A total of 6 x 10 sec tests will be performed and the first five tests will be separated by a 50 sec stationary recovery period. Verbal encouragement will be given throughout the test to insure maximum physical effort. After completion of the test, participants will continue cycling for 2-3 min against zero resistance to aid recovery. Peak power (W), mean power (W) and the power drop (5) will be calculated.

Repeated sprint ability (RSA)

The RSA test will consist of 10 x 30 m sprints with a 180° turn at 15 m. Each test will be separated by 30 sec of passive recovery[206]. Each maximal effort sprint will be timed using electronic timing gates (Fusion Sport International, Coopers Plains, Australia). The RSA test will be preceded by a standard warm-up. The best 30 m sprint time and the total time required to complete the 10 sprints will be used to calculate a fatigue index[207]. A 5.0 µL capillary blood will be collected from a finger prick 5 min before and after completion of the RSA test and used to measure blood lactate concentration (Lactate Pro, Arkay, Inc, Kyoto, Japan).

Maximal Aerobic Capacity ($\dot{V}O_2$max)

An incremental treadmill protocol will be used to measure $\dot{V}O_2$max. Participants will warm-up at 8 km h^{-1} for 3 min at 1% gradient, after which the treadmill velocity will be increased by 1.0 km h^{-1} every 3 min. At the end of each 3-min stage, participants will straddle the moving treadmill and a 5.0 µL blood sample will be taken from the earlobe to determine whole blood lactate concentration. When blood lactate concentration reaches 4 mmol·L^{-1}, the treadmill velocity will be kept constant and the gradient increased by 1% every 60 s until the participant reaches volitional fatigue.

HR, ratings of perceived exertion (RPE), expired O_2, CO_2 and, ventilatory volume will be continuously recorded. HR will be measured using telemetry (Polar Vantage NV™ Polar, Port Washington, NY). RPE will be obtained using the Borg 16-point category scale.

Respiratory metabolic responses will be determined using standard open-circuit spirometry techniques (Sensormedics Vmax 229, SensorMedics Corp., CA). Prior to testing, the gas analysers will be calibrated with standard gases of known concentration. The criteria for attaining $\dot{V}O_2$max will be at least three of the following: plateaux in oxygen consumption despite increases in external work, RPE > 18, RER > 1.1 and heart rate > 95% of the age predicted max.

Blood Lactate Sampling and Measurement

Blood samples will be drawn from the earlobe. Prior to each sample, the ear lobe will be wiped with alcohol and allowed to dry thoroughly. The base of the ear lobe will be jabbed with a lancet (Accu-Check Softclix, UK) and the first drop of blood wiped away. Pressure will be placed on the ear lobe with the thumb and forefinger in order to provide an appropriate sample. The sample of whole blood will be automatically aspirated into a single use, enzyme-coated electrode test strip (Lactate Pro, Arkay, Inc, Kyoto, Japan). The reagent strips fill by capillary action directly from the earlobe site. Whole blood samples will be analysed using a hand-held portable analyser (Lactate Pro Akray, Japan). The measuring range is 0.8 - 23.0 mmol·L^{-1}.

Blood Lactate Interpretation

Lactate threshold will be determined subjectively from plots of the lactate concentration versus work rate, by visually identifying the treadmill velocity that best corresponds to a departure from a linear baseline pattern. Blood lactate markers at 2.0

mmol·L^{-1} and 4.0 mmol·L^{-1} will also be identified from the treadmill velocity vs. blood lactate plot.

Global Positioning System

As previously described in the methods section of Chapter 3 (Page 63).

Statistical Analysis

A principal component analysis (PCA) will be initially undertaken on the physical and physiological parameters. To ensure factors derived from the PCA are orthogonal, varimax rotation will be used and minimum eigenvalue for extracted factors will be set as 1. A one-way ANOVA will be undertaken on the extracted factors followed by regression analysis using a General Linear Model. Partial eta squared will be used to interpreted effect sizes. A value of ≥0.01 will be defined as small, >0.01-0.06 as medium and ≥0.14 as large. A p value of <0.05 will be considered significant. Data analyses will be performed using the Statistical Package for Social Science (SPSS) software version 24 IBM (IBM, Chicago, IL, USA).

Data management

Data collection will be done using paper and electronic formats. All data will be extracted from the relevant laboratory systems after the tests are completed and stored on Microsoft Excel (Microsoft, USA). The STATSports GPS data files will be exported to Microsoft Excel (Microsoft, USA). Data analyses will be performed using the Statistical Package for Social Science (SPSS) software version 24 IBM (IBM, Chicago, IL, USA).

Participant's identity, or other personal information, will not be revealed or published. Study participants will be assigned an ID number under which all personal information will be stored in a password-protected files on a secure server (Google Drive) maintained by DCU. The raw data and hard copies of the consent forms will be stored in

a locked cabinet in the School of Health and Human Performance. The named investigators will have access to the data . No other persons will have access to the raw data. Data will be kept for a minimum of five years from the date of publication of the research after which the data will be shredded by the principle investigator (PI). No personal data will be used for the purpose of publication of the results of the research. The PI`s will be responsible for security of the collected data.

Quality Control and Assurance

The PI's have extensive experience conducting research in both laboratory and field-based settings. The School of Health and Human Performance has a detailed standard operating procedures for each of the study protocols . All researchers will be familiar with the laboratory procedures and the safety statement prior to data collection.

Expected Outcomes

Based on the findings in study 3 it is expected that up to 75% of game time will involve low to moderate intensity activity that will rely primarily on the aerobic energy system to support the metabolic demands. Therefore, it is likely that both the TD and RD covered during match play will be positively related to $\dot{V}O_2max$. Among elite junior soccer players, TD covered was greater in players with a higher $\dot{V}O_2max$[131].

Although VHIR accounts for only 9% of the TD covered during 15-a-side competitive games, these bouts of high intensity activity can have a significant impact on

match outcome. Consequently, there is an expectation that measures of speed, (5 m and 20 m sprint speed) power (vertical jump, countermovement jump, Margaria-Kalamen, peak power and Wingate test) will be positively associated with VHIR.

Similar to other invasion team based sports, the capacity to perform repeated sprints is important for success in GF. The replenishment of muscle CP occurs via the breakdown of ATP generated using aerobic metabolism. Professional basketball players have a higher $\dot{V}O^2max$ than amateur players and perform repeated bouts of short duration, high intensity exercise bouts more often than their amateur counterparts[136]. Similarly, soccer players with higher $\dot{V}O_2max$ perform a greater number of sprints and cover a larger distance than players with a lower maximal aerobic capacity[131].

Players with a lower $\dot{V}O_2max$ and $\%\dot{V}O_2max$ at the lactate threshold and at the fixed blood lactate concentrations 2.0 mmol.L-1 and 4.0 mmol.L-1 are probably more likely to rely on anaerobic glycolysis during competitive match play which is likely to impair their ability to perform repeated high intensity bouts compared to better physically conditioned players. It is hypothesized that $\dot{V}O_2max$, $\%\dot{V}O_2max$ at the lactate threshold and at the fixed blood lactate concentrations 2.0 mmol.L-1 and 4.0 mmol.L-1 will explain a considerable amount of the variance in RD. Unsurprisingly, body fat percentage is expected to be inversely associated with TD, RD and VHIR while it is likely that peak isokinetic quadriceps and hamstring strength will be related to both VHIR and RD.

Ethical Considerations

Ethical approval will be sought through the Dublin City University Research Ethics Committee prior to the commencement of the study. A verbal explanation of the study along with an information sheet will be provided to all study participants. The nature and risks involved in the study will be explained prior to starting the study, and a contact number will be provided. Participants will have the opportunity to ask questions and will have time to consider their participation prior to signing a written consent form.

Participants may experience some muscle soreness in their legs or nausea following the sprint test, maximal exercise test and match play. Exercise testing carries with it a very small risk of abnormal heart rhythms, heart attack, or death in less than one in 30,000 patients. The pre-test likelihood of these risks in asymptomatic men < 55 years of age is very low. There may be discomfort when taking finger prick blood test.

The School of Health and Human Performance has the facilities to deal with all aspects of this study and an emergency plan is in place for adverse events. All minor injuries will be addressed by an individual trained in first aid (either a member of the research team or the staff). The laboratory is equipped with an emergency crash cart and defibrillator. An individual trained in first aid (or Advanced Cardiac Life Support) will be present during each test. In the unlikely event of a serious adverse outcome, the subject will be brought to a local hospital.

Reporting and Dissemination

Weekly meetings will take place between members of the research team. These meetings will provide opportunities to access progress, provide feedback, and monitor the development of the research project. Meeting notes and any agreed actions will be distributed among the members of the research team. Follow-up face-to-face meetings will also be organised as needed to facilitate effective communication.

The study findings will be presented at scientific meetings and published in peer-reviewed journals. The study participants will be provided with a copy of their individual results and the overall findings of the study. It is anticipated the study findings will be published in appropriate peer review journals. Authorship guidelines will be agreed prior to the commencement of the study.

Limitations

A limitation of the study is the fact that many aspects of the full-sided competitive games cannot be controlled and may impact the outcome, such as environmental factors, team tactics, score line, and the number and influence of replacements in a given game.

Chapter VII

CHAPTER VII

STUDY 5

Coaching Practices Among Adult Club Level Gaelic Football Coaches

Rationale

In recent years the majority of intercounty managers/coaches have discarded the traditional rigid team formation and have adopted formations and tactics that enable a more dynamic approach to both defence and offence. For example, it is now common practice for teams to withdraw all or some of the midfield and forward players to establish a defensive zone 45 m from their own goal line and from which counterattacks can be instigated. Indeed, a recent study, found that defensive counterattacking differentiated winners from losers with an accuracy of 87.5%[84].

Many of the tactical strategies employed by intercounty GF teams are now being adopted at club level. In contrast, many elements of coaching practice at club level remain largely guided by tradition and emulation. In the traditional approach, the session starts with TF activities before finishing with a 15-a-side game or involving all players if less than 30 players are present. The focus of the traditional approach on developing skills in a non-pressurised environment coupled with lack of opportunity for contextual processing and decision making is likely inadequate preparation for the MPD of the modern game. In contrast, PF activities are heavily linked to a GBA. This approach

promotes the development of perceptual-cognitive and technical skills underpinning superior performance during competitive match play[87].

No published studies exist on coaching practices among club level GF coaches, although they account for more than 95% of all GAA coaches. A recently published study reported that intercounty GF coaches spent more time on TF activities in preseason and more time on PF activities during the competitive season[22]. In both the preseason and competitive season, coaches sequenced TF activities in the first half of sessions followed by PF activities. The purpose of this study was to examine current coaching practices among adult club level GF coaches.

Study Aims

1. To examine the proportion of estimated training time allocated to both PF and TF activities in the preparation of adult club level GF teams
2. To examine the sequencing of both PF and TF activities undertaken during training sessions in the preparation of adult club level GF teams
3. To investigate the rationale for the use of SSG, MSG and LSG during training sessions in the preparation of adult club level GF teams

Hypotheses

1. There will be no significant differences in the proportion of training time allocated to both PF and TF activities in the preparation of adult club level GF teams

2. There will be no significant differences in the sequencing of both PF and TF activities undertaken during training sessions in the preparation of adult club level GF teams
3. There will be no significant differences in the reasons coaches use SSG, MSG and LSG during training sessions in the preparation of adult club level GF teams

Methods

Participants

A total of 344 club level GF coaches (U-12 to senior level) with a least one year coaching at adult club level participated in the study. Coaches who have taken an official GAA coach education course within the previous ten years were eligible to participate. Table 6.1 summarizes the characteristics of the coaches.

Survey Development

The survey was adopted from the work of Kinnerk et al., (2020)[21] and was administered via an on-line platform, Survey Monkey. The topics and questions included in the questionnaire were developed in collaboration with three academic coaches with an average of 30 years coaching experience at club, intercollegiate and intercounty level. An original version of the questionnaire was completed by 12 GF coaches with a range of coaching experience. Feedback from each coach was obtained via a phone interview. A number of changes were made to the original questionnaire based on the feedback. These included i) using more basic terminology, ii) removal of some questions, iii) change from a Likert to a ranking scale for some of the questions and iv) reduce the amount of text by including a video to explain the GAA OTú coaching model. The final version of the survey is in Appendix B.

