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The role of small-sided games in physical- and technical training of game sports

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Foreword

For this thesis, i want to thank Dr. Roland Leser. He has been patient to counsel and encouraged me. It's an honor and a great pleasure to work with you.

"I am strong when I am on your shoulders

You raise me up to more than i can be"

Erklärung zur Magisterarbeit

Ich erkläre hiermit, dass die vorliegende Magisterarbeit von mir selbst verfasst wurde und ich keine als die von mir angeführten Quellen und Hilfsmittel verwendet habe.

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1 Introduction

In modern sport matches, high-intensity activities are becoming more and more important. Players should perform much more repeated high-intensity running (sprinting), especially at elite level (Di Salvo et al., 2007, p. 222). Meanwhile, the requirements in competition are that, on one hand, players should not only obtain comprehensive technical capabilities, such as executing a large number of technical actions, but also they should be proficient in performing key technical actions (e.g. with the smallest touch number per possession to win more time and space for better opportunities in competition). For example, in soccer matches, the average number of ball touches per possession lies between 1.74 (central defenders) and 2.26 (central attacking midfielders) touches in the Spanish and English first division (Dellal, Wong, Moalla & Chamari, 2010, p. 51). The attitude is reported (Boma, 1983; Mallo & Navarro, 2008, p. 166) that the maximum benefits of exercises will be obtained, through the appropriate stimulus in training sessions, which are similar to the needs in match play. Thus, some specific training exercises should be considered, in order to effectively develop these capabilities.

In recent years, along with the benefits of small-sided games (SSGs) found, as a specific tool SSGs are widely used in physical and technical trainings. In response to this, to improve the effects of application of SSGs, a comprehensive understanding for SSGs, such as, trainings form and scopes of application as well as the role in physical and technical training, should be emphasized in the round.

In the context, considering the results of published experiments, this study focuses on the comprehensive understanding and analyses of the role of SSGs in physical and technical trainings, to search some effective practical applying measures. The detailed objectives of research are listed.

- A systematic interpretation for SSGs, with focus on scope of application and reasons (why SSGs to be applied).
- How to effectively apply SSGs for high-intensity activities?
- Which SSGs are appropriate for which skills? How to effectively apply SSGs for ball possessions?

This study mainly consists of two parts, theoretical part and practical part.

The second chapter is the theoretical part, in which SSGs are comprehensively introduced. In chapter 2, definitions, trainings form, scopes of applications and benefits as well as methods of analyses are demonstrated in turn.

Chapter 3 and chapter 4 are the practical part, in which the role of SSGs for physical and technical training is analyzed.

In chapter 3, the role of SSGs for fitness training is mentioned, especially its effect on high-intensity activities. And, some practical applications of measures are proposed.

In chapter 4, first the relation between SSGs and frequency of technical actions are explained. Secondly, the effects of modified touch rules for ball possessions are analyzed. On the basis of the results of analyses, some appropriate measures are proposed.

In chapter 5, important findings and conclusions are summarized.

2 Small-sided games (SSGs)

In recent years, a lot of research focuses on small-sided games (SSGs). As a result, many advantages of SSGs are found. The applying of SSGs as a tool to enhance technical, tactical and physical abilities of players are well proved (Casamichana & Castellano, 2010, p. 1615; Dellal et al., 2011, p. 322; Hill-Haas, Coutts, Dawson & Rowsell, 2009a, p. 8). Thus, SSGs are applied not only as a common warm-up, but also as a part of regular training programs in various forms (Hill-Hass, Coutts, Rowsell & Dawson, 2009b, p. 636). For example, SSGs are used widely to improve technical skills and tactical abilities (Jones & Drust, 2007, p. 150) as well as to develop aerobic fitness (Dellal, et al., 2011a, p. 341). Rampinini et al. (2007, p. 659) suggest that SSGs should be used as a special tool to optimize the conditioning stimulus in fitness training.

In addition, it is reported (Carling, 2010, p. 319) that the performance in sport matches depends on the successful interaction, which is a result of the technical, tactical and physical aspects of the game. For example, the tactical goal to achieve depends on the players' abilities in a certain area of the playing field with others to cooperate. It can be foreseen if more aforementioned components (e.g. technical, tactical and physical ability) can be developed simultaneously, the better effect of training sessions would be achieved.

Therefore, special training sessions, based on the game-conditions with fewer players in smaller field dimensions, become a popular method for youths and adults. In this sense, in order to better understand the role and effect of SSGs as a training method, SSGs must be analyzed comprehensively.

In the following, in terms of all published literature to the best of the author´s knowledge, SSGs will be observed systematically with focus on scope of application and reasons.

2.1 Definition

What are SSGs? Before examining the reasons for the application of SSGs and exploring their benefits, the definition of SSGs should be interpreted. In order to systematically comprehend it, some understandings for SSGs, which are published from other literature, should be considered specially.

SSGs are game sports that the teams with few players and compete on a smaller sized field. SSGs are fun game sports that cause more interactions for the players, because fewer players can share one ball much more. And SSGs are different from adult version with these characteristics (Snow, 2011, p. 1):

- Reduced field size
- More involved playing time
- More opportunity to play on both sides of the ball
- More opportunities to score goals

SSGs, consisting of appropriate sizes of goalposts, ball and playing field as well as related simple rules, are designed to meet the needs of children between the age of five and twelve. SSGs are regarded as a preferred tool in training session for professional players and as an appropriate method of acquiring skills for the development of young players (Small, 2006, p. 4).

It is indicated by New South Wales Rugby League (2013, p. 1) that SSGs are deemed to be a training aid of the design for practice of the game based situation. In order to suit various training sessions, SSGs are used with modified rules.

- Skill based games
- Fun based games
- Conditioning based games
- Teamwork based games
- Situational based games
- Problem solving based games

It is indicated by Delta youth Soccer Association (2008, p. 3) that SSGs embrace the concept of fun and enjoyment, which is vital, if children are willing to develop a lifelong love for game sports. The rules of SSGs are similar to those in adult game sports. The exceptions are that the playing field is smaller and each team with fewer players. In terms of age groups, the size of pitch and the number of players as well as goal size, the forms of SSGs vary from 3vs3 to 8vs8 under age 12.

SSGs are game sports with fewer players competing on a smaller-sized field, and are modified forms of 11-a-side football. They are designed to meet the needs of players under the age of 13, who have very different developmental characteristics and needs from adult players. It's emphasized that SSGs have a special role for youth players, who are under 13. The idea of SSGs is focused on the satisfactions of desires and increases of enjoyment, in particular the age appropriate development (Football Federation Australia, 2011, p. 4).

Small-sided games are concerning learning, self-experiencing, and having a lot of touches on the ball and above all, children having fun every time they step on the pitch.

Willett, (2003, p. 4) shows that SSGs are such an exercise:

- Small-area games are game-like competitive drills that utilize a playing surface with a reduced size
- The number of participants is lowered
- Special rules and conditions are applied
- Small-area games are designed to concentrate on multiple skills and situations, increasing puck touches and situational repetitions

In conclusion, it can be determined that the term of SSGs is discussed and defined as very comprehensive. The definitions of SSGs always refer to the same content, namely any played game is an approach with fun and enjoyment for young players to grow into the adult game of 11 versus 11 through modified rules such as size of goalposts, ball and playing field as well as number of players etc. (Moye & Parker, 2012, p. 11).

2.2 Suitable for what kind of sports

In what kind of sports should SSGs be a useful tool? In order to explore this issue in detail, first of all, all published views and opinions to the best of the author's knowledge are according to their types classified (e.g. soccer and handball, etc.). Afterwards, they will be explored with the classification theory (Mitchell, Oslin & Griffin, 2006, p. 20).

Some representative views are listed and all found literature will be comprehensively discussed in subsequent chapters.

Soccer

On Owen, Twist and Ford (2004, p. 50) study, by 1-a-side and 2-a-side SSGs, the highest number of technical behavior per player and the highest number of mean heart rate are generally achieved. With these forms only few participants compete with each other, the technical ability and fitness of players can be improved effectively.

Results of Katis and Kellis (2009, p. 374) show that the performances of sprint and agility of players are affected, when they participate in 3-a-side SSGs. Players perform more technical behaviors (e.g. short passes tackles and scored more goals etc.) in 3-a-side SSGs. Playing in 3-a-side SSGs could be a better way to perform technical and fitness

trainings. In contrast, the loads of physical performance in field tests are less, when they participate in 6-a-side SSGs. At the same time, 6-a-side SSGs can provide an appropriate environment for tactical trainings. It is also a useful tool to be recommended in training sessions.

Hill-Haas et al. (2009a, p. 1) indicate that higher physiological and perceptual loads are through small format (2-a-side and 4-a-side) SSGs training imposed. Furthermore, not only the mean but also maximal sprint duration and distances are increased by the large format (6-a-side) SSGs. It is suggested that the smaller formats (e.g. 2-a-side and 4-a-side) SSGs could be used for fitness trainings such as aerobic-anaerobic training. Moreover, larger formats (6-a-side) SSGs are appropriate for match-specific training such as increasing ability.

Casamichana and Castellano (2010, p. 1615) report, that using SSGs enables the modulation of the intensity of soccer-matches. The physical and physiological loads of players' could be affected, when individual playing areas per player are modified. It is a specific way with SSGs to improve players' endurance.

Although Dellal et al. (2008, p. 1449) believe that the proportion of total distance covered in high-intensity running, duels and a large amount of possessions could be increased within SSGs, and varieties of match situations are reached by varying the technical instructions within SSGs. All the aforementioned elements are beneficial for a variety of training sessions. Then, the suggestion is that through altering the number of ball contacts per individual possessions, the physical and technical loads could be manipulated.

Furthermore, there are many studies with similar conclusions which suggest that technical and physical loads (e.g. heart rate, rating of perceived exertion and blood lactate) could be modified within SSGs, when the factors such as size of pitch, rule of games, and number of players are altered. And SSGs are recommended as a useful tool in training sessions for a wide utilization (Grant et al., 1999, p. 3; Impellizzeri et al., 2006, p. 483; Owen et al., 2004, p. 50; Dellal et al., 2008, p. 1449; Gabbett & Mulvey, 2008, p. 543; Mallo & Navarro, 2008, p. 166; Castagna et al., 2009, p. 1954; Coutts et al., 2009, p. 79).