Survey Content

The survey was divided into 5 sections. (Full survey can be seen in Appendix B)

Section 1 - demographic information (6 questions)

Section 2 - prior coach education (1 question)

Section 3 - current coaching activity (6 questions)

Section 4 - approach to coaching in pre and competitive season (6 questions)

Section 5 - general understanding of games and their implementation (15 questions)

Procedure of Survey Distribution

Each of the four GAA provincial councils maintain a database containing the contact details of individuals who have completed ≥ 1 coach education course. Each provincial coaching officer emailed the questionnaire to all coaches who had completed a coach education course within the previous 10 years.

Statistical Analysis

Frequencies and percentages were used to describe the demographics and coaching experience of the coaches. A Kruskal-Wallis test was used to compare demographics, coaching experience and the percentage of time spent on TF and PF activities between coaches from the 4 provinces to ensure that no under coverage bias existed within the cohort of coaches who participated.

The Chi Square test of association was used to determine if a statistically significant difference existed in the distribution of estimated time spent by coaches on PF and TF activities in preseason and competitive season. The Chi Square test of association was used to determine if there was a significant association between the game size and the coach's primary reason for using the different game sizes. A z-test for comparing proportions was used to test for differences in the primary reason a coach selected SSG, MSG and LSG across the different game sizes.

Analysis could not be performed on the sequencing of the training activities because the assumption of independence of observation within the data that is necessary for the relevant statistical tests was not met. Data analyses were performed using the Statistical Package for Social Science (SPSS) software version 27 IBM (IBM, Chicago, IL, USA).

Results

Participant Characteristics

Although 56% of the coaches were from Connacht, There were no significant differences in their demographics and coaching experience compared to coaches from the other 3 provinces. Table 6.1 summarizes the characteristics of the entire cohort of survey respondents. The majority of the 344 coaches (55%) indicated that they were coaching between 1-5 years and 75% were in the 35-54-year age bracket. Only one of the coaches was female.

Table 6.1. Survey participant characteristics

Variable	No of Coaches
Gender	
Male	343
Female	1
Age range	
Under 18	2 (0.6%)
18-24	7 (2%)
25-34	41 (12%)
35-44	156(45%)
45-54	106 (31%)
55-64	30 (9%)
65+	2 (0.6)
Province	
Connacht	192 (56%)
Munster	48 (14%)
Ulster	44 (13%
Leinster	58 (17%)
Overseas	2 (0.6%)
Number of years' experience coaching adult teams	
1-5	189 (55%)
6-10	94 (27%)
11-15	32 (9%)
16-20	15 (4%)
21+	14 (4%)

Coaches Estimated Time Spent on TF and PF Activities

Statistically significant differences were noted for a small number of variables when comparing Connacht to the other three provinces. The percentage of time coaches from Connacht spent on conditioning was significantly higher in preseason compared to coaches from Leinster. During the competitive season the percentage of time spent on drills was significantly higher in Connacht compared to coaches from

Leinster and Ulster. However, these differences were, determined not to contribute to bias within the sample.

TF Activities - Combined

The percentage of session time devoted to TF activities during preseason and competitive season training sessions is illustrated in Figure 6.1. Significantly fewer coaches ($p<0.05$) used TF activities for 1% - 10%, 11% - 20% and 21% - 30% of the total session time during preseason compared to the competitive season. Significantly more coaches ($p<0.05$) used TF activities for 51% - 60%, 61% - 70%, 71% - 80%, 81% - 90% and 91% - 100% of the total session time in preseason compared to the competitive season.

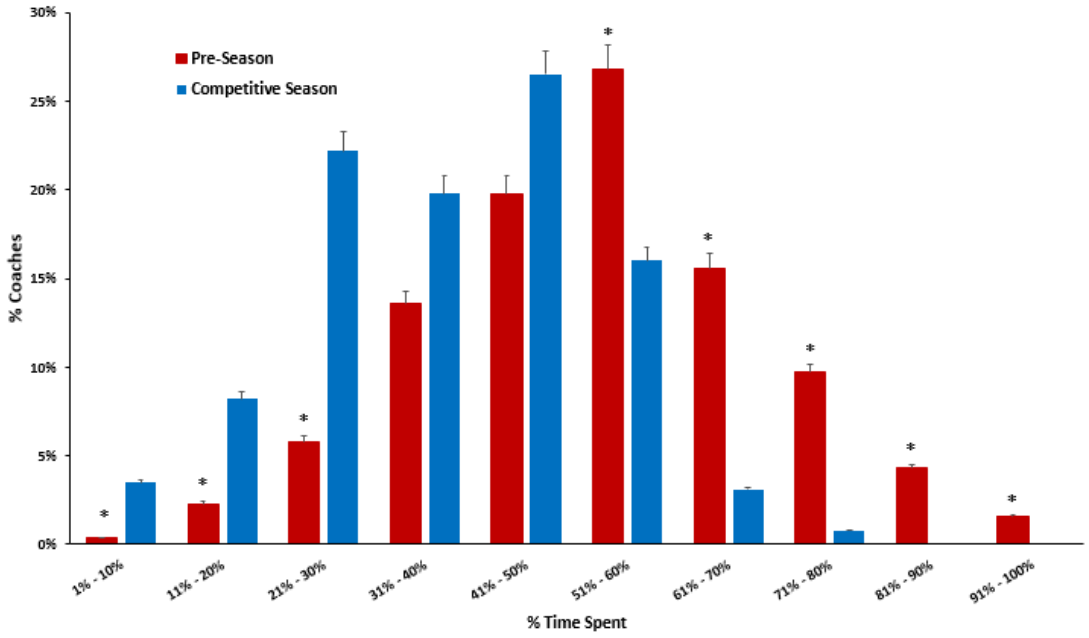

Figure 6.1: Percentage time spent on TF activities in preseason compared to competitive season training sessions. *p≤0.05 vs. competitive season

TF Activity - Conditioning

The percentage of session time devoted to conditioning during preseason and competitive season training sessions is illustrated in Figure 6.2. A significantly greater number of coaches ($p<0.05$) focused on conditioning for 11% - 20%, 21% - 30%, 31% - 40%, 41% - 50% and 51% - 60% of the total session time during preseason compared to the competitive season. Significantly less coaches ($p<0.05$) indicated spending 0% and 1% - 10% of the total session time on conditioning during preseason compared to the competitive season. No coach indicated that their conditioning accounted for >60% of the total session time during the preseason or competitive season.

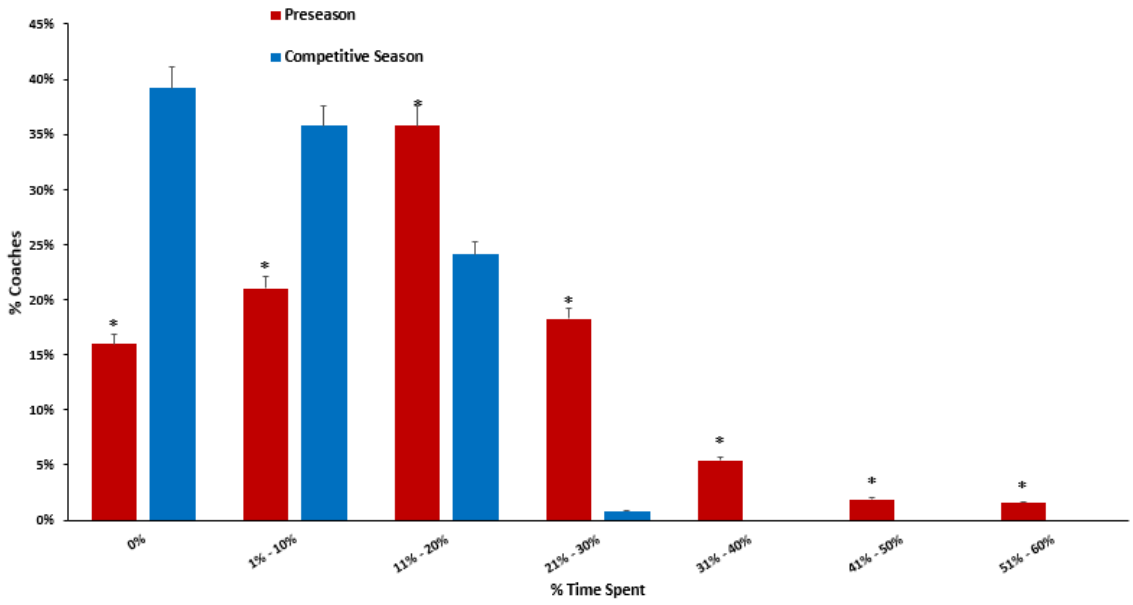

Figure 6.2: Percentage time spent on conditioning in preseason compared to competitive season training sessions. *p≤0.05 vs. competitive season

TF Activity - Drills

The percentage of session time devoted to drills during the preseason and competitive season training sessions is illustrated in Figure 6.3. Significantly more coaches ($p<0.05$) focused on drills for 11% - 20% and 21% - 30% of the total session time in preseason compared to the competitive season. Compared to the competitive season, significantly fewer coaches ($p<0.05$) used drills for 0% of the total session time during preseason. No coach indicated that their drills accounted for >60% of the total session time during the preseason or competitive season.

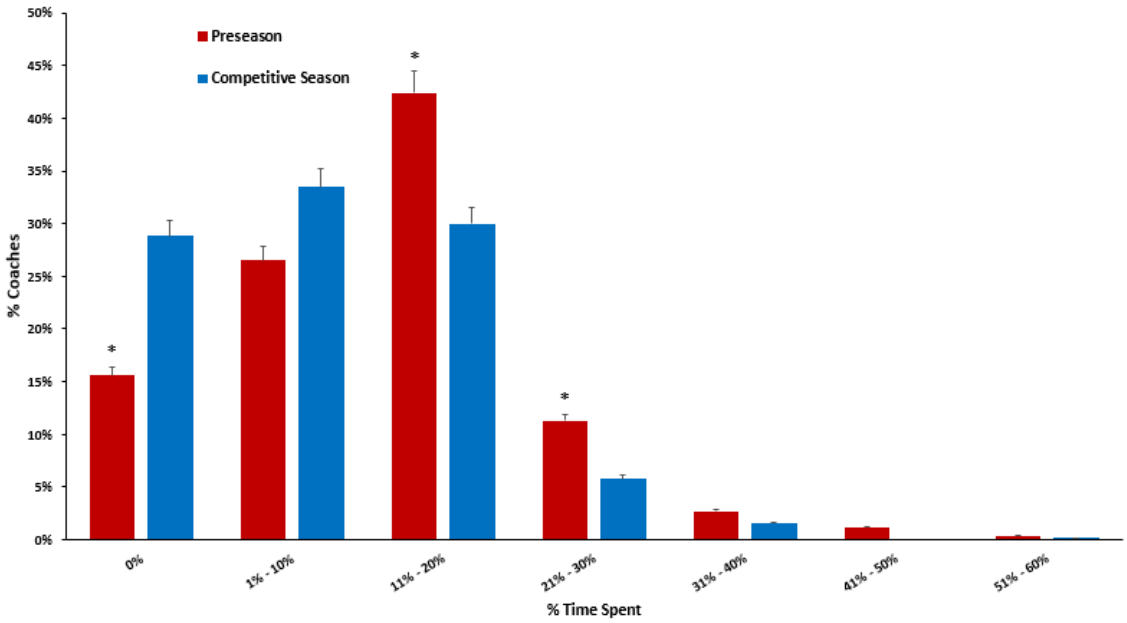

Figure 6.3: Percentage time spent on drills in preseason compared to competitive season training sessions. *p≤0.05 vs. competitive season

TF Activity – Skills in Isolation

The percentage of session time devoted to skills in isolation during the preseason and competitive season training sessions is illustrated in Figure 6.4. No coach indicated that skills in isolation accounted for >30% of the total session time during the preseason or competitive season.