Basketball

Although Klusemann, Pyne, Foster and Drinkwater (2012, p. 1463) show that the technical, physiological and physical demands could be increased by using basketball SSGs, especially with few players or take place in a relative small field. For instance, in comparison to 4-a-side, there are more than 60% behaviors in 2-a-side and more than 20% in half court games. Moreover, the percentage of maximum heart rate (%HR_{max}) and

global ratings of perceived exertion are higher in 2-a-side than in 4-a-side. In addition, more sprints and high intensity-running in 2-a-sided than in 4-a-side are generated and compared to full court games less jogging in half court games is needed.

In the study of Sampaio, Abrantes and Leite (2009, p. 463), the results indicate that when players execute tasks in training sessions within both game forms (3-a-side and 4-a-side), their mean heart rate are above 80% of HR_{max}. Thus, due to the high physiological loads, it is recommended that SSGs could be a useful tool for aerobic trainings with specific benefits. On the other side, because of playing with balls, players could improve their abilities of technical and tactical skills, when they perform game forms. This is the biggest difference between SSGs and others common intermittent running training. The authors also recommend that SSGs play not only a significant role in physiological training, but are also very important for technical and tactical training with enormous advantages. Indeed, it should be further integrated in training sessions. It is similar to the report, but more advanced than those found by Pinar et al. (2009, p. 445). In their study, the results demonstrate that the activities of participants could be even more exciting, when they execute mini basketball with specific rules (e.g. reduced number of players on court and reduced court size), which are modified for SSGs. In this context, it is suggested that, basketball SSGs according to some appropriate rules to carry out the match, greater effects could be obtained.

Rugby

The main finding of the Kennett, Kempton and Coutts (2012, p. 2037) study are that there are different physiological responses such as blood lactate and physical loads (e.g. high-speed running distance) by different rugby SSGs formats, consisting of different numbers of participants. Differences of field size could cause different physical loads and physiological responses. Thus, these researchers suggest that rugby SSGs can be a suitable solution for the high-intensity physical and physiological specific training session.

The results of Gabbett, Abernethy and Jenkins (2012, p. 487) study demonstrate that the physiological responses by large field size are larger than by small field size. Field size of SSGs could be an important factor to regulate the physiological demands of participants. The finding of these researchers suggests that through altering field size during SSGs the physiological response of players can be controlled.

It is similar to those reported by Kennett et al. (2012, p. 2037) and Gabbett et al. (2012, p. 487). The finding (Foster, Twist, Lamb & Nicholas, 2010, p. 906) demonstrates that the

physiological responses of players are sensitive to the number of players, and suggests that the 4-a-sided form is advisable to achieve an appropriate aerobic condition stimulus.

Hockey

The result of Gabbett (2010, p. 1321) shows that in comparison to competition, game-based training sessions generate time spent in low-intensity activities more than in moderate and high-intensity activities. It is suggest that game-based training session is a useful tool to improve skills of players.

Handball

Buchheit et al. (2009, p. 251) argue that the physiological responses in both game-forms (4-a-side and 6-a-side) are maintained in high-intensity (above 90% HR_{max}). Therefore, it could be used to keep the stimulus for specific aerobic fitness condition trainings. In addition, in comparison to the 6-a-side game-form, more technical behaviors are found in the 4-a-side game-form. In view of this difference of results between both game-forms, the author suggests that by altering the number of players within handball SSGs a feasible and effective attempt to adjust accurately the physiological responses and technical activities of players for specific training sessions can be made.

According to the above published reports, SSGs as a means of training are to be used effectively for team sports. These advantages are also confirmed by Gabbett, Jenkins and Abernethy (2009, p. 273). The main finding of their search is that physical fitness, process of skills learning and ability of decision-making would be improved by SSGs.

Game category

Whether SSGs are suitable for all team sports? Such as volleyball and baseball. In order to explore this issue further, a classification system will be introduced.

According to the tactical similarity and intrinsic characteristics of games, Mitchell et al. (2006, p. 20) propose a classification system that divides many different sports and to be shown in table 1.

- Invasion games
- Net/ wall games
- Striking /field games
- Target games

Invasion games:

In invasion games, there are two opponents, one is an attacker and another is a defender. The purpose of the attacker is to invade the defender's territory. One point will be scored, when the attacker has completed the task, so that the ball or other objects will be carried or caught with foot, with hand or with specific racket across the specific line (e.g. baseline), thrown or shot into a goal or specific target (e.g. basket) in the opponents' territory (Pearson, Webb & McKeen, 2005, p. 5). The essence of this game is invasion of space, the attacker invades space to score more points, whereas, prevent the oppositions from getting the ball or scoring within the rules of the game as far as possible.

Net/ wall games:

The net/wall games consist of two opposing teams or individuals. The participating teams will be divided by a net or share the match field. The intention of most games in this category is sending the object (e.g. tennis, volleyball, table tennis) to another one with the goal that the opponent is unable to return it effectively (Griffin et.al., 2005. p. 41).

Striking/ field games:

In striking/field games, a striking team (offensive) and a fielding team (defensive) are involved. The primary task for the players in an offensive team is to hit the ball into a specified area, while the players in a defensive team try to catch the ball and to take it to a designated area. On offense, the attacker should hit the ball or object accurately and powerfully in order to gain as much time as possible for his teammates to score. On defense, players should try to prevent the offense by catching the ball or object as quickly as possible, before it hits the ground (e.g. bases and wickets).

Target games:

In this category, there are two forms of either with opposed target games or no rival target games. In the opposed target games, players can knock or block the balls to score and to defend (e.g. billiard). Conversely, in no rival target games (e.g. golf or bowling), the process of decision is individual, which doesn't depend on other factors.

Tab.1: The classification system in sport (Mitchell et al., 2006, p. 20)

Target games	Striking/ field games	Net/ wall games	Invasion games
Golf Bowling Billiard Curling Boccia	Baseball Softball Cricket	Badminton Tennis Table tennis volleyball Squash	Basketball Soccer Handball Water polo Hockey Lacrosse Rugby Football Frisbee

Due to the published reports to the best of our knowledge, all the aforementioned sports, in which many excellent training effects are obtained through SSGs, are in the category of Invasion games. According to the classification, volleyball is a team sport, but participating parties should be isolated in their territory, these games lack invasive characteristics. In contrast to the sports like basketball or soccer, striking/field games (e.g. baseball, softball), the chased target of attacker and defender are different at the same time. For example, in baseball, a batter attempts to get points by reaching his base, the target of pitchers is to prevent simultaneously effective hitting and running of batter. In terms of the explanation (Lames, 1991, p. 33), due to the different objective at the same time, the interaction process in striking/field games is limited. In this respect, it is different from invasion games.

According to the finding (Pearson & Webb, 2008, p. 610), some invasion games are listed:

- Football
- Rugby
- Basketball
- Lacrosse
- Hockey
- Ringette
- Bandy
- Soccer
- Ultimate Frisbee
- Handball
- Polo
- Water polo
- Field hockey

In addition, some modified small field games can be effectively implemented in soft-ball (t-ball), Australian football (free ball), netball (korfball), field hockey (minkey), basketball (mini-ball), soccer, and more recently Gaelic games (go games) (Whelan, 2011, p. 14).

On the basis of the previous theories and studies, SSGs would be used as an effective training method for team sports, which contains the invasive characteristics. This argument is also supported by Whelan (2011, p. 14).

2.3 The forms in application

According to Snow (2011, p. 14), the amount of possible passing interactions depends on the number of players in the game situation. For game sports, the interactions are tactical possibilities. According to the study of Small (2006, p. 31), the increment in passing interactions between 4vs4 and 11vs11 games are significantly from 12 to 110. In terms of the result the more players in a game, the more complex the environment in the same situation, and the more difficult to make decisions for players. That is also supported by Small (2006, p. 8).

The ability of children to make decisions in a changing situation relies on their developmental age and their preparation as well as the complexity of the situation. In many game sports, some game rules, which are formulated for adults, are not suitable for children. For example, in soccer, the 11-a-side format is the adult version. With the goalpost and field size of adult version, children would make a decision among many choices and respond in a short time before complicated environments. It is different from making a correct tactical decision. In particular for children, who are under the age of twelve (Small, 2006, p. 6; Schmidt, 1999).

Due to the necessity of the age-appropriate forms of SSGs for children, many sports associations propose different formats of SSGs for children. Through changing the size of goalposts, ball and playing field as well as reduced rules these formats can adapt to the physical and psychological characteristics of the different age group. These forms will be listed in accordance with different sports.

Soccer

In many countries, SSGs are widely applied as a training mean for young players. Not only in the major football countries European and South American countries (e.g. Netherlands, England and Brazil), but also in many countries in Asia and North America such as Japan and USA, SSGs are widely introduced to young players too.

Australia

In 2008, a consistent format of SSGs, as the national standard format for young football players between six and twelve years old, is introduced in Australia. This format can be seen in table 2.

Tab. 2: The SSGs of Australian national playing formats (Football Federation Australia, 2011, p. 10)

Playing format	Under 6	Under 7 & 8	Under 9 & 10	Under 11 & 12
Numbers	4 v 4	5 v 5	7 v 7	9 v 9
Field size	length: 30 m width: 20 m	length: 30 m width: 20 m	length: 40 m width: 30 m	length: 60 m width: 30 m
Goal size	min:1.80mx0.90 m max:2.00mx1.00 m	min:1.80mx0.90 m max:2.00mx1.00 m	min:4.80mx1.60 m max:5.00mx2.00 m	min:4.80mx1.60 m max:5.00mx2.00 m
Ball size	size 3	size 3	size 3	size 4
Goalkeeper	no	no	yes	yes
Playing time	2 x 15 minutes	2 x 20 minutes	2 x 25 minutes	2 X 30 minutes

In addition, some rules in this national standard format are modified, in order to reduce the complexity of games, such as, fouls and misconduct as well as the offside rule.