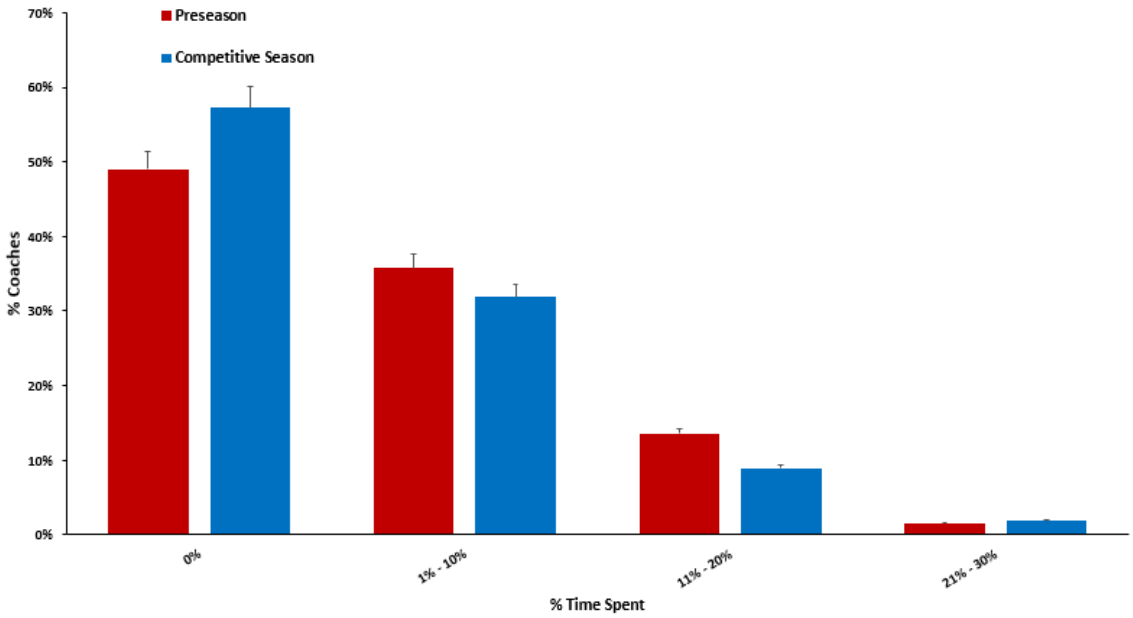

Figure 6.4: Percentage time spent on skills in isolation in preseason compared to competitive season training sessions. *p≤0.05 vs. competitive season

PF Activities - Combined

The percentage of session time devoted to PF activities during preseason and competitive season training sessions is illustrated in Figure 6.5. Significantly more coaches ($p<0.05$) focused on PF activities for 1% - 10%, 11% - 20%, 21% - 30% and 31% - 40% of the total session time in preseason compared to the competitive season. Compared to the competitive season, significantly fewer coaches ($p<0.05$) used PF activities for 61% - 70%, 71% - 80% and 81% - 90% of the total session time during preseason. No coach used PF activities > 90% of the total session time during preseason or competitive season.

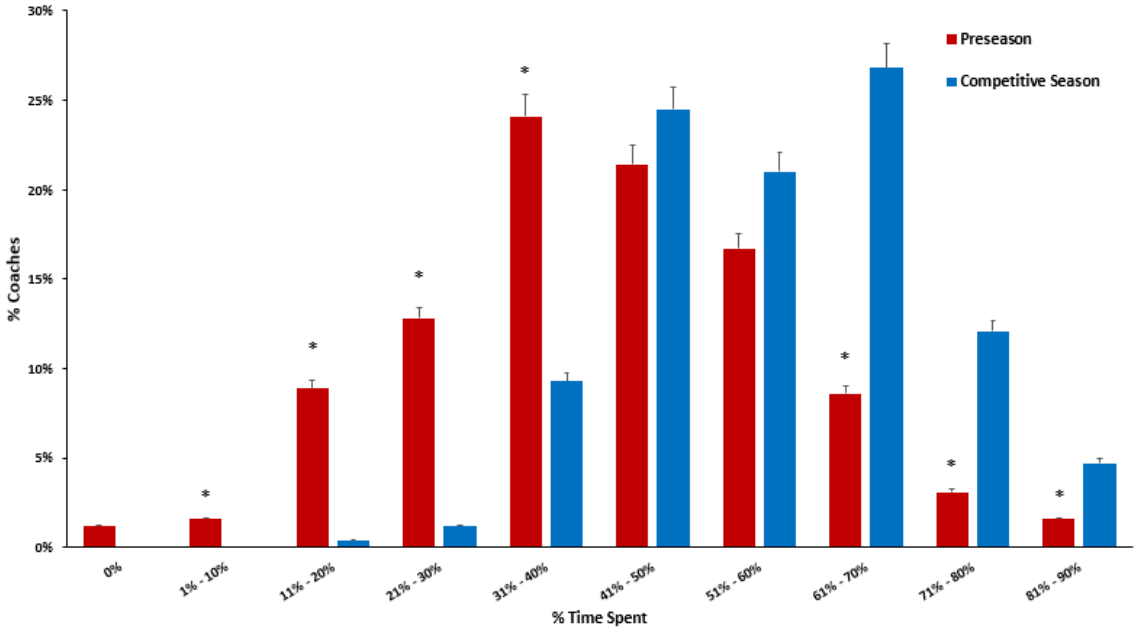

Figure 6.5: Percentage time spent on PF activities in preseason compared to competitive season training sessions. *p≤0.05 vs. competitive season

PF Activity - Applied Skills Practice

The percentage of session time devoted to applied skills practice during the preseason and competitive season training sessions is illustrated in Figure 6.6. Significantly more coaches ($p<0.05$) indicated spending 0% of the total session time on applied skills practice in preseason compared to the competitive season. No coach indicated that applied skills practice accounted for >50% of the total session time during the preseason or competitive season.

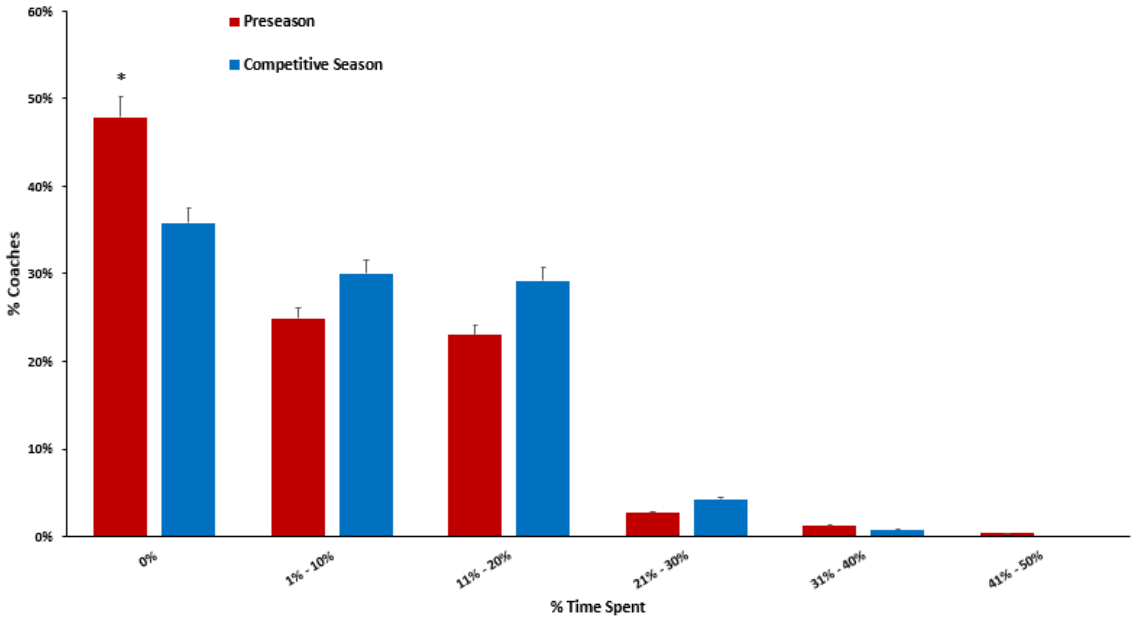

Figure 6.6: Percentage time spent on applied skills practice in preseason compared to competitive season training sessions. *p≤0.05 vs. competitive season

PF Activity - SSG

The percentage of session time devoted to SSG during the preseason and competitive season training sessions is illustrated in Figure 6.7. Significantly more coaches ($p<0.05$) focused on SSG for 31% - 40% of the total session time in preseason compared to the competitive season. Compared to the competitive season significantly fewer coaches (<0.05) indicated using SSG 0% of the total session time during preseason. No coach indicated that SSG accounted for >70% of the total session time during the preseason or competitive season.

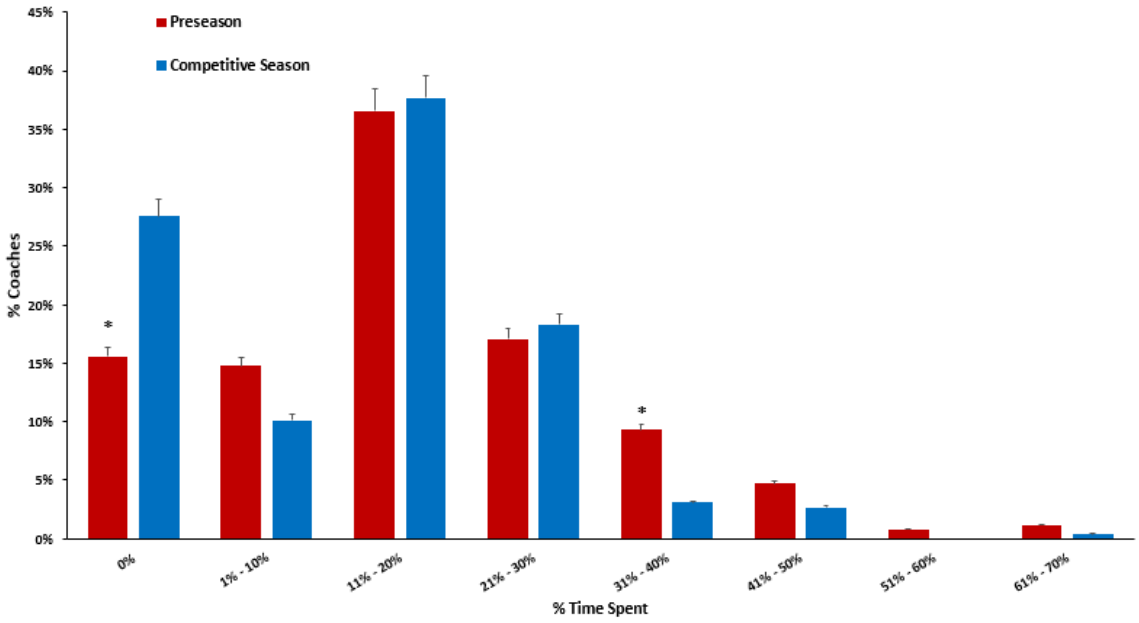

Figure 6.7: Percentage time spent on SSG in preseason compared to competitive season training sessions. *p≤0.05 vs. competitive season

PF Activity - MSG

The percentage of session time devoted to MSG during the preseason and competitive season training sessions is illustrated in Figure 6.8. Significantly more coaches ($p<0.05$) used MSG for 1% - 10% of the total session time in preseason compared to the competitive season. Significantly less coaches ($p<0.05$) indicated using MSG for 21% - 30% and 41% - 50% of the total session time during preseason than the competitive season. No coach indicated that MSG accounted for > 60% of the total session time during the preseason or competitive season.

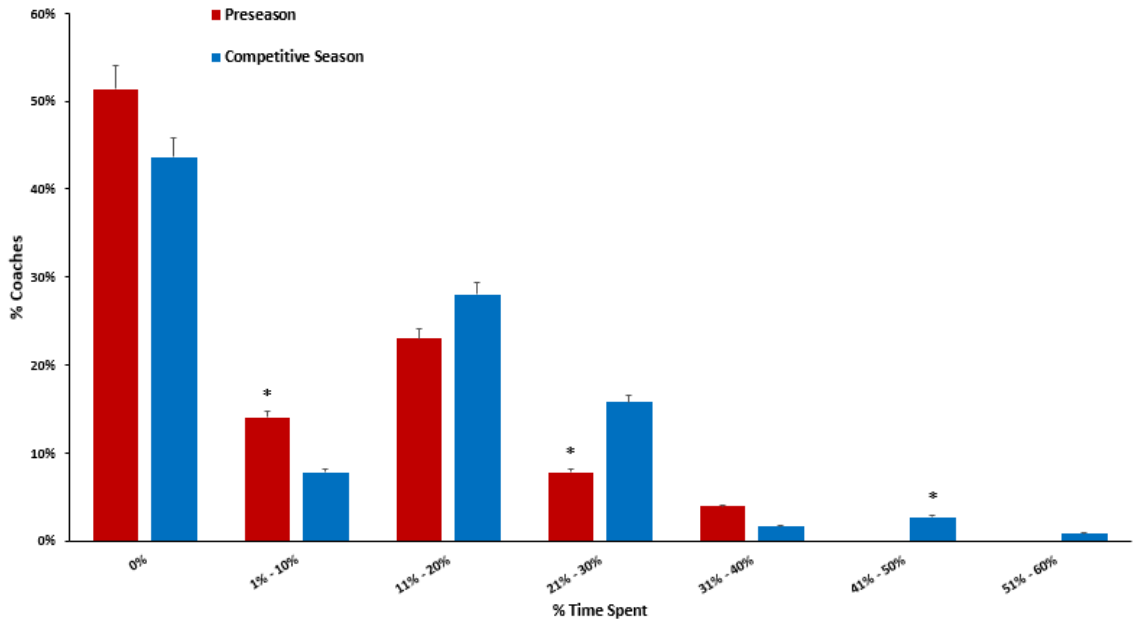

Figure 6.8: Percentage time spent on MSG in preseason compared to competitive season training sessions. *p≤0.05 vs. competitive season

PF Activity - LSG

The percentage of session time devoted to LSG during the preseason and competitive season training sessions is illustrated in Figure 6.9. Significantly more coaches ($p<0.05$) indicated spending 0% of the total session time on LSG in preseason compared to the competitive season. Significantly less coaches ($p<0.05$) used LSG for 11% - 20%, 21% - 30% and 41% - 50% of the total session time during preseason compared to the competitive season. No coach used LSG for 61% - 70% and 91% - 100% of the total session time during preseason or competitive season.

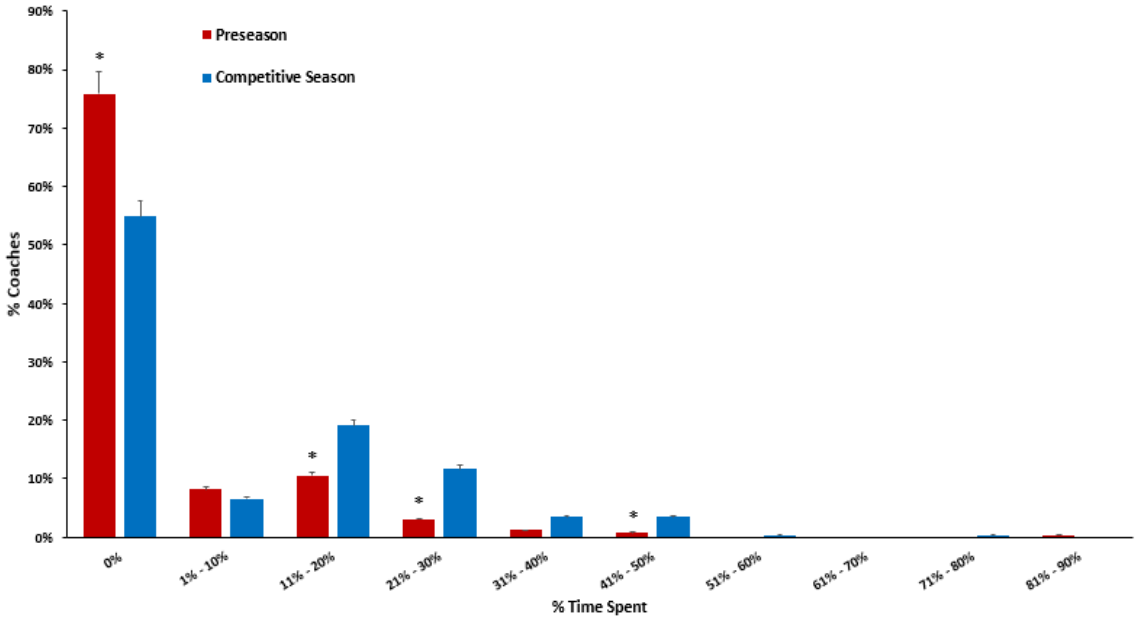

Figure 6.9: Percentage time spent on LSG in preseason compared to competitive season training sessions. *p≤0.05 vs. competitive season

PF Activity - FSG

The percentage of session time devoted to FSG during the preseason and competitive season training sessions is illustrated in Figure 6.10. Significantly more coaches ($p<0.05$) selected FSG for 0% of the total session time in preseason than the competitive season. Compared to the competitive season significantly fewer coaches ($p<0.05$) indicated using FSG for 11% - 20%, 21% - 30%, 31% - 40% and 41% - 50% of the total session time during preseason. No coach used FSG for 91% - 100% of the total session time during preseason or competitive season.

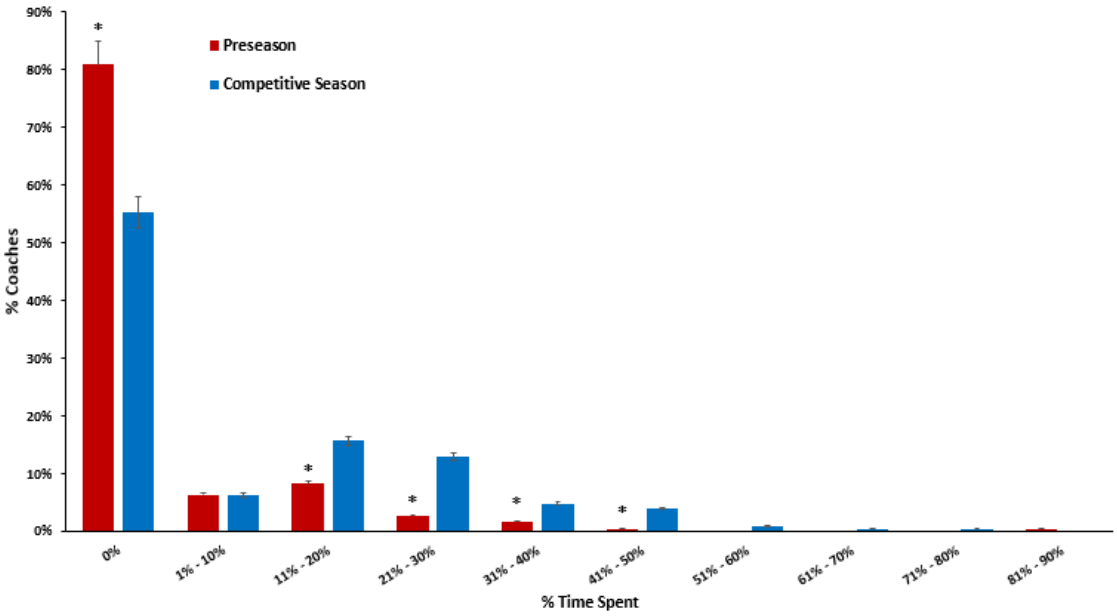

Figure 6.10: Percentage time spent on FSG in preseason than the competitive season training sessions. *p≤0.05 vs. competitive season

Sequencing of Session Activities

The sequencing of PF and TF activities in training sessions during the preseason and the competitive season are summarized in Figure 6.11 and Figure 6.12. Coaches used TF activities as the first activity more often than PF activities during both the preseason and competitive season. More PF than TF activities were used for the third and fourth activities during training sessions in both the preseason and competitive season.

The sequencing of specific PF activities for both preseason and competitive season training sessions are summarized in Figure 6.13 and Figure 6.14. In general, coaches indicated a preference for SSG as the second and third activities during both the preseason and competitive season. MSG were used primarily for the first and second activities during preseason and for the third and fourth activities during the competitive season. Coaches indicated using LSG/FSG primarily as the third and fourth activities during both the preseason and competitive season.

The sequencing of specific TF activities for both preseason and competitive season training sessions are summarized in Figure 6.15 and Figure 6.16. Coaches had a preference for drills and conditioning as the first activity during both the preseason and competitive season. A higher percentage of coaches performed skills in isolation during the first, second and third activities in competitive season compared to preseason.

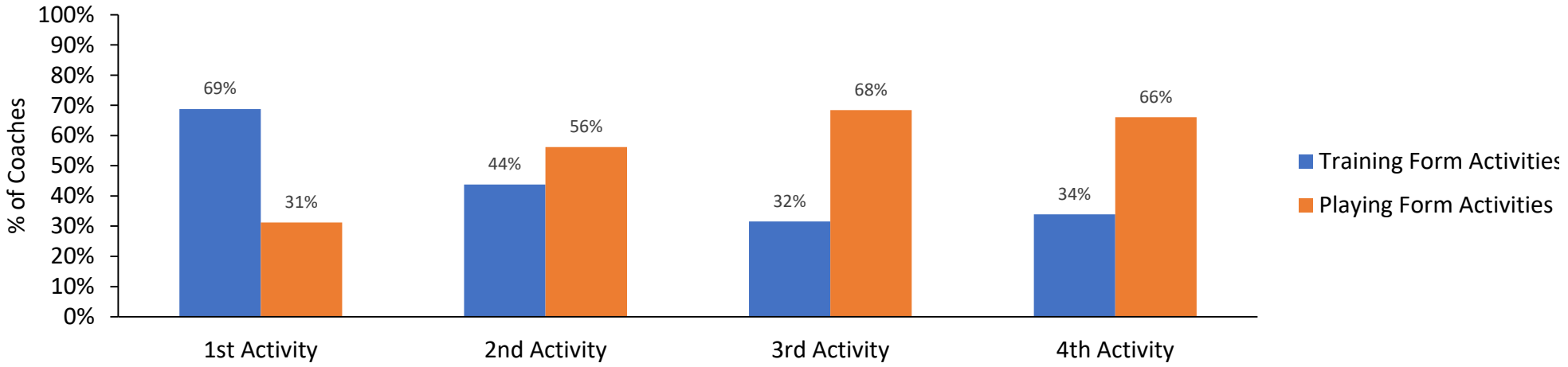

Figure 6.11: Sequencing of post warm up TF and PF activities during the preseason