The offside rule: no offside for all 6-12 year old age groups.

Fouls and misconduct: there are only indirect free kicks with the exception of a penalty kick. All indirect free kicks within the penalty area shall be taken outside the 8m penalty line.

USA

A similar guideline designed to young football players is published by US Youth Soccer in 2011. Based on the template, each state proposes also different modified formats. The stages of development are shown in table 3.

Tab. 3: The stages of development (Snow, 2011, p. 8)

Playing format	Under 6	Under 8	Under 10	Under 12
Numbers	3 v 3	4 v 4	6 v 6	8 v 8
Field size	length: 30yards width: 25yards	length:35 yards width:30yards	length:60yards width:45yards	length:80yards width:75yards
Goal size	wide: 18ft high: 6ft	wide:18ft high:6ft	wide:18ft high:6ft	wide:18ft high:6ft
Ball Ssze	size 3	size 3	size 4	size 4
Goalkeeper	no	no	yes	yes

In this guideline, the offside rules to U6, U8 and U10 are the same one, but some rules (e.g. free kick, penalty) would be changed in different age groups. This will correspond to the increasing age. The rule for free kicks to U6 and U8 is that all free kicks should be directly implemented, and the rule of penalty kick for the same age groups is no any penalty kicks to call, but both rules to U10 are conform to FIFA with the 8 yards exceptions.

The following is an overview of a large amount of samplings of FIFA national football associations, which recommend the age-appropriate SSGs for children (Snow, 2011, p. 9-14):

Latvia

- For U6 - 5vs5, 25x40 m pitches, 2x3 m goals, ball size 4
- For U8 - 7vs7, 25x40 m pitches, 2x5 m goals, ball size 4
- For U10 - 7vs7, 40x60 m pitches, 2x5 m goals, ball size 4
- For U12 - 7vs7, 40x60 m pitches, 2x5 m goals, ball size 4

Malta

- For U6 to U8, 5vs5, 2x15 min duration
- For U8 to U10, 7vs7, 2x20 min duration
- For U10 to U12, 9vs9, 2x25 min duration

Hungary

- For U6 to U7, 4vs4, 20x30 m pitches, 1x1 m goal, ball size 3
- For U8 to U9, 6vs6 (5+GK), 30x40 m pitches, 3x2 m goal, ball size 4
- For U10 to U11, 8vs8 (7+GK), 40x60 m pitches, 5x2 m goal, ball size 4
- From U12 normal team, pitches and championship

Spain

- For U7 to U10, 5vs5 (4+GK), 35x23 m pitches, ball size 3, 2x20 min duration
- For U11to U13, 7vs7(6+GK), 60-70x45-55 m pitches, ball size 4, 2x35min duration
- For U14toU16, 9vs9 (8+GK), 70-75x55-60 m pitches, ball size 5, 2x40min duration
- 11vs 11competiton begins at age 17

Basketball

England

For children, the process of the skills learning is related to their physical development and maturation (Schmidt & Lee, 1999, p. 31). In order to be suitable for their stage of development, mini-basketball, on the basis of standard basketball, is introduced as the adapting game of basketball to suit the demands of children (Spencer, 2012, p. 1). The relation between the numbers in a team and age in mini-basketball for children can be seen in table 4.

Tab. 4: The relation between the numbers and ages (Spencer, 2012, p. 2)

Age	Number in a team
5-7	2v1, 3v1, 2v2, 3v3
7-9	3v1, 2v1, 2v2, 3v3, 4v2, 4v3, 4v4
9-12	3v2, 3v3, 4v2, 4v3, 4v4, 5v3, 5v4, 5v5

The ball and goal in mini-basketball have been also modified accordingly.

Ball

- Years 1 to 4 Key Stage 1 size 3 (circumference 55-58cms)
- Years 5, 6 & 7 key Stage 2 size 5 (circumference 68-73cms)

In key stage 1, soft ball can be introduced for children for specific skills training. Larger and lighter balls can be used in key stage 2 for younger children, which can make a decision by themselves.

Goal

The recommended heights of the basket are:

- Goal for year 1 to 4 is through 1.5m to 2.1m.
- Goal for 5 to 7 is through 2.1m to 2.6m

The competition framework

In order to provide all young people in England with a consistent and appropriate level of competition at all ages, the English Schools Basketball Association (ESBBA) outlines a national framework, in which basketball could spread with various forms at schools, such as 2vs2, 3vs3 and 4vs4 mini-basketball is applied generally in key stage 2 and key stage 3. The partial framework in key stage 2 and 3 can be viewed in table 5.

Tab. 5: The partial framework in key stage 2 and 3 (ESBBA, 2012)

Stage	Age	Format	Ball	Duration
Stage 2	7-9	3v3 mixed teams	size 3	5 minute
Stage 2	9-11	3v3, 4v4or 5v5 mixed teams	size 5	4x5 minute
Stage 3	11-13	5v5 sex separate teams	Size 6 boy Size 5 girls	4x10/15 minute

Rugby

New Zealand

Because of the purpose to develop the ability of children according to a reasonable and consistent plan, which should correspond to their physical development, the New Zealand Rugby Union (NZRUGBY) designs the small blacks development model for all kiwi young people under the age of 13. The appropriate modified rules and formats are the essential contents. The main modifications of the development model are shown in table 6.

Tab. 6: The main modifications of small black development model (Hockey New Zealand, 209)

Age Grade	U6 & U7	U8 & U9	U11 & U12 & U13
Number per team	7	10	15
Field size	1/2	1/2	full
Conversion	No	0	2
Ball size	2.5	3	3
Tackle	rip	tackle	tackle
Kick-off	free pass	tap and pass	normal
Kicking	no	encourage running & passing	yes
Penalty	free pass	tag and pass	normal
Duration	2x20min	2x25min	2x30min
Scrums	no	5 person	8 person
Lineout	no	5 person	8 person

Australia

Since 1991, Australian Rugby Union frames the Australian rugby player pathway, which is modified recently for young players at the age of 6 to 12. The modified rules of rugby games are summarized in table 7.

Tab. 7: The laws summary for U6 to U12 (Australian Rugby Union, 2011. p. 13)

Age grade	U6	U7	U8	U9	U10 &U11	U12
Number	7	7	7	10	12	15
Area	1/4	1/4	1/2	1/2	full	full
Duration	2x10min	2x15min	2x15min	2x20min	2x20min	2x25min
Ball size	2	2	3	3	4	4
Conversions	no	no	optional	yes	yes	yes
Kick-off	punt	punt	punt or drop	punt or drop	drop	drop
Kicking	no	no	no	no	yes	yes

Others common pathway laws for U6 to U12 (Australian rugby union, 2011. p. 13):

- Scoring
  - ✓ No drop goals
  - ✓ No penalty goals
- Lineout
  - ✓ No quick throw-ins
  - ✓ No variation in numbers allowed
  - ✓ Must have a lineout receiver
- Foul Play
  - ✓ Yellow card = 5 minutes
  - ✓ Yellow card and red card player may be replaced
- Scrum
  - ✓ Defending scrum-half can't go past midline and cannot leave scrum
- Tackle
  - ✓ Slinging tackles, fending to the head and squeeze ball illegal

Hockey

New Zealand

In order to suit the physical development stages of players in all age groups, the hockey New Zealand Association in 2009 formalizes a "recommended hockey modules" for standardized applications of hockey. In this official manual, three stages are divided in accord with the physical conditions of young players:

- Small sticks hockey – modules for 5-13 year olds
- Secondary school hockey – modules for 13-19 year olds
- Senior/ open grades – modules for 18+ year olds

Moreover, the form in each stage is modified, which is based on the need of the skills (technical) and cognitive (tactical) development of children. The recommended hockey modules are listed in table 8.

Tab. 8: Recommended hockey modules (Hockey New Zealand, 2009)

	Type	Number	Field size (m)	Goals	Goalkeeper	Penalty corners	Duration
Small sticks hockey (for 5-13)	U6	3v3	22x27	modified	no	no	20 min
	U9	4v4 (skills)	22x27	modified	no	no	30 min
	U9	6v6 (tactic)	25x55	modified	no	no	40 min
	U11	6v6 (skills)	25x55	modified	no	optional	40 min
	U11	8v8 (tactic)	45x55	modified	optional	optional	40 min
	U13	8v8 (skills)	45x55	standard	yes	yes	40 min
	U13	11v11 (tactic)	91x55	standard	yes	yes	50 min
Secondary school hockey (for 13-18)	skills	6v6	45x55	standard	optional	optional	50 min
	mixed	6v6	45x55	standard	optional	yes	50 min
	advanced	11v11	91x55	standard	yes	yes	50/60 min
Indoor hockey (for 18+)	indoor hockey	6v6	44x22	modified	yes	yes	40 min

Due to the general purposes to provide an age appropriate environment for children to raise their interests and to stimulate their potentials, the forms of SSGs are designed in various forms, which match stages of physical development of children. On the basis of previous studies, in general the forms of SSGs for the younger occur with a lower number of players and under simpler rules. Conversely, the forms of SSGs for the older occur with a higher number of players and under adult rules.

2.4 Why small-side games?

It is recommended by many researchers that in terms of numerous benefits SSGs are applied as main tools in training sessions more and more (Owen, Twist & Ford, 2004, p. 50; Katis & Kellis, 2009, p. 374; Dellal et al., 2008, p. 1449; Castagna et al., 2009, p. 1954; Coutts et al., 2009, p. 79; Gabbett, Abernethy & Jenkins 2012, p. 487; Grant et al., 1999, p. 1; Impellizzeri et al., 2006, p. 483; Williams & Owen, 2007, p. 100). In this chapter, these reasons will be demonstrated comprehensively.