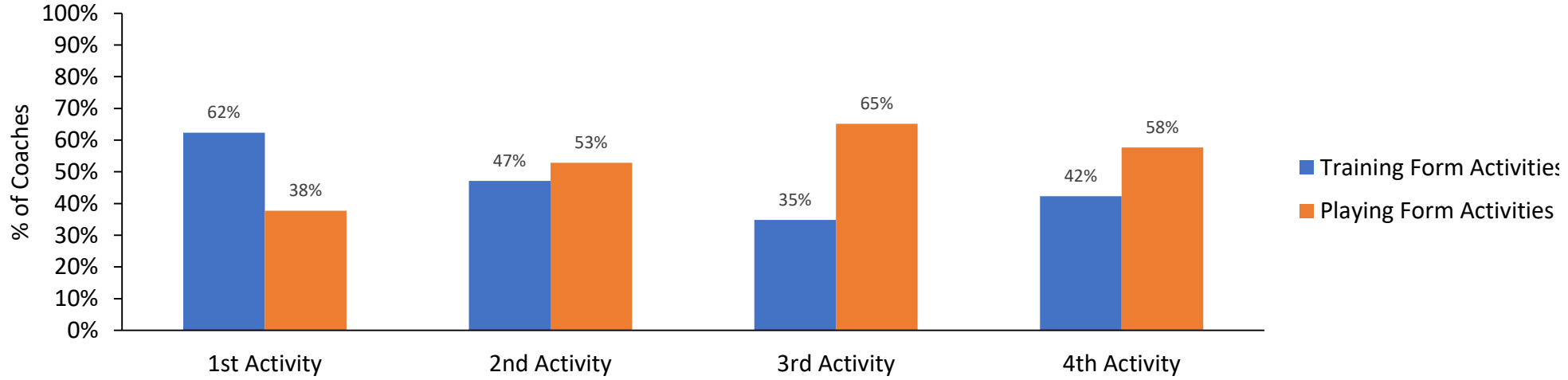

Figure 6.12: Sequencing of post warm up TF and PF activities during the competitive season

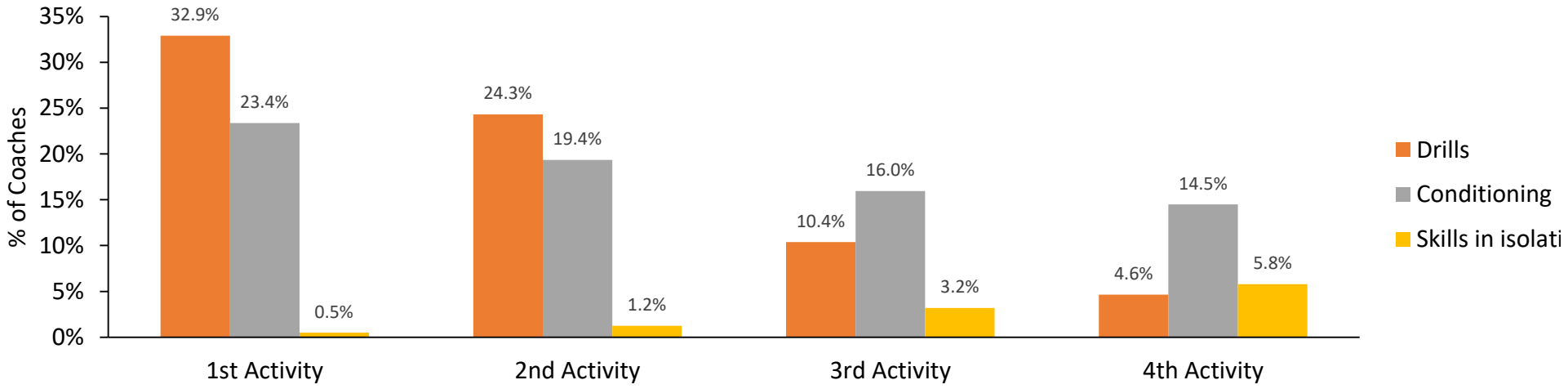

Figure 6.13: Sequencing of post warm up TF activities during the preseason

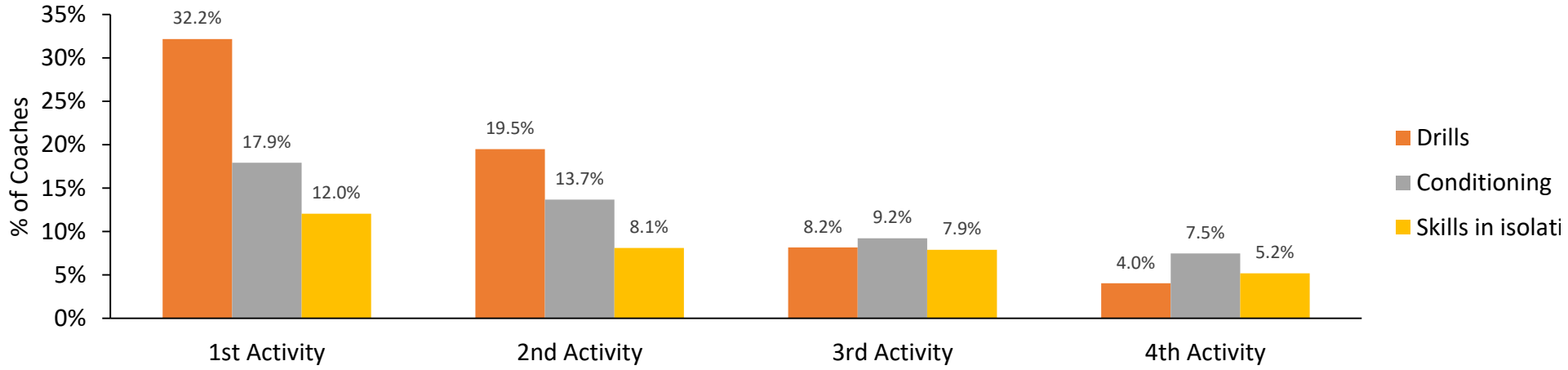

Figure 6.14: Sequencing of TF activities for competitive season

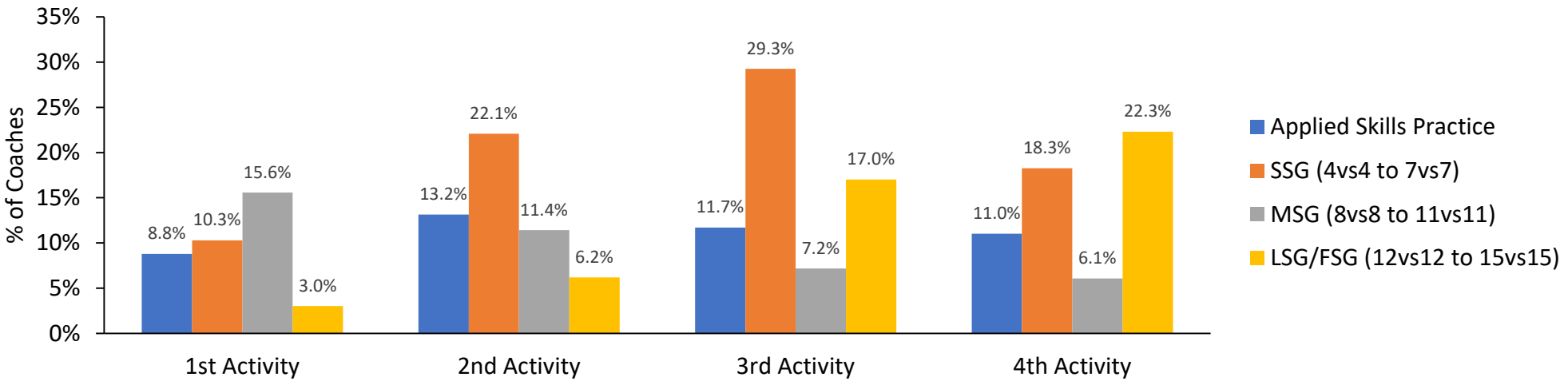

Figure 6.15: Sequencing of post warm up PF activities during the preseason

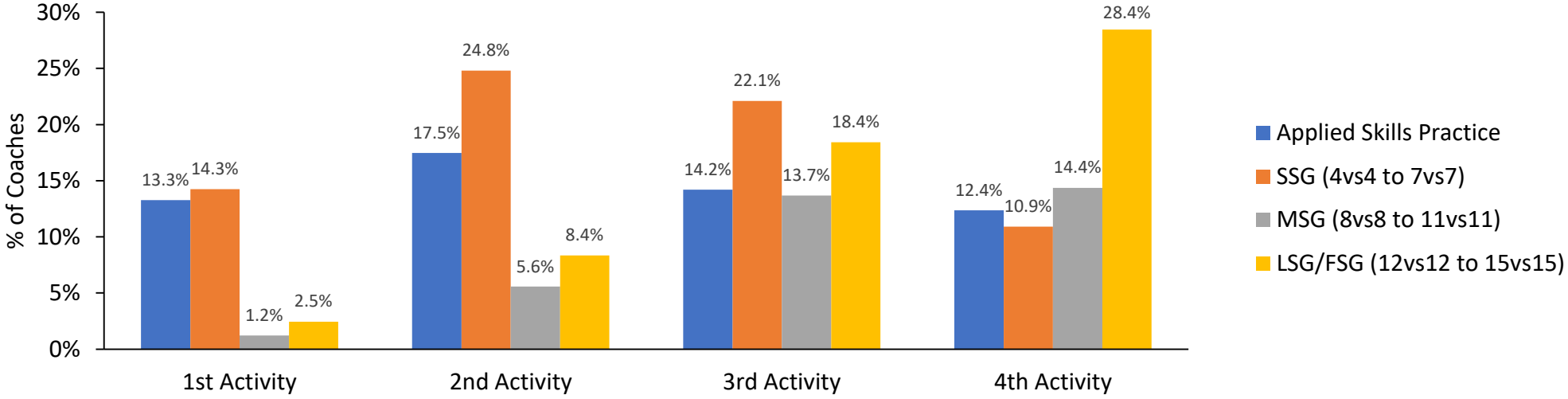

Figure 6.16: Sequencing of post warm up PF activities during the competitive season

Primary Reason Why Coaches Use Small, Medium and Large Size Games

The primary reasons identified by coaches for using SSG, MSG and LSG are summarised in Figure 6.17. There were no significant differences in the percentage of coaches who ranked participant feedback and psychological focus as the primary reasons for incorporating small, medium and large size games during training. The percentage of coaches that selected team play and tactical prowess as the primary reason was significantly higher ($p<0.05$) in LSG than in MSG and SSG. The percentage of coaches that selected team play and tactical prowess as their primary reason for using a specific game size was significantly higher ($p<0.05$) in MSG than in SSG. The percentage of coaches that selected technical proficiency as their primary reason for using a game was significantly lower ($p<0.05$) in LSG than in MSG and SSG. The percentage of coaches that selected physical fitness as their primary reason for using a specific game size was significantly lower ($p<0.05$) in LSG and significantly higher ($p<0.05$) in SSG compared to MSG.

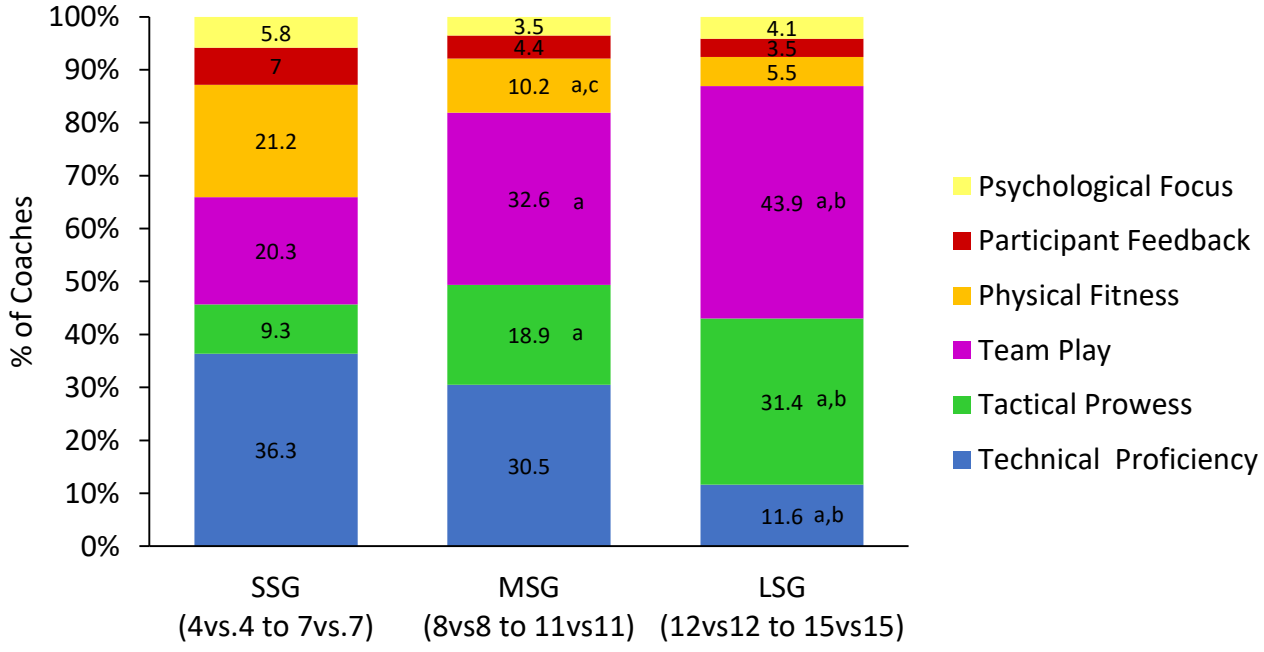

Figure 6.17: Top ranking reason why coaches use small, medium and large size games. Values are %; between game = [a]$p<0.05$ vs. SSG; [b]$p<0.05$ vs. MSG; [c]$p<0.05$ vs. LSG;

Discussion

To date, no previous studies have assessed the coaching practices of club level GF coaches. Prior to 2008, the GAA`s Coaching and Games Development Committee recommended a DTG approach to coaching. TF activities for the purpose of developing technical skills were for the most part developed in isolation. In contrast, the current GBA to coaching focuses on creating an environment where technical skills, physical fitness and team play are developed through TF activities such as MG`s. This approach is also believed to provide opportunities to develop perceptual-cognitive skills such as anticipation and decision-making which are important to overall performance and match outcomes in GF[6]. The results from study 3 indicate that the activity profiles along with the number of individual technical skills performed are significantly greater during MG's than 15-a-side GF games. In contrast, there is very little difference in the team play characteristics and HR responses between MG's and 15-a-side games.

This is the first study to assess coaching practices among club level GF coaches in relation to intra session duration and sequencing of TF and PF activities during both the pre-season and the competitive season. TF activities that include primarily athletic development activities and performing skills in isolation, were found to predominate during pre-season with PF activities being utilized to a greater extent during the competitive season. The focus on TF activities during preseason is likely due to the traditional belief of many coaches that physical fitness and technical skills could not ideally

be developed using game-based activities[140]. The activity profiles particularly the RD and both HIR and VHIR along with the number of technical skills performed during the 7-a-side and 11-a-side games indicate that MG's replicate the physical demands and technical skills performed during competitive match play while simultaneously developing game related perceptual-cognitive skills and technical proficiency. Considering that club level GF players only train collectively two to three times per week it would seem to be more prudent to devote a larger proportion of a training session on PF activities than TF activities.

Regardless of the phase of the season, GF coaches indicated a preference for using TF activities during the early part of training sessions followed by PF activities. Presuming that TF activities are preceded by a warm-up it is likely that a sizable portion of a training session lapses prior to players having the opportunity to develop their perceptual-cognitive skills in a meaningful way. Surprisingly, coaching practices at club level are very similar to the recently reported findings among intercounty coaches[21]. In response to a survey, intercounty GF coaches indicated an approximate 60:40 split in the time allotted to TF and PF activities, respectively in pre-season with the ratio reversed during the competitive season[21]. Similar to club level coaches, a high proportion of intercounty coaches sequenced TF activities during the first half of training sessions before progressing to PF activities. Similar findings have been reported for youth soccer coaches[141], professional youth soccer coaches[142] and youth cricket coaches[143].

Chapter VIII

Discussion

A GBA refers to a broad conceptualization of a number of iterations of games-based pedagogies characterized by a shift from a coach centred and skills-based approach to a player-centred approach aimed at developing game appreciation, tactical awareness, decision-making and technical execution in the context of games[208]. The GAA currently recommends a GBA for coaches at all levels. MG`s are adjusted formats of play involving the manipulation of one or more constraints (conditions) while maintaining the fundamental dynamics and specificities of the sport and are commonly used to facilitate a GBA to coaching. The use of MG's has been shown to promote positive changes in tactical behaviours[209], technical execution[210] and physiological and physical demands[211] among players while also increasing opportunities for the development of perceptual-cognitive skills under situations comparable to those found during competitive match play[212].

Although a relatively large number of studies have evaluated the activity patterns, technical skills, possession characteristics and physiological demands during MG's involving several invasion team-based field sports, the lack of uniformity with regards to study design makes it very difficult to compare findings or to apply the findings to competitive MPD`s. For example, surprisingly, few previous studies involving team-based field sports have taken account of the competitive match-play derived RPA or the length to width ratio of the playing area when designing MG's. An arbitrarily selected RPA and

length to width ratio may result in the provision of a playing space that fails to replicate the tactical demands of the official match.

The primary objective of the current PhD thesis was to assess the coaching practice of senior club GF coaches and to compare selected MPD's between 15-a-side competitive GF games and MG's involving reduced player numbers. The number of players per team was relativized to the 15-a-side game, i.e., match derived (Owen et al., 2014) and categorized as medium (11-a-side) and small (7-a-side). A minimum of 7 players facilitated the deployment of a goalkeeper and a player in each of the 5 outfield playing lines - full back, half back, midfield, half forward and full forward. Furthermore, the length to width ratio was maintained in both MG's, standard goal posts and uprights were used, normal GF rules were applied and all games were officiated by a qualified referee.

Study 1 and study 2 evaluated the variability in MPD between i) four 15-a-side competitive senior club GF games, ii) three 7-a-side and iii) three 11-a-side MG`s. The number of hand passes and pickups was the only measured MPD that was different between the three 15-a-side games whereas the time spend in high-speed running zone were the only measured MPD that differed between the three 11-a-side games. There were small differences in some of the activity patterns (time spent in the running zone, distance in high intensity zone, percentage of time in low and high intensity) and one technical skill between the three 7-a-side games. All other measured MPD were similar between the three 7-a-side games. Overall, these findings indicate that the measured

MPD's (activity patterns, technical skills, possession characteristics and physiological demands) are very consistent across the 15-a-side competitive senior club GF games and the MG's used in the present study. The average values across the four 15-a-side competitive senior club GF games and the three 7-a-side and three 11-a-side MG`s were therefore compared in study 3.

Both medium (11-a-side) and small (7-a-side) size MG's replicated or exceeded many of the MPD associated with 15-a-side competitive senior club GF games. The fact that the percentage of total game time that the ball was in play was significantly higher in both MG's compared to the 15-a-side games afforded more players with a greater number of opportunities to be directly involved in match activities. This is exemplified by the 1.8- and 2.5-fold higher number of individual ball possessions during MG's compared to 15-a-side games. Each individual ball possession requires some degree of contextual processing involving identifying and acquiring environmental information that is subsequently integrated with existing knowledge to select and execute an appropriate response[213]. With very few exceptions, the average number of technical skills performed during the MG's was significantly greater compared to the 15-a-side game. In effect, the MG formats provided a greater number of opportunities for developing technical skills under similar conditions to those encountered in competitive games. Although the number of team possessions was similar between the MG's and the 15 a-side games, the percentage of team players involved, the average possession duration and the number of skills performed per possession was also greater during the MG's.

Prior to 2019, no published study had evaluated the activity profile of club level GF players during competitive games using GPS. One of the primary aims of this PhD was to examine the volume and intensity of activity performed by club level GF players during four championship games. The fact that there was no difference in any of the measured activities (total distance, relative distance and distance in each speed zone, percentage time in each speed zone, the number of actions, the distance covered and the percentage of playing time in low, high and very high intensity zones or the number of accelerations and decelerations) between the four 15-a-side games provided evidence for a high level of consistency between games. In one respect this finding is perhaps not surprising considering that the data was collected on players from a single team over the four games. Most GF teams develop a system of play that is consistent from game to game while also allowing for small variations in the tactical approach, depending on the opposition. In recent years, most club level GF teams have adopted a tactical approach that is based on defensive counterattacking. It is likely that the opposition adopted a similar approach in each of the four games and that this may help to explain the similar activity profiles in each game.

The average TD and the relative distance covered during the 15-a-side games was similar to that reported in a recently published study that evaluated the activity profiles among adult club level GF players[24]. Most of the 15-a-side game time involved low intensity activity involving walking and jogging with the remaining time being spent in HIR and VHIR. In addition to TD and RD, activity data derived from GPS technology includes

the distance covered in a number velocity-based movement categories that vary in intensity and are associated with verbal descriptors such as low, moderate and high-speed running. Little or no empirical evidence is provided regarding the validity of the velocity-based movement thresholds used in studies involving GF. Using a two-stage unsupervised clustering technique, Brady et al., (2021) recently generated six unique movement categories and their respective velocity thresholds for elite Gaelic football and hurling referees[214]. The newly generated velocity thresholds had a stronger relation with the raw velocity data and resulted in a significantly greater volume of high speed and very high-speed running distances for GF and hurling referees compared to the generic thresholds. Notwithstanding the limitations of using velocity thresholds that are not validated for club level GF players, MG's with reduced player number and using match derived RPA are effective in replicating or exceeding the activity profile during 15-a-side games. In general, the MG' s involved a greater volume of higher intensity exercise bouts than 15-a-side games and the volume of some high intensity activities was greater during 7-a-side games than 15-a-side games.

The ability to optimally perform game related activities in an unpredictable manner for the entire game is dependent on the complex interactions between several physiological and metabolic processes. Athletic development coaches spend considerable time designing and implementing training programs that overload the appropriate physiological and metabolic systems required for optimal performance. However, with a few exceptions, it is not practically possible to continuously monitor physiological and

metabolic processes during GF games. An alternative approach is to use selected laboratory-based measurements to indirectly estimate the contribution of various physiological systems and metabolic process to activity patterns during competitive match play. Study IV was designed to identify the physical and physiological factors that relate to TD, RD and VHIR of club level GF players during competitive match play. It was not possible to collect the data due to restrictions imposed following the outbreak of Covid19 in March 2020. It was hypothesized that there will be a significant correlation between $\dot{V}O_2$max and both TD and RD covered during competitive club level GF games. In addition, it was hypothesised that in addition $\dot{V}O_2$max, the number of high and very high intensity bouts will be also related to measurements of anaerobic power and capacity and strength.

Study V provides important information regarding coaching practices, particularly as it relates to the timing and sequencing of activities within individual training sessions and across the season and the type of MG's commonly used in training. Surprisingly, the current practices among senior club GF coaches align with intercounty GF coaches [21] where the proportion of training time currently devoted to TF and PF activities is largely dependent on the phase of the competitive calendar and the period of the training session. The preference for using TF activities during the early part of training sessions and prior to the competitive season is probably based on the misguided belief that PF activities are not suitable for developing the technical and physical attributes required for optimal performance during the competitive season. The results from study III indicate the MG's can replicate or even exceed the number of technical skills performed and the activity

demands of 15-a-side competitive GF games. A recent meta-analysis reported that small-sided games were effective for enhancing technical execution among young and youth team sports players. Randomized controlled trials are needed to determine whether the MG's are as effective in developing perceptual cognitive abilities, enhancing technical execution and improving physical fitness as the traditional approach.

Study Limitations

1. Participants were recruited from only two counties and may not reflect senior club level GF players nationally.

2. The surface area in the four, 15-a-side championship games could not be controlled as venues were selected by the GAA`s competition authorities

3. External commitments of participants in the 48 h prior to each game were not monitored

4. Coaching practices were self-reported and maybe therefore open to bias

Practical Applications

MG`s are commonly used to prepare GF teams but to date there have been limitations to how they have been applied in relation to the FG. The majority of studies to date have fail to take into account RPA, size and shape of the FG when designing MG`s. This is the first study to provide a structured framework to evaluate the effect of modifying playing conditions (constraints) during MG`s on MPD. This information can now be used by GF coaches to better design MG`s to adequately prepare players for MPD of the 15-a-side game.