2.4.1 Benefits of SSGs

An increasing number of benefits of SSGs are reported with further research. Some benefits of SSGs will be exemplified:

In Australia, SSGs are widely used, on the basis of following benefits (Football Federation Australia, 2011. p. 5):

- More fun and individual enjoyment due to smaller fields and simplified rules
- More playing time, which maximizes individual participation and involvement
- Far more repeated touches of the ball by all players on the field
- More shots on goal

In terms of results from the research study (Small, 2006. p. 32), the benefits of 4-a-side and 7-a-side SSGs are demonstrated:

- Far more repeated touches of the ball by all players
- More passes are attempted in a forward direction in the SSGs
- More attacking 1v1s final third and penalty area entries
- More shots on goal and technical skills by goalkeepers
- Repeated decision making experience
- The ball is in play far more in the SSGs

According to Spencer (2012, p. 4), on the basis of the following benefits SSGs can provide an age-appropriate environment for young players:

- …young player to touch the ball more often and to become more skillful with it!
- …young player to make more, less-complicated decisions during the game!
- …young player to be more physically efficient in the field space they are playing in!
- …young player to have more involved playing time in the game!
- …young player to have more opportunity to play on both sides of the ball!
- …young player to have more opportunities to score goals

According to the summary of the above views, the benefits of SSGs are embodied mainly in the technical development (e.g. more touch, more passes) and tactical improvement such as less-complicated decisions. This finding is also supported by Willett (2003, p. 6).

2.4.2 Data

In chapter 2.4.1, many researchers report that amount of technical behaviors to execute is one of the benefits of SSGs. Therefore, some researchers try to prove the quantitative gaps of technical behaviors between SSGs and 11v11 form. In order to identify comprehensively the quantitative differences of technical behaviors between different forms, Small (2006, p.14) did some tests at youth and professional level. The results of his study are shown in table 9.

Tab.9: Results summary (Small, 2006, p. 14)

	Performance			Juvenile		
Formats	4v4	7v7	11v11	4v4	7v7	11v11
Average touches per player	115	55	22	117	57	26
Average touches per minute per player	2.86	1.4	0.74	2.91	1.42	0.86
Attempted 1v1s	113	79	50	93	60	28
Total goals per game	26	11	2	33	11	5
Final 3rd entries	69	44	25	84	34	17
Attempt passing	352	241	180	288	380	208
First time passes	74	47	29	98	76	66
Total time ball out of play(min)	3.1	3.4	13.9	3.2	5	13.1
Percentage time ball out of play (%)	7.7	14	34.7	8	12.5	32.8

The results demonstrate clearly that players can carry out technical behaviors (e.g. average touches per player, average touches per minute player, attempt passing) far more often in both SSGs forms (4vs4 and 7vs7) than in the adult-form (11vs11).

For example, to attempt the technical behaviors 1vs1 by the 4-a-sided form take place up to three times more than adult-form. In contrast, in both SSGs forms players can have far more playing time than in adult-form (11vs11). Therefore, due to the relationship between the ball out of play and the number of technical behaviors, more technical skills are performed in SSGs. This view is supported also by other research results.

Results of Spencer (2012, p. 12) shows that the number of touching the ball per minute per player in 4-a-Sided is 4.3, in 11v11 only 0.37. In addition, the main findings of the study (Football Federation Australia, 2011, p. 8) in comparison with 11v11 form player touch ball five times more (than) in 4-a-sided and 50% more (than) in 7-a-Sided SSGs. In average, goals are scored every 1.5 minutes in 4-a-Sided form games, 3.6 minutes in 7-a-Sided form games and 8 minutes in 11v11 form games. The study (Grant et al., 1999b, p.

3) concludes that compared to 11v11 matches, players complete in 8-a-Sided form games more activities (e.g. possessions of the ball and attempted more short-and long passing).

In this context, the general consensus is that the executed activities of technical behaviors are in SSGs far more than in 11vs11 form games.

2.4.3 The reason for technical training

Based on the fact that SSGs are promoted as an important tool for youth players in many countries in chapter 2.3. The reason will be explored in this thesis.

Technical training is the process of development and perfection of movement skills. It is devoted obtaining and improving sport skills (Kunz, 1992, p. 8).

Technical training in sport is a new motion for learning as well as improving and perfecting already acquired movements (Lehnertz, 1991).

2.4.3.1 Classification of technical training

In terms of training methods, technical training is divided into two forms (Lehnertz, 1991, p. 153):

- Skills acquisition training
- Skills application training

Skills acquisition training

It's a process that the technical pattern will be polished repeatedly. It is important that the skilled movement can be implemented with a high-quality again and again as much as possible in a no interference environment (Lehnertz, 1991, p. 154).

Skills application training

The aim of skills application training is in interferential environment (e.g. positive defensive behavior) to develop the already acquired skills, which is learned in a simplified environment, in order to be executed steadily in match. The situations-adapted application of acquired skills is the key in this type training. This type training is especially important

for the competition game sports, because the environments are often changed (Lehnertz, 20011, p. 154).

According to Martin, Klaus and Lehnertz (2001, p. 58), the skills application training should be carried out in multilateral variables and competition specific conditions. The measures of the degree of difficulty and complexity should be increased gradually, which is implemented through the variation of motions' execution and motions' environment as well as exercises in competition conditions.

In addition, a large amount of repeated technical behaviors can cause adaptation and automation, which can accelerate the stability of skills in competition (Pöhlmann, 1994, p. 67). Hence, the feature of effective Skills application training is that a great amount of repeated technical behavior can be performed in variable situations which should take place under competitive conditions (Martin, 2001, p. 11).

It is known (the data in chapter 2.4.2) that in comparison to adult form (11vs11) technical behaviors such as touches and passing are far more often carried out by SSGs.

Moreover, in chapter 2.3, it is introduced that the age-appropriate SSGs as a standard training tool are promoted in many countries. Their degree of difficulty and complexity, which can be adjusted through the revision of rules, the changes of number players and changes of are suitable for the physical development of youth.

In this context of above facts, SSGs are able to meet the demand of skills application training and are suitable for skills application training. This conclusion is also supported Hohmann et al., 2006. p. 121). Based on the result of his study that many specific situations need to be solved and many technical behaviors need to be performed in a small street football. It is recommended to improve the adaptions ability.

In terms of the results of the study, SSGs are beneficial to enhance the effect of skills application training.

2.4.3.2 Learning stage of skills

2.4.3.2.1 Three stages model

The learning process of skill is divided into three stages:

- First learning stage: development of rough coordination
- Second learning stage: formation of fine coordination
- Third learning stage: stabilization of fine coordination and casting of variable availability (Meinel & Schnabel, 2007, p. 163).

The first learning stage: development of rough coordination

The first learning stage is titled as development of rough coordination including the learning process from announcement of the new skills to the stage in which the learners can perform the movement under favorable implements conditions (Meinel & Schnabel, 2007, p. 165).

The second learning stage: formation of fine coordination

This stage includes the learning process from reached stage of rough coordination to that stage in which the learners can perform the movement almost flawlessly (Meinel & Schnable, 2007, p. 174). At this stage, the conception of a movement is improved constantly and refined. Meinel & Schnabel (2007, p. 174ff) argue that under usual conditions the execution of the movement takes place easily and under standardized conditions a high performance with high reliability is achieved.

The third learning stage: stabilization of fine coordination and casting of variable availability

The third stage comprises the learning process from the reached stage of fine coordination to that stage, in which the learner can perform the movement also under difficult and unusual conditions (Meinel & Schnabel, 2007, p. 187). In this stage, the main task is the stabilization of movement that it should succeed in performing even in difficult conditions as well as in competitions conditions (Rieder, 1991, p. 34).

Compared to the second stage, the learned movements in this stage are essentially enhanced, which can be carried out successfully under changed conditions.

It is necessary that the accurate coordinated movement process, but beyond that, a quick adaptation of the performed movement in a new situation is more emphasized. That means that the learner must comprehend the new situation and reprogram their movement to ensure the obtaining of optimal execution in the existing situation. Therefore, there is a consequence for technical training that during the training not only the optimal movement stereotypes should be polished, but also a variation of tasks set owns a high priority to prepare the changing situations in the competition for players (Hollmann & Hettinger, 2000, p. 148).

In agreement with Hollmann and Hettinger, it is reported by Rieder (1991, p. 36) that one of most important characteristics of the third stage is:

Schnelle Anpassung an wechselnde Bedingungen in Kampf- und Mannschaftssportarten [fast adaptation on varying condition in combat- and team sports] (Rieder, 1991, p. 36).

In chapter 2.1, it is expounded that SSGs are also a competition games carried out with fewer player in reduced size and focusing mainly on multiple skills and specific situations. SSGs are the simplified competition games that the adjustments of relations and complexity are achieved through appropriate changes of rules and number of players etc.

Even in the simplest SSGs, which takes place with minimum number of players and simplest rules, also possess the characteristics (e.g. shoot, break through, active balancing defense, and so on) of the competitions games. In such SSGs, the implementation of technical movements is still under difficult conditions, compared to the habitual trainings environments. Therefore, the competition situations in SSGs are changed constantly.

Consequently, due to those characteristics SSGs are suitable for the third learning stage of skills.

In order to interpret further the suitability of SSGs for technical training, that is suited for the process of the gradual increase of difficulty and content according to the process of skills to master. In the following sections, SSGs will be expounded with the principles of technical training.

2.4.3.2.2 The principles of technical training

The principles of technical training have the aim to observe the spectrum of their objectives. There are four categories of objectives (Hohmann et al., 2006, p. 116):

- The learning of skills (Skills acquisition training): learning of new technical skills to automating of the dynamic optimum.
- The diversification of skills (skills variation training): learning from variants of skills to situation appropriate using of variations.
- The adaptation of skills (skills adaptation training): adjusting skills to environmental conditions such as terrain (slope, underground), space (spatial constellations of opponents and field, ball) and time (quick changes of environmental conditions).
- The shielding of skills (skills shielding training): stabilizing or shielding skills against opponents' influences or conditional loads.

Based on the level of players, the contents of technical training are different.

For beginners, on the basis of the adapted environment, acquisition of skills is emphasized. With the improvement of technical capability, the proportion of skills' variation and adaptive faculty for situations as well as interferential behaviors under confrontations are increased gradually. The interferential factors are especially emphasized.