This study provides a framework for researchers and practitioners involved in invasion field based sports to objectively assess the effect of manipulating/altering other constraints on MPD.

Since 2008 the GAA`s National Coaching and Games Development Committee have recommended that coaches at all levels use GBA. However, this is the first study to have evaluated coaching practices of adult club level Gaelic football players. While acknowledging the work undertaken by the GAA over the past 20 years in relation to coach education, the findings from this study would indicate that coaching programmes need to be better aligned to a GBA approach. Coach education should focus on practitioners understanding how to best use PF and TF activities in the preparation of teams.

Future Directions

- The findings from this PhD indicate that MG`s replicate and, in some instances exceed MPD of competitive games. Future studies investigating the effect of altering constraints during MG's on tactical behaviours, technical execution, perceptual-cognitive skills along with physiological and physical demands a should take account of the dimensions of the playing area and how the playing area is related to the 15-a-side game.
- There is emerging evidence to support the use of a GBA in the preparation of teams involved in field-based team sports but the current practice of GAA coaches is

mainly aligned to a DTG approach. More research is needed to evaluate the putative benefits of a GBA approach on MPD during 15-aside games.

- Identify the barriers among club level GF coaches to implementing a GBA and provide an appropriate coach education programme to facilitate the delivery of a GBA.
- Evaluate the effectiveness of adopting a GBA to performance and match outcome in 15-a-side games.
- Appraise the efficiency of a GBA on MPD and competitive outcome at junior, intermediate and senior adult levels in GF to see are results comparable.
- Considering that many of the fundamental tactical and technical skills of GF are developed at underage level it is imperative that players at younger age grades are exposed to a GBA. There is therefore a need to evaluate the current practices of youth level GF coaches.

Conclusion

There was relatively little inter game variability within 7, 11 and 15 a-side games. MG`s were able to replicate and surpass activity profiles when compared to 15-a-side competitive match play while HR responses were matched. MG`s offer more opportunity for technical skills to be performed and developed than during 15-a-side match play. The 7-a-side games provided almost three times the mean number of individual player possessions compared to 15-a-side games. A similar number of team play opportunities are offered to players competing in 7, 11 and 15 a-side games while the time per team possession and the number of skills per possession was significantly greater in the MG.

The investigation of coaching practices undertaken with adult club level GF teams indicated that coaches used TF activities more in preseason and PF activities more in competitive season. With regards the sequencing of training activities regardless of the phase of the season, TF activities were used more in the early portion of training sessions and PF activities towards the end of training sessions.

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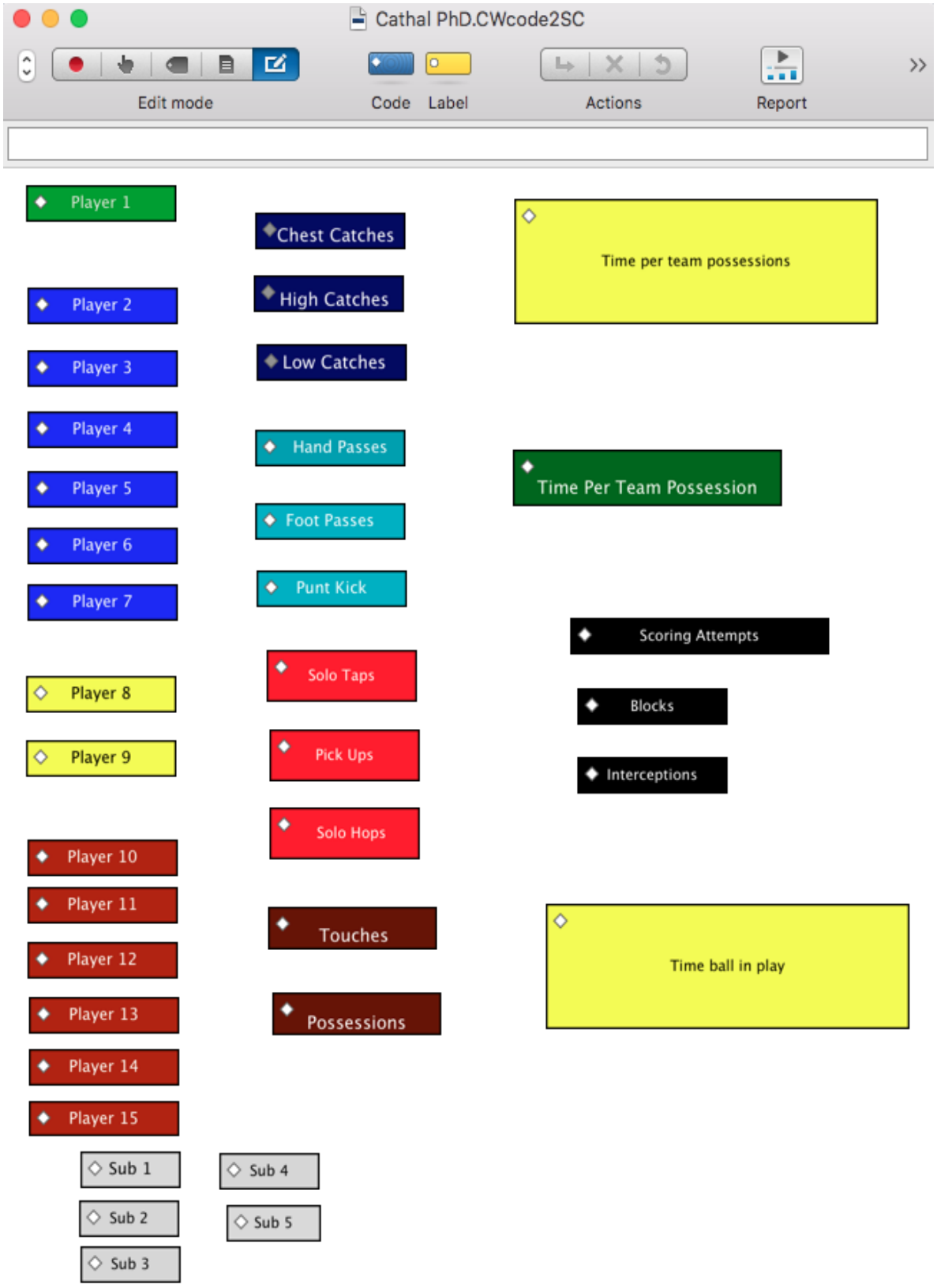
APPENDIX A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Hand Passes
Foot Passes
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Touches
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Scoring Attempts
Blocks
Interceptions
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APPENDIX B

Standard Protocol Items for Observational Studies (SPIROS)

Table 1: Checklist of preliminary items

Section and topic	Description / sub-categories	Addressed on page number
i) General Information		
Title	Descriptive title identifying study design	page 1
Protocol version	Version or amendment number and date and summary of changes	Text headers
Protocol summary	Brief summary of protocol research	page 2
Sponsor and partner institute name	Name of sponsor and participating institutes (if applicable)	pages 6 and 19
Investigators name	Name of principal and co investigators.	page 6
Affiliation of investigators	Affiliated institutions of investigators	page 19
Principal researcher contact detail	Name, email address, affiliation of Principal researcher for correspondence.	page 1
Table of content	Table of content	Figure 1 and Table 1
Page number	Page number on each page of protocol	Pages 4-17
List of Abbreviations	A detailed List of all abbreviations used in protocol with full form.	NA
ii) Introduction		

Background of study	Scientific background of study	Pages 4-5
Review of prior research	Summary of all previous relevant research	Pages 4-5
Rationale of study	Justification for conducting the study	Page 5
Aim	Broader aims and specific objectives of the study	Pages 5-6
Objective of study	Primary and secondary objectives of study	Pages 5-6
Prespecified hypothesis	Prespecified null or alternative hypothesis	NA

iii) Methods		
Study design	Description of type/design of study	Page 6
Study setting	Description of setting, locations, relevant dates, including periods of recruitment/survey, exposure, follow-up, and data collection. Schedule of study procedure – Figure or table	Pages 6-14 Figure 1 or table 1
Sample size	Estimated number, calculation and assumptions Power calculation	Pages 14-15 Pages 14-15

Sampling procedure	Description of sampling strategy to ensure representativeness and control of potential bias	Pages 9-10
Participants	**Cohort study**—eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up. For matched studies, give matching criteria and number of exposed and unexposed **Case-control study**—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls For matched studies, give matching criteria and the number of controls per case	Pages 7 and 9-10 NA

	Cross-sectional study—Give the eligibility criteria, and the sources and methods of selection of participants	
Variables	• All outcomes • Exposures- definition of exposure of interest, • Predictors • Potential confounders • Effect modifiers	Pages 12-14

Data Sources/ Measurement	• For each variable of interest, give sources of data and details of methods of assessment (measurement). • Describe comparability of assessment methods if there is more than one group • Data collection points table • Blinding procedure	Pages 9-14 NA Table1 NA
Bias	Describe any efforts to address potential sources of bias More specifically- • Information bias • Selection Bias • Control for confounding	Pages 9-10 and 16
Statistical analysis plan	• Method of primary / secondary outcomes and additional analysis • Handling of missing data • Post-hoc analysis	Page 15 NA NA

Handling of withdrawals and lost to follow up	Describe the procedures to be followed when a participant ceases participation in the study prematurely or is lost to follow up	Pages 7 and 9
Replacements	Provide information on whether or not participants who discontinue the study will be replaced via additional recruitment to maintain the required sample size.	NA
Outcome	Define and describe all primary and secondary outcome or lost to follow up	Page 14
Database management	• Detail plan of database management including: • Data collection (electronic or paper based), • Source data • Data entry • Data editing • Coding • Data storage • Record retention • Data confidentiality	 Pages 9-10 Pages 9-10 Pages 9-10 Pages 9-10 Pages 9-10 Pages 9-10 Pages 9-10 Pages 9-10
Validation of instrument	Reliability / validity of instrument or plan to establish validation	Pages 6 and 9-10
Follow up	Plan of follow up and addressing lost to follow up	Page 9

Quality control	• Method of quality control • Monitoring (internal and external) • Training of surveyors	Pages 9-10 Pages 9-10 Page 6
Quality assurance	Plan of quality assurance	Pages 9-10
Expected outcome /results	A brief description of expected outcome or results	NA

iv) Ethical consideration		
Ethical approval	Weather it has been obtained and name of ethical committees. If approval not sought , Reason	Pages 6 and 16
Agreement and consent	Method of taking consent. Reason if consent not sought	Page 8
Risk / Harm to participants	Any potential risk or harm to study participants	NA
Adverse event and Severe adverse event reporting	Outline how Adverse Event and Severe adverse event information will be collected.	NA

v) Reporting and dissemination		
Protocol amendments	Methods of communicating to investigators/IRBs and documenting	Pages 9-10
Dissemination	How results will be disseminated to participants, practitioners, public	Pages 16-17
Publication Plan	Who has right to publish; restrictions; authorship guidelines Open Access	Pages 9-10 and 17 Page 20
Reporting of early stopping	Dissemination of results if trial is stopped early (for any reason)	NA
vi) Others		
Limitations	Limitations of proposed study, including risk of bias	Page 16
Strength of study	Highlight strengths of proposed study	Pages 3 and 15-16
References	List of references cited in protocol	Pages 17-19
Data collection forms	Summary table of all forms used for data collection at each point of study	Table 1
Informed consent forms	Sample of informed consent form, translated into local language	supplementary file 4
Funding	Source of funding and the role of the funders for the present study	Page 20

Acknowledgement for protocol development	Acknowledgement of persons involved in protocol preparation	Page 19
Data sharing policy	To describe how data will be made available in public domain.	Page 20
Contributions of authors to protocol	Listed authors should have participated sufficiently in preparation of protocol with details of their contribution.	Page 19
Trial registry	For observational studies also registered as trial	Page 3
Annexures	Data collection form /instruments Informed consent form Standard operating procedures (SOPs) Detailed Statistical analysis plan (SAP)	supplementary file 3 supplementary file 4 Figure 1 and supplementary file 2 Page 15

APPENDIX C

GAA Club Coaches current familiarity and usage of small, medium and large sided games

Study information

Thank you for agreeing to explore the coaching approaches in club men's & ladies Football, Hurling and Camogie at youth and adult level. We are looking to hear from club coaches currently coaching between U12 and Senior grades. The study will also examine coaches' knowledge and use of small, medium and large games. Completion of this survey should take approximately 30 minutes. There are 35 questions to be completed which range from ticking a box to ranking questions on coaching approaches in Gaelic Games. Please answer all questions, reflect appropriately on each question and provide your honest answer.