For experts, the learning of basic skills is completed. The main content of technical training emphasizes the application of skills under interferential behaviors of opponents' or conditional loads.

In terms of the level stage, a heuristic composition of trainings for technical training is demonstrated in figure 1.

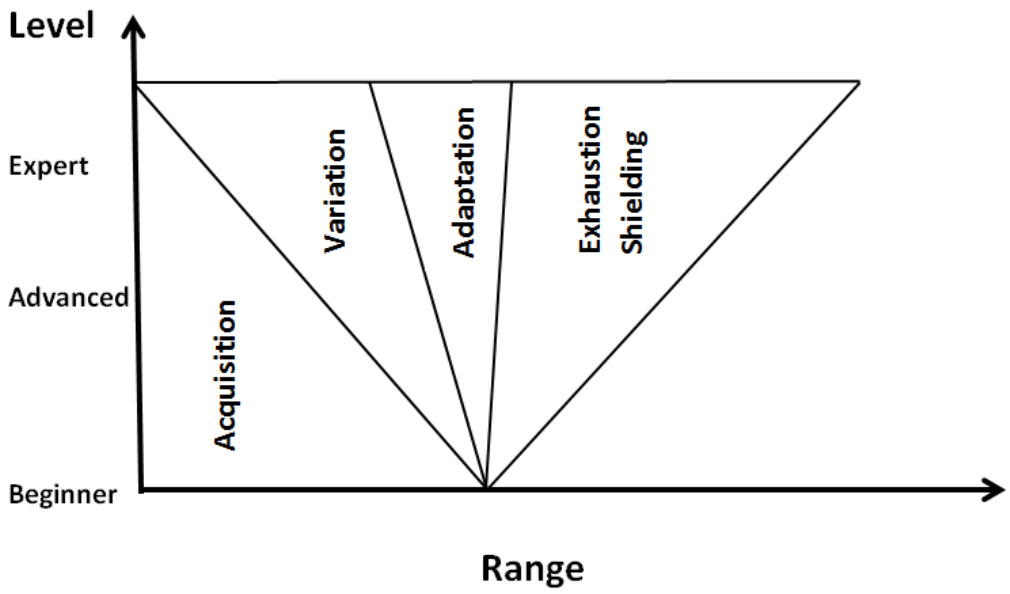

Figure.1: Heuristic composition of trainings for technical training (Hohmann et al., 2006, p. 116).

First of all, the main content of technical training is acquisition of basic skills such as header, stopping, pass and shoot as well as dribbling etc.

With the increase of technical capability, the proportion of the variation of skills' application and interferential factors of environment (e.g. deceptive movement, fair charge, field, goal, ball and basic tactics) are increased. In particular, when players are enabled to acquire a

higher technical capability, the proportion of opponents' influences in the arrangement of training content is significantly increased. For example, number of participants, 2vs3, 3vs4 in a specific competition situation according to tactical needs and fill gap as well as balancing defense etc.

Due to the description in chapter 2.3, the needs to variation of skills' application and the influence of environmental changes are fewer within younger age-appropriate SSGs, which are carried out with fewer players, smaller field and goal as well as simplified rules.

With the development of skills, in terms of the increasing of field and number of players as well as standardized rules, the complexities of the relationship between two participating parties, which constitute mainly the tactics in competition, are enhanced simultaneously.

Further, the intensity of SSGs is close to the intensity of competition gradually.

In the context of above three aspects (skills application training and learning stages of skills as well as the principles of technical training), SSGs can complete the transition from initial acquisition of skills to master the skills in competition.

In the next chapter, the reason that SSGs should be applied in youth training will be explained from the aspect of tactical training.

2.4.4 The benefits of SSGs for tactical training

In order to be a top level player, it is necessary that not only physical ability and technical skills, but also certain tactical competences should be possessed. These tactical competences are extreme important, especially for the invasion sport games, where players have to adapt to new game configurations constantly due to the complex and rapid changing environment. The great variability and complexity of game situations in team game sports is an obstacle to the players who should know the relevant information and interpret it correctly as quickly as possible in competitions environments. For example a case by beginners, they are often not able to make quick and accurate decisions, because it is different for them to apperceive the positions of their teammates and opponents. The difference of performance between a top athlete and a beginner is especially the tactical competences and cognitive processes, which are seen as essential aspects of decision making (Lopes, 2011, p. 65).

Top players like Michael Jordan in basketball and Wayne Gretzky in hockey can show a high performance especially in the situations where they are under massive stress and time pressure. These types of players are often referred as a "playmaker", in that they

have a superior ability to “read” the games, and thus are able to make the best decision even at a critical moment. If they are covered by stronger players, they can anticipate their actions and change their movements so that they almost always get an advantage over the opponent.

Lopes (2011, p. 65) argues that top players have three characteristics leading to a better decision than beginners:

- Experts can discern the relevant information of the environment.
- In their long-term memory, they have a large repertoire of possible hypotheses and possible measures and can therefore better judge their decisions about their chance and risks.
- Signal recognition, hypothesis establishing and decision results are closely linked.

It is similar to this how players analyze the competitions situations and make their decisions, depends on how they perceive the environment. The different level of cognitive ability is the essence of tactical competences’ difference between top players and beginners (Lopes, 2011, p. 65).

Before considering the benefits of SSGs for tactical training, the theories of cognitive learning process should be presented firstly, that is the basis for the present study.

2.4.4.1 Cognitive learning process

As a general theory of tactical learning, the anticipative behavioral control theory (Hoffmann, 1993, p. 44) is selected, this can be explained by cognitive processes. In order to explain the variability of tactical decisions on similar situations, Raab (2002, p. 166) proposes the SMART (situation model of anticipated response-consequences in tactical decisions) and the T-ECHO (tactical decision-explanatory coherence by harmonic optimization) model, two integrative and dynamic process theories that are considered as sport game-specific concretions of anticipative behavioral control.

In view of the importance, the theory of Hoffmann and both cognitive models of Raab are described in detail.

Anticipative behavioral control

According to Hoffmann (1993, p. 44), man has the need for anticipative behavior. If he tries to fulfill this need, he learns to interact with the environment. Based on this idea, Hoffmann develops his theory associating the learning mechanisms with anticipative behavior control each other. This hypothetical mechanism can be read schematically in figure 2.

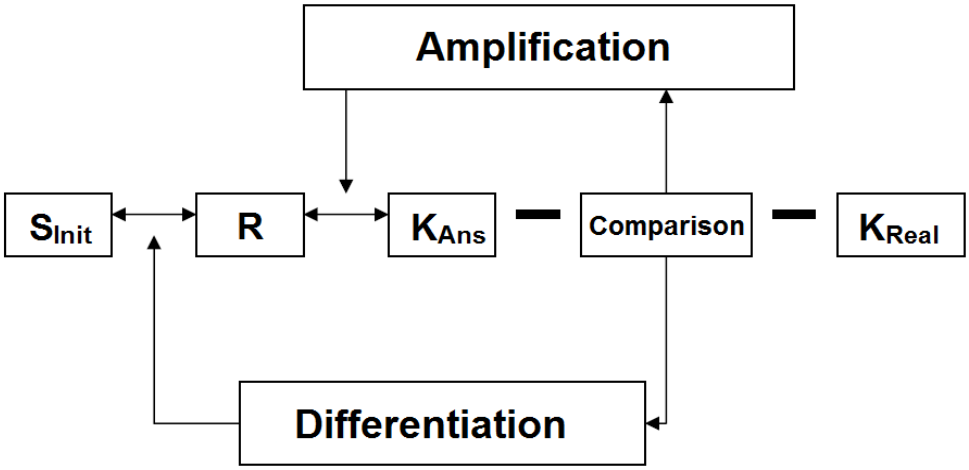

Fig. 2: Learning mechanisms according to Hoffmann (1993, p. 44).

It should be pointed out that, relying on the prior experiences in a similar situation (S-init), the intentional actions (R) will always occur together with an expected consequence (K-ans). After the action occurred, these anticipated consequences (K-ans) with real consequences (K-real) are compared. If the action is successful (K-ans=K-real), then the current situation could be solved, these actions are enhanced.

This learning process means that under the same situational environment the same result is always expected, which is linked to a corresponding action.

If no agreement can be found between the anticipated and the real consequences (K-ans≠K-real), the real action will be differentiated from anticipated consequence and the cycle of learning mechanism will begin again. Those stimuli in the initial situation, which are not confirmed for the previous anticipations, will be connected with the unexpected occurred consequences.

Organisms with such a learning mechanism would always extend complete knowledge about, under which environmental conditions which of their possible behaviors lead to which consequences. They could apply this knowledge continuously and effectively for a specific use their behavior to desired goals under changing environment.

For example, in game sports match, a striker tries to break through. Based on different weathers, the conditions of the field are different. If it rains, due to the muddy ground, strikers can't play with advantages of speed. If it snows, because of the smooth ground, the track of ball is irregular. Environmental factors need to be taken into account in order to make decisions.

The perception to situations includes not only the current situation but also changeability through their behavior (Hoffmann, 1993. p. 47).

Based on the anticipative behavior model, Raab (2002, p. 151) develops two models (SMART and T-ECHO), which focus on the interpretation of complicated dynamic cognitive processes.

SMART model

This theory is applied to sport games and analyzed the game tactical decision with respect to general cognitive strategies, when searching for information, the search for information and the generation of alternative is stopped.

First, under time pressure the general cognized solutions are generated and the best one will be selected. Then, the total number of solutions associated by a player with situational cognized solutions variants decreases according to the quality. With increasing expertise, the selected decisions are less, but more situations adapted.

There is a more complicated situation:

In a counterattack, an attacker (A) is moving forward quickly with ball near the penalty area, while a striker (B) in penalty area is waiting for a pass from the attacker (A) or other teammates. A back wing (C) tries to defend the attacker (A), at the same time other full back (D) is moving for balancing defense. At this moment, the attacker (A) faces many choices, such as dribbling, break through, flank pass etc. He should make a decision as soon as possible, which is most appropriate for the current situation. With the increase of practical experiences, attacker (A) can understand gradually in this case, through which behavior, it is most likely to achieve a good result (high possibility for goal).

For example, with which tactical decisions, a high possibility for goal can be achieved.

T-ECHO model

T-ECHO model is based on the anticipations model developed by Hohmann et al. (2006, p. 132; Raab, 2002, p. 151). This Model is regarded as a game specific conception of anticipative behavior control.

The knowledge value basis (top down-instance) and the situational perception (bottom up instance) are in the equivalent level. The tactical decision (intension) is generated as the harmonious and optimal result of an alternating reconciliation process lying between two instances (the perception of current environment and the previous internalized goal and values to individual alternatives (desires)). The model also assumes that the two instances (knowledge-/ value basis and situational perception) can cause different preferences that compete for the final action's decision.

The dynamic process of generating tactical decisions can be seen in figure 3.

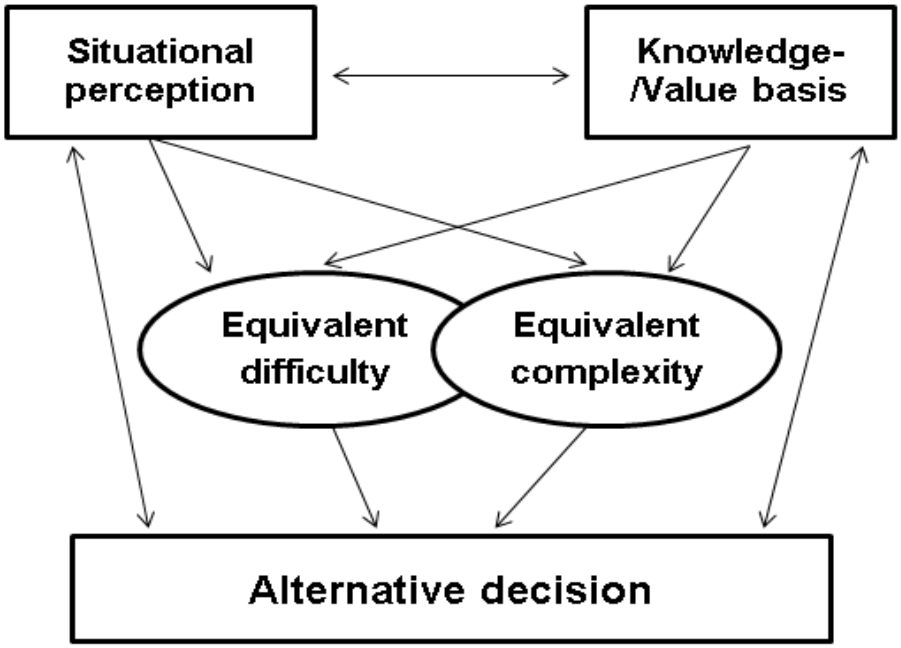

Fig. 3: The T-ECHO model for the explanation of tactical decision in sport game (Hohmann et al. 2006, p. 132; Raab, 2002, p. 151)

In the same case (in SMART Model), the attacker (A) makes a decision based on the following factors:

- Situational perception: speed, moving track, position, intentions of related players etc.
- Knowledge-/ value basis: as soon as possible accurate passing to the offensive player, who is at the best position for shooting according to the current situation.
- Difficulty: distance, speed, field quality, technical ability, etc.
- Complexity: defensive behaviors of the opponents, requirement to passing quality, etc.

The factors above need to be considered, if the attacker (A) needs to make an appropriate decision.

A person, who learns through these mechanisms, can always acquire a complete knowledge of the consequences of actions in a certain situation. Therefore, the person can apply certain actions effectively for future behavior in order to achieve the desired goal. The collection of experience in a certain game situation causes the beginner to have a safer actions performance, in that he learns to anticipate the consequences of movements (Lopes, 2011, p. 70).

2.4.4.2 The significance of anticipative behavior

The knowledge (experience) about consequence of behavior under different conditions, which can be obtained through a lot of competitions, is useful, because it creates the conditions for the appropriate use of behaviors to achieve future goals. The need to predict behavioral consequences supports learning processes that serve to meet future performance requirements. In this sense, it includes an anticipation of behavioral requirements that should be performed in the future. The anticipation for behavioral consequences is developed as a mechanism that supports effectively not only the overcoming of current but also of future behavioral requirements, which promotes the integration of organisms with their environment and increases their ability to adapt to changing environmental conditions (Hoffmann, 1993. p. 54).

For tactical training, the significance of anticipative behavior in sport can be seen:

- Enhancement of celerity

Experienced players (e.g. football or handball player), react in general actions (key press) for unspecific symbols faster than less experienced. In addition, in general the

experienced handball goalkeepers react in specific choice responses (visible throwing motion) 70ms faster than non-visible (Hohmann et al. 2006, p. 132).

- Perception

It is reported that experienced volleyball player recognize the ball 3 times faster than less experienced players in a volleyball specific perceptible test which is an ultra-short slide shows of images of competitions situation (Hohmann et al. 2006, p. 132).

- Enhancement of accuracy

In general anticipation tests, better players can anticipate the timing of the achievement of an incoming light beam much more precisely and constantly than weaker players. Moreover, more experienced players of netball (e.g. volleyball, tennis, football, table tennis) anticipate earlier and more accurately than inexperienced beginners in sport game-specific tests, which is based on the slide show of images of game situations as well as the video presentation of film sequences to action processes and the final output of action. Furthermore, they can also react at video presentation with their own active attack actions with ball correctly and faster in compare with less experienced players (Hohmann et al., 2006, p. 132).

According to the mentioned facts above, based on the significance of anticipative behavior (experiences) players can perform more effectively under the complicated and quick changing environment of competition, regardless of whether in the general tests or in sport game-specific tests. Therefore, in this sense the anticipative behavior is very important for the execution of tactical action in competition, especially for some invasion team sports (e.g. basketball, handball, football etc.) in which players need to make a lot of decisions quickly under complicated situations.

The benefits through SSGs to improve processes will be explored.

2.4.4.3 Benefits of SSGs for cognitive processes

On the basis of the published literature so far, the benefits of SSGs for the improvement of cognitive processes are showed in two aspects:

- amount of repetitive technical behaviors
- consistency with the cognitive process

Amount of repetitive technical behaviors

For players, every touch is a decision, which is made in terms of the environment of competition. As the results in chapter 2.4.2 show, players need to make a lot of decisions under complicated situations of competition by SSGs, which requires the performance of many technical behaviors. According to the theories in chapter 2.4.4.1, players can increase the tactical understanding of game scenes and enhance their comprehensive cognition (match experiences) due to the large amounts of decision, in particular, the process of selection can be accelerated under specific and complicated competition environment. Ths view is supported:

- Because of their great specific experiences players can read out the specific situations for the optimal action decisions from game processes (Hohmann et al., 2006, p. 143).
- Raab (2002) point out that small street soccer is a useful learning path for technical and tactical expertise. The learning path is characterized by confrontation with an extreme high number of solved situations, which guarantees the constitution of appropriate responses of movements.
- By the training of SSGs, players can experience many similar competitive situations that they may meet in match, and these situations are suggested to improve their decision making and tactical competences through functional movements (Owen et al., 2004, p. 50).

Consistency with the cognitive process

It is recommended (Hohmann et al., 2006, p. 136) that the training of anticipation should be purposefully organized. The aim is to set up mental representations of action situations. On their basis the multiple tactical skills can be used effectively as a situation-specific action. It makes perfect sense for beginners that the target of games can be reduced by technical-tactical simplifications on an initial game. Consequently, the small forms of games are preferred, which under the educational-methodological varied conditions leads to easing und repeating certain game actions. For example, the 3vs3 form in the introduction of basketball game and 4vs4 form of water polo with both hands for catching and throwing.

In the strategies of implicit learning, a similar view (Raab 2002, p. 151) is proposed that a free or methodical modified game is beneficial to the perceptual accentuated learning of action references.

As in chapter 2.3 described, the SSGs, which are modified for younger players, contain simplified rules and a small number of participants. With the increasing age, the contained number of participants and integrity of rules as well as complexity are also rising. Thus, in this sense the arrangements of complexity by SSGs are in line with physical development and improvement of cognitive ability.

Therefore, in terms of the above two benefits (amount of repetitive technical behaviors and consistent with the cognitive process), SSGs are very important for players to promote their cognitive development, especially for the understanding of specific competitions situation.

In order to understand comprehensively the role of SSGs in physical-, technical- and tactical training, all published methods and parameters of analysis to the best of the author's knowledge will be introduced in chapter 2.5.

2.5 Published methods and parameters

2.5.1 Physical analysis

Time-motion

Time-motion analysis is widely applied to quantify the players' movement in a range of sports such as soccer, handball, and basketball as well as hockey etc. The physical activity of players' motion as movement pattern is measured using various systems, for instance, ultra-wide-band system (ubisense) and local position measurement (LPM) system as well as global positioning system (GPS). The distance travels of each player during SSGs are recorded and then translated into total distance covered and time spent at various speeds of movement (Dellal et al., 2011a, p. 341; 2011, p. 2371; 2011, p 322; Barbero-Alvarez et al., 2008, p. 63; Hill-Haas et al., 2009a, p. 1; 2009c, p. 111; Casamichana & castellano, 2010, p. 1615; Brito, Krustrup & Rebelo, 2012, p. 946).

For the analysis, four categories are established:

- Stationary/walking: 0-6.9 km h^{-1}
- Low-intensity running: 7-12.9 km h^{-1}
- Medium-intensity: 13-17.9 km h^{-1}

- High-intensity running: >18 km h^{-1} (Hill-Haas et al., 2009, p. 1; Casamichana & Castellano, 2010, p. 1615)

In addition, the above criteria are subdivided further by some researchers:

- Standing: 0-6.9 km h^{-1}
- Walking: 7-9.9 km h^{-1}
- Low-intensity running Jogging: 10-12.9 km h^{-1}
- Medium-intensity running: 13-15.9 km h^{-1}
- High-intensity running: 16-17.9 km h^{-1}
- Maximal speed running (sprint): > 18 km h^{-1} (Hill-Haas et al., 2008, p. 487; Barbero-Alvarez et al., 2008, p. 63; Castagna et al., 2009, p. 490)

In general two thresholds (13-17.9 km h^{-1} and > 18 km h^{-1}) are used to evaluate the distance covered in categories of running speeds HIR (high-intensity running) and sprint (maximal speed running).