Results of this study will be used to inform and improve coaching development in Gaelic Games. Such detailed information on coaching at club level is currently not available and your honest response will greatly facilitate a tailored response to the needs of practicing coaches. This will also be the first set of data to be collected on coaching approaches at club level.

All responses remain completely anonymous with confidentially guaranteed. Please note you are under no obligation to participate in the study and you are free to withdraw from the study at any time without reason.

If you have further questions regarding this research please feel free to contact me on the following email cathal.cregg.connacht@gaa.ie

Participant Consent

Title: GAA Club Coaches current familiarity and usage of small, medium and large sided games.

By ticking the 'agree' box below you are adhering to the following points and may participate in the study.

*I have read and understood the participant information provided above

*I understand what the project is about and what the results will be used for

*I am fully aware of all the procedures involving myself and of any risks and benefits associated with the study.

* I know that my participation is voluntary and that I can withdraw from the study at any stage without giving reason.

*I am 18 years of age or older

*I am currently coaching (or have been in the past 12months) a club team in men's football, ladies Football,

Demographic Information

* 2. What Gender do you identify as

- ◯ Male
- ◯ Female

* 3. What is your age

- ◯ Under 18
- ◯ 18-24
- ◯ 25-34
- ◯ 35-44
- ◯ 45-54
- ◯ 55-64
- ◯ 65+

* 4. How many years' experience do you have coaching Gaelic Games?

* 5. How many years' experience do you have coaching GAA at Adult club level?

* 6. Please indicate ALL levels at which you have COACHED by ticking the appropriate box(es)below

- [ ] Club Youth
- [ ] Club Adult
- [ ] County Youth
- [ ] County Senior
- [ ] Schools
- [ ] 3rd Level Colleges

* 7. Please indicate ALL levels at which you have PLAYED by ticking the appropriate box(es)below

- [ ] Club Youth
- [ ] Club Adult
- [ ] County Youth
- [ ] County Adult
- [ ] Schools
- [ ] 3rd Level Colleges
- [ ] Never played

Coach Education

* 8. What levels of coaching education have you completed(or are currently completing)? Please tick ALL that apply.

- [ ] No formal coach education
- [ ] GAA Foundation Level
- [ ] GAA Award 1
- [ ] GAA Award 2
- [ ] Coach Education Tutor Award
- [ ] Coach Education Tutor Trainer Award
- [ ] Ulster GAA Level 3 Diploma Course
- [ ] Diploma of Sports Coaching (or equivalent)
- [ ] Bachelor in Physical Education (or equivalent)
- [ ] Bachelor in Sport and Exercise Science
- [ ] Sports Science related Masters (e.g. Masters in Sports Performance)
- [ ] Sports Science related PHD
- [ ] Other (please specify)

Describing Your Team

* 9. In what code are you currently coaching your club team?

- ◯ Hurling
- ◯ Gaelic Football
- ◯ Ladies
- ◯ Camogie

* 10. What is the age-group/grade of the current team you are coaching?

- ◯ Under 12
- ◯ Under 13
- ◯ Under 14
- ◯ Under 15
- ◯ Under 16
- ◯ Under 17
- ◯ Under 18
- ◯ Under 19
- ◯ Under 20
- ◯ Junior
- ◯ Intermediate
- ◯ Senior

* 11. In what province is your team currently situated?

- ◯ Connacht
- ◯ Leinster
- ◯ Munster
- ◯ Ulster
- ◯ Overseas

* 12. How many years have you been coaching your current team?

- ◯ 0-1 years
- ◯ 1-2 years
- ◯ 2-3 years
- ◯ 3-5 years
- ◯ 5-10 years

* 13. How many members of your management team hold responsibility for the design and coaching of pitch sessions?

- ◯ 1 (me only)
- ◯ 1 (not me)
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 6 (or more)

* 14. Approximately how many hours per week do you spend coaching this team on field (please do not include off-field contact time)?

- ◯ 0 - 1 hours
- ◯ 1 - 2 hours
- ◯ 2 - 3 hours
- ◯ 3 -4 hours
- ◯ 4 -5 hours
- ◯ 5 - 6 hours
- ◯ 7- 8 hours
- ◯ 8 -9 hours
- ◯ 9 + hours

Coaching Approach - Describing your current Practice in EARLY SEASON

• Please note, the following definitions will be used for this page to describe content activity that a coach may use for their session

• **Drills:** Exercises practiced unopposed in lines that require the repetition of skills and prescribed directional movement.

• **Skills in isolation:** Similar to drills but don't occur in lines and are often completed with little or no movement allowing the player to solely concentrate on the skill being practiced.(e.g. 3 players passing to each other randomly throughout the field with no pressure)

• **Applied skill practice:** Activities that involve some level of opposition and where technique is exposed to pressure and elements of decision making are required with 6 or less players in formations such as (e.g. 1vs1/2vs2/3vs3/3vs2/4vs2 etc).

• **Small sided games:** Activities that involve games from 4vs4 to 7vs7 where rules or conditions may or may not be employed.

• **Medium sided games:** Activities that involve games from 8vs8 to 11vs11 where rules or conditions may or may not be employed.

• **Large sided games:** Activities that involve games from 12vs12 to 14vs14 where rules or conditions may or may not be employed.

• **Full sided games:** Game play with the full complement of players (15vs15) where rules or conditions may or may not be employed.

• **Conditioning:** Exercises completed without the ball that usually focuses on improving fitness, speed, agility etc .

* 15. In a pitch session, in **EARLY SEASON**, please estimate on average the duration of this session in MINUTES

* 16. In a pitch session, in **EARLY SEASON**, please estimate the **percentage time (%)** spent in each activity as this applies to your practice (Assume you have a full squad of players available)

(Note: This must add up to 100 at the end. You do not need to put a number in every box if it does not apply to your practice. Please enter a number. Decimals, percentages and non-numerical characters are not accepted)

Small sided games (4vs4 to 7vs7)	
Drills	
Conditioning	
Large sided games (12vs12 to 14vs14)	
Medium sided games (8vs8 to 11vs11)	
Skills in isolation	
Warm Up	
Applied Skills Practice	
Full sided games (15vs15)	
Cool Down	

* 17. Considering the question you have described in Q16(**EARLY SEASON**), please sequence the order of this session by ticking the relevant boxes i.e. indicated the 1st activity, the 2nd activity etc in your session. (Assume you have a full squad of players available)

(Note: you can tick the listed activities on multiple occasions i.e. 2/3 different activities occurring at the same time and/or an activity occurring a number of times throughout a session: only list the number of activities you use, you are not required to list all 8)

	Small sided games (4vs4 to 7vs7)	Drills	Conditioning	Large sided games (12vs12 to 14vs14)	Skills in isolation	Full sided games (15vs15)	Warm Up	Applied Skills Practice	Medium sided games (8vs8 to 11vs11)	Cool Down
1st Activity	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
2nd Activity	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
3rd Activity	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
4th Activity	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
5th activity	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
6th activity	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
7th Activity	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
8th Activity	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

* 18. In a pitch session, in **PEAK SEASON**, please estimate on average the duration of this session in MINUTES

* 19. In a pitch session, in **PEAK SEASON**, please estimate the **percentage time (%)** spent in each activity as this applies to your practice . (Assume you have a full squad of players available)

(Note: This must add up to 100 at the end. You do not need to put a number in every box if it does not apply to your practice. Please enter a number. Decimals, percentages and non-numerical characters are not accepted)

Small sided games (4vs4 to 7vs7)	
Drills	
Conditioning	
Large sided games (12vs12 to 14vs14)	
Medium sided games (8vs8 to 11vs11)	
Skills in isolation	
Warm Up	
Applied Skills Practice	
Full sided games (15vs15)	
Cool Down	

* 20. Considering the question you have described in Q19(**PEAK SEASON**), please sequence the order of this session by ticking the relevant boxes i.e. indicate the 1st, 2nd activity etc in your session. (Assume you have a full squad of players available)

(Note: you can tick the listed activities on multiple occasions i.e. 2/3 different activities occurring at the same time and/or an activity occurring a number of times throughout a session: only list the number of activities you use, you are not required to list all 8)

	Small sided games (4vs4 to 7vs7)	Drills	Conditioning	Large sided games (12vs12 to 14vs14)	Skills in isolation	Full sided games (15vs15)	Warm Up	Applied Skills Practice	Medium sided games (8vs8 to 11vs11)	Cool Down
1st Activity	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
2nd Activity	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
3rd Activity	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
4th Activity	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
5th activity	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
6th activity	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
7th Activity	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
8th Activity	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Understanding of Games

Please note, the following page will be used to describe the **GAA`s Total Playing Performance Model** formerly know as the OTu coaching model.

The Total Playing Performance Model **can be viewed in this short video link** (https://www.youtube.com/watch?v=4TJXCHfZKxo&feature=youtu.be) or **read through text below**

The Total Playing Performance Model is reflects the 6 major categories of playing capacities. The 3T's - Technical Proficiency, Tactical Prowess and Team Play - and the 3P's - Physical Fitness, Participant Feedback and Psychological Focus.

Technical Proficiency: The ability to perform the underlying techniques accurately, consistently and at match tempo. (skills)

Tactical Prowess : The ability to weigh up match situations and decide on the best option to take and when to take it in order to optimise time, space and scores (attack) or minimise these (defence). (decision making)

Team-Play: The ability to anticipate movements and to synchronize who should go where – in a support play context – or in relation to agreed strategies in terms of actual play or set-pieces i.e. tactical ploys.

Physical Fitness: The ability to perform the basic techniques, engage in physical contests and respond to signs, sounds and signals experienced during the game with the least possible expenditure of energy

Participant Feedback - is a two-way communication process which allows for ongoing adjustments to be made in order to capitalise on strengths, minimise limitations and maintain continuous improvement.

Psychological Focus : The ability to maintain attention on the 'here and now' by minimising disruptions from within and without.

Small sided games: Activities that involve games from 4vs4 to 7vs7 where rules or conditions may or may not be employed

Medium sided games: Activities that involve games from 8vs8 to 11vs11 where rules or conditions may or may not be employed

Large/Full sided games: Activities that involve games from 12vs12 to 15vs15 where rules or conditions may or may not be employed

* 28. Please rank the listed elements of the Total Playing Performance Model in order of how beneficial you feel small sided games(4vs4 to 7vs7) are at developing them (on a scale from 1-6; 1=most beneficial 6= least beneficial)

- Technical Proficiency
- Tactical Prowess
- Team Play
- Physical Fitness
- Participant Feedback
- Psychological Focus

* 29. Please rank the listed elements of the Total Playing Performance Model in order of how beneficial you feel medium sided games(8vs8 to 11vs11) are at developing them (on a scale from 1-6; 1=most beneficial 6= least beneficial)

- Technical Proficiency
- Tactical Prowess
- Team Play
- Physical Fitness
- Participant Feedback
- Psychological Focus

* 30. Please rank the listed elements of the Total Playing Performance Model in order of how beneficial you feel large/full sided games(12s12 to 15vs15) are at developing them (on a scale from 1-6; 1=most beneficial 6= least beneficial)

- Technical Proficiency
- Tactical Prowess
- Team Play
- Physical Fitness
- Participant Feedback
- Psychological Focus

* 31. When trying to effect change in Technical Proficiency, Tactical Prowess, Team-Play, Physical Fitness, Participant Feedback and Psychological Focus during games which of the conditions listed would you generally manipulate/change?