In terms of above criteria, the common used parameters are listed:

According to the duration (Hill-Haas et al., 2008, p. 487; 2009c, p. 111 Casamichana & Castellano, 2010, p. 1615; Dellal et al., 2011a, p. 341):

- Mean sprint duration
- Total sprint duration
- Average maximum sprint duration
- Average minimum sprint duration
- Time between sprints/sprint frequencies
- Time spent above 18 km h^{-1}
- Maximum sprint duration

According to the distance covered (Hill-Haas et al., 2008, p. 487; 2009a, 1; 2009c p. 111; Barbero-Alvarez et al., 2008, p. 63; Dellal et al., 2012, p. 957; Castagna et al., 2009, p. 490):

- Mean sprint distance
- Mean total distance covered during the first and second halves
- Total distance covered
- Total sprint distance

- Average maximum sprint distance
- Average minimum sprint distance
- Total distance in HIR
- Percent total distance in sprint
- Percent total distance in HIR
- Maximum sprint distance

Moreover, some specific parameters are applied for specific assessments.

Relative distance covered per minute

It is used as a global index of task intensity to represent the general activities' intensity of players (Casamichana & Castellano, 2010, p. 1621).

Sprint activity ratio

It's used to calculate for reflection of the activities of players during SSGs. It's calculated that by dividing the elapsed time gap between the first sprint and the final sprint during the total time of SSGs and by multiplying the total number of sprint >18 km h^{-1}. This ratio can differentiate the difference of performances in sprints' frequencies (Hill-Haas et al., 2009c, p. 111).

Work-to-rest ratio

The ratio can provide the global information about the activity pattern of movements. It records the distance covered in each of the speed categories. The variable is estimated with using the distance covered at a speed of 0-6.9 km h^{-1}as "rest" and while all others categories with speed great than 6.9 km h^{-1} are considered as "work". If the ratio is >1, it means that the activity pattern has a longer distance covered at high intensity (Casamichana & Castellano, 2010, p. 1621).

2.5.2 Physiological parameters

In order to demonstrate the intensity of exercise exhaustively, measurements of some important physiological parameters such as heart rate and concentrations of blood as well as ratings of perceived exertion (RPE) are necessary.

2.5.2.1 Heart rate

Heart rate responses are recorded through a short range radio telemetry monitors, which can record heart rate of players (e.g. maximum heart rate and individual mean heart rate etc.) continuously during SSGs. Using special software tools, the time spent within each intensity zone during SSGs can be quantified and expressed as (Dellal et al., 2011, p. 322; 2011, p. 2371; Katis & Kellis, 2009, p. 374; Hill-Haas et al., 2008, p. 487; 2009c, p. 111; Casamichana & Castellano, 2010, p. 1615):

- Percentage of HR max (%HR_{max})
- Reserve HR (%$HR_{reserve}$)
- Mean heart rate (%HR_{mean})

Therefore, various intensity zones for analysis of SSGs are established by some researchers (Duarte et al., 2009, p. 37; Barbero-Alvarez et al., 2008, p. 63):

- Very vigorous activity: time spent above 85% of HR_{max}
- Moderate activity: time spent between 65% and 85% of HR_{max}
- Low activity: time spent below 65% of HR_{max}

The 5 HR zones are used (Dellal et al., 2011, p. 2371):

- Zone 1 <75% of HR_{max}
- Zone 2 75-84% of HR_{max}
- Zone 3 85-90% of HR_{max}
- Zone 4 >90% of HR_{max}

The recorded heart rate can be divided into 5 intensity zones by Jones & Drust (2007, p. 150)

- >50% of HR_{max}
- 50-60% of HR_{max}
- 60-70% of HR_{max}
- 70-85% of HR_{max}
- >85% of HR_{max}

In addition, Brito et al. (2012, p. 946) divide with 5 intensity zones:

- <70% of HR_{max}
- 70-80% of HR_{max}
- 80-90% of HR_{max}
- 90-95% of HR_{max}
- >95% of HR_{max}

2.5.2.2 Blood lactate

Blood lactate [la] is a physiological indicator to measure anaerobic glycolysis' contribution. Capillary blood samples are taken from each player after SSGs training. Blood lactate concentration will be determined using a blood gas analyzer (Dellal et al., 2011a, p. 341; 2011, p. 322; Hill-Haas et al., 2008, p. 487; 2009a, p. 1).

2.5.2.3 Rating of perceived exertion

In comparison with heart rate and blood lactate concentration, the global ratings of perceived exertion (RPE) using 6-20 scale is suggested to be a good global indicator to determine the internal load in training such as how hard the players find the trainings session and internal intensity as well as the exercise load. After each SSGs, the perceived exertion rating scale is recorded immediately using the borg scale (6-20 scale), which is a standardized question without providing information to players and with respect to some previous measurements (Dellal et al., 2011a, p. 341; 2011b, p. 322; Hill-Haas et al., 2008, p. 487).

For example, some questions are listed (Brito et al., 2012, p. 946):

- In general, how hard is the game today?
- How do you classify the effort made during the game?
- How hard physically is the game today?
- How tired are you at the moment?

2.5.3 Technical parameters

In order to film the technical activities of players, all SSGs are recorded with using fixed digital video cameras around the pitch area. The video should be played back several times for the analysis to confirm the accuracy of all technical behaviors.

All the technical actions of Players' during the SSGs are determined with a hand notation system, which observes, codes and registers all technical behaviors (Dellal et al., 2011, p. 322; Owen et al., 2004, p. 50; Katis & Kellis, 2009, p. 374; Duarte et al., 2009, p. 37; Kelly & Drust, 2009, p. 475; Casamichana & Castellano, 2010, p. 1615):

- Number of duels
- Number of percentage of successful passes
- Number of ball losses
- Number of total number of ball possessions
- Number of passes
- Number of receives
- Number of turns
- Number of dribbles
- Number of headers
- Number of tackles
- Number of interceptions
- Number of blocks
- Number of short passing (distance less than 10 m)
- Number of long passing (distance more than 10 m)
- Number of shots on goal
- Number of clearances
- Number of controls
- Number of squat jumps

2.5.4 Tactical parameters

All tactical behaviors during SSGs are filmed using fixed digital cameras and determined with software tools for analysis according to these criteria (Costa et al., 2010a, p. 10; 2010b, p. 58; 2010c, p. 73):

Game principles

- Penetration
- Offensive coverage
- Width and length

- Depth mobility
- Offensive unity
- Delay
- Defensive coverage
- Balance
- Concentration
- Defensive unity

Action outcomes

- Offensive phase
    - ✓ Shot at goal
    - ✓ Keep possession of the ball
    - ✓ Loss of ball possessions
- Defensive phase
    - ✓ Regain the ball possessions
    - ✓ Ball possessions of the opponent
    - ✓ Shot at goal of the opponent

3 Role of SSGs for physical training

The modern game sports are demanding for high-intensity activities. It‘s important for players to perform repeated high-intensity actions (Di Salvo et al., 2007, p. 222). In addition, the most successful teams can perform much more high-intensity actions in matches, especially when they are in possession of the ball (Bradley et al., 2009, p. 159). According to playing positions, elite players perform running in high-intensity (HIR) for total distance covered between 226.1m to 334.0m and running in sprints for total distances from 193.6m to 278.2m in high level matches (Iaia et al., 2009, p. 291). Therefore, it’s necessary for elite players, to possess a high fitness level to cope the physical response of the match.

In recent years, SSGs are widely used as a tool for physical training. Thus, it is necessary to comprehensively understand the role of SSGs for physical training in order to improve the effect on physical training. Many researchers concern about the efficiency of SSGs in physical training (Hill-Haas et al., 2009a, p. 1; Casamichana, & Castellano, 2010, p. 1615; Dellal et al., 2011a, p. 341; 2011, p. 2371; Katis, & Kellis, 2009, p. 374; Duarte et al., 2009, p. 37; Kelly, & Drust, 2009, p. 475; Castagna et al., 2009, p. 490). Based on various objectives and criteria, such as certain group (elite and amateur) and modified rules (one touch and two touches as well as free play), these results of their studies are relatively fragmented and have certain limitations. To the best of the author’s knowledge, the role of SSGs for physical training is also lacking a full understanding, for instance can SSGs meet the demand of high-intensity for match-play? How to effectively apply SSGs for high-intensity activities?

Therefore, the aim of this chapter is to examine the role of SSGs for improving effects of training for high-intensity activities. In this context, in order to fully understand this issue, in terms of all published literature, the role of SSGs for high-intensity activities will be shown.

3.1 Analyses to the results

At present, researches focus mainly on three aspects.

- Field and number of players;
- Modified rules;
- Time regimes.

All published literature will be enumerated in detail.

3.1.1 Field and number of players

Experiment 1

In order to examine the influence of various formats by SSGs on physical loads of players, Hill-Haas et al. (2009a, p. 1) carried out the experiment, which consists of three SSGs (2-a-side, 4-a-side and 6-a-side). The results can be seen in table 10.

Tab. 10: The time-motion characteristics of higher intensity running (Hill-Haas et al., 2009a, p. 1)

Time-motion variable	Format		
	2 vs. 2	4 vs. 4	6 vs. 6
Total distance (m)	2574m ± 16	2650m ±18	2590m ± 33
Total distance at 0-6.9 km/h	1176m ± 8[a]	1128m ±10	1142m ± 16
Total distance at 7.0-12.9km/h	933m ± 21	1041m ±25	925m ± 37
HIR (total distance at 13.0-17.9 km/h)	411m± 13	436m ± 15	442m ± 22
Total distance in sprints (>18km/h)	44m ± 24[a,b]	6m5 ± 36	71m ± 36
Average sprint (>18km/h) duration (s)	1.42 ± 0.2[a,b]	1.75 ± 0.3	1.88 ± 0.4
maximum sprint duration (s)	2.34 ± 0.7[a,b]	2.91 ± 0.9[c]	3.53 ± 0.9
Average Sprint (>18km/h) distance (m)	6.3 ± 1.3[a,b]	8.3 ± 2.0	9.2 ± 2.3
maximum sprint distance (m)	11.5 ± 3.9[a,b]	15.3 ± 5.5[c]	19.4 ± 5.9
Total number of sprints	7 ± 3	8 ± 4	8 ± 3
Time between sprints (s)	230 ± 126[a,b]	179 ± 78	189 ± 81

[a]2 vs. 2 versus 4 vs. 4: P< 0.05;
[b]2 vs. 2 versus 6 vs. 6: P <0.05;
[c]4 vs. 4 versus 6 vs. 6: P<0.05.

Results

There are no significant differences between any formats of SSGs in total distance covered 0-6.9 km/h and total distance covered at 7.0-12.9 km/h as well as total distance covered at 13.0-17.9 km/h, except the total distance covered (0-6.9 km/h) between the 2-a-side and 4-a-side formats of SSGs (1176 ± 8m and 1128 ± 10m).

But significant differences exist between the 2-a-side format and others formats (4-a-side and 6-a-side) in sprint (>18km/h) for total distance covered (44 ± 24m, 65 ± 36m, 71 ± 36m) and both average duration and distance (1.42 ± 0.2s, 1.75 ± 0.3s, 1.88 ± 0.4s and 6.3 ± 1.3m, 8.3 ± 2.0m, 9.2 ± 2.3m respectively).

In contrast to the 2-a-side format of SSGs, not only more total distances covered in sprints but also more average durations and distances of sprints are generated in two larger formats of SSGs (4-a-side and 6-a-side). In general, larger fields can cause more movements in sprint.

In addition, both maximum duration and distance in sprints (2.34 ± 0.7s, 2.91 ± 0.9s, 3.53 ± 0.9s and 11.5 ± 3.9m, 15.3 ± 5.5m, 19.4 ± 5.9m) indicate also significant differences between all formats (2-a-side, 4-a-side and 6-a-side) respectively. In terms of the greater

maximum distance and duration in sprints, the 6-a-side format differs significantly from other formats of SSGs (2-a-side and 4-a-side). The qualities of sprints are higher, when more absolute playing fields are available.

Although no significant differences exist for total number of sprints between any formats of SSGs, it seems that there are also significant differences for sprint frequency (time between sprints) between small format (2-a-side) and other two formats (4-a-side and 6-a-side) of SSGs (230 ± 126m, 179 ± 78m and 189 ± 81m, respectively). According to the comparison, larger areas can cause more high-frequency sprints than smaller playing fields.

The results demonstrate that in general, with the expansion of playing field, frequency and quality of sprints can be simultaneously increased significantly.

Experiment 2

The study (Casamichana & Castellano, 2010, p. 1615) has the aim to examine physical responses during different SSGs, which consist of different individual playing areas (275 m^2, 175 m^2, and 75 m^2). Results of this study can be seen in table 11.

Tab.11: Physical variables of players in different SSGs (Casamichana & Castellano, 2010, p. 1615).

Time-motion variable	SSGs-L	SSGs-M	SSGs-S	Correlation with EPT
Total distance (m)	999.6 ± 50.0[a,b]	908.9 ± 30.6[c]	695.8 ± 37.1	0.683★
Distance covered per minute (m)	125.0 ± 6.2[a,b]	113.6 ± 3.8[c]	87.0 ± 4.6	0.683★
stationary/walking (0-6.9km/h) (m)	378.2 ± 37.2	390.6 ± 30.4	401.7 ± 27.7	-0.577★
low-intensity running (7.0-12.9km/h)(m)	366.3 ± 74.8	329.3 ± 54.0	238.9 ± 41.7	0.6577★
Medium-intensity running (13.0-17.9km/h)(m)	180.9 ± 42.6[b]	155.4 ± 41.4[c]	50.2 ± 21	0.787★
High-intensity running (>18km/h) (m)	74.2 ± 58.9[b]	28.5 ± 33.3	4.9 ± 5.5	0.128
Maximum speed (km/h)	23.1 ± 2.6[b]	20.4 ± 1.9	18.1 ± 1.5	0.253
Sprint frequency	5.8 ± 3.9[b]	3.0 ± 2.2	0.8 ± 0.7	0.251
Work-to-rest ratio	1.7 ± 0.3[b]	1.3 ± 0.2[c]	0.7 ± 0.2	0.805★
Effective playing time (s)	394 ± 33	364 ± 9	325 ±17	

SSGs-L (large pitch), SSGs-M (medium pitch), SSGs-S (small pitch)
[a]SSGs-L > SSGs-M P<0.05;
[b]SSGs-L> SSGs-S P<0.05;
[c]SSGs-M> SSGs-S P<0.05.
pearson's correlation coefficients: ★P <0.01

Results

Significant differences are observed for most variables between the three SSGs formats. There are significant differences for total distance and distance covered per minute between the three formats of SSGs (999.6 ± 50.0m, 908 ± 30.6m, 695.8 ± 37.m1 and 125.0 ± 6.2m, 113.6 ± 3.8m, 87.0 ± 4.6m, respectively). In contrast to smaller field formats, more general intensities are generated in medium format, but less than in large format. The general intensities are increased, when the individual playing areas per player increase gradually.

For high-intensity activities (13.0-17.9km/h and >18km/h), it seems that a similar pattern of activity (work-to-rest ratio) exists in others formats (1.3 in medium and 1.7 in large) in comparison with the smaller (0.7) format.

For the work-to-rest ratio, it appears that a significant difference exists between medium and smaller playing field (1.3 ± 0.2 and 0.7 ± 0.2). In this respect, considering the significant difference (155.4 ± 41.4m and 50.2 ± 21.0m) for the variables in distance intensity running (13.0-17.9 km/h) between the same formats (medium and smaller), players perform significantly more higher intensity running (13.0-17.9 km/h) in medium field, in comparison to smaller format. Furthermore, significant differences are also found between the large and smaller format for sprint (>18 km/h) and higher intensity running (13.0-17.9 km/h) (74.2 ± 58.9m, 4.9 ± 5.5m and 180.9 ± 42.6m, 50.2 ± 21.0m, respectively). Compared to smaller format, players perform much more high-intensity activities (higher intensity running and sprint) in larger format of SSGs.

In addition, compared to the smaller format, both variables (sprint frequency and maximum speed) are similar in large format. Significant differences for sprint frequency (5.8 ± 3.9 and 0.8 ± 0.7) and maximum speed (23.1 ± 2.6km/h and 18.05 ± 1.5km/h) are also respectively observed. The percentages of proportion for sprints (high-intensity running> 18km/h) and the absolute value (maximum speed) increase significantly, with the expansion of individual playing areas per player. Not only the number of sprints, but also the qualities of sprints are higher in large format than in smaller format.

The results demonstrate that higher physical activities (HIR and sprints) increase, especially the quantity and quality of sprints, when the individual available playing area per player is increased.

In addition, for the variable effective playing time (EPT), there are significant differences between various formats of SSGs. When the playing field becomes smaller, there is a concomitant decrease for EPT with the shortest duration corresponding to the smaller format (in smaller format 325 ± 17s; in medium format 364 ± 9s; in larger format 394 ±

33s). Moreover, it seems that there is a strong and positive correlation between effective playing time and almost all general and special physical variables (total distance, distance covered per minute, work-to-rest ratio etc.). At the same time, there is a negative correlation between EPT and total distance covered in stationary/ walking (-0.577★).

Experiment 3

Dellal et al. (2011, p. 2371) try to examine the physical loads during various formats of SSGs (2vs.2, 3vs.3, and 4vs.4) at different levels (professional and amateur) according to the same pitch ratio per player (1:75) (m^2). The results are described in table 12.

Tab.12: Physical activity of players at professional and amateur levels (Dellal et al., 2011, p. 2371)

Level of players	Number of players	Total distance covered (m)	Total distance covered in HIR (m)	Total distance covered in sprint (m)
Professional	2vs.2	1157.7 ± 83.0	245.5 ± 37.9	177.6 ±21.9
	3vs.3	2014.0 ± 154.5	422.5 ± 33.4	315.6 ± 52.6
	4vs.4	2663.7 ± 236.7	482.7 ± 71.2	381.8 ± 56.6
Amateur	2vs.2	1086.7 ± 106.4★	225.7 ± 34.6★	160.2 ± 19.7★
	3vs.3	1861.0 ± 154.7★	383.9 ± 51.9#	272.2 ± 46.8#
	4vs.4	2419.8 ± 272.5★	480.4 ± 50.5	327.8 ± 47.8★

★significantly lower than professional $p<0.05$;
significantly lower than professional<0.01.

Results

Professional level:

In contrast to 2-a-side format (1157.7 ± 83m), players perform much more total distance covered in 3-a-side format of SSGs (2014.0 ± 154.5m), whereas significantly less than in 4-a-side format (2663.7 ± 236.7m) for professional players.

It's similar for both variables (HIR and sprint), compared to 2-a-sided format (245.5 ± 37.9m and 177.6 ± 21.9m), and much more high-intensity activities are significantly generated in 3-a-side format (422.5 ± 33.4m and 315.6 ± 52.6m), whereas less than in 4-a-side format (482.7 ± 71.2m and 381.8 ± 56.6m) at professional level.

Amateur level:

It appears that there is a similar tendency at amateur level too. Not only the total distance covered, both variables of high-intensity activities (HIR and sprint) rise also significantly with the increase of playing area and number of players according to the same pitch ratio per player.

The results demonstrate the consistency of the effect of SSGs at different levels. With the increasing playing area, more physical loads will be generated, especially for the high-intensity activities (HIR and sprint).

In addition, through the comparison with results of players at different levels, the high-intensity loads, performed by professional players, are generally higher than others, which are generated by amateur players in figure 4, except the total distance covered in HIR in 4-a-side.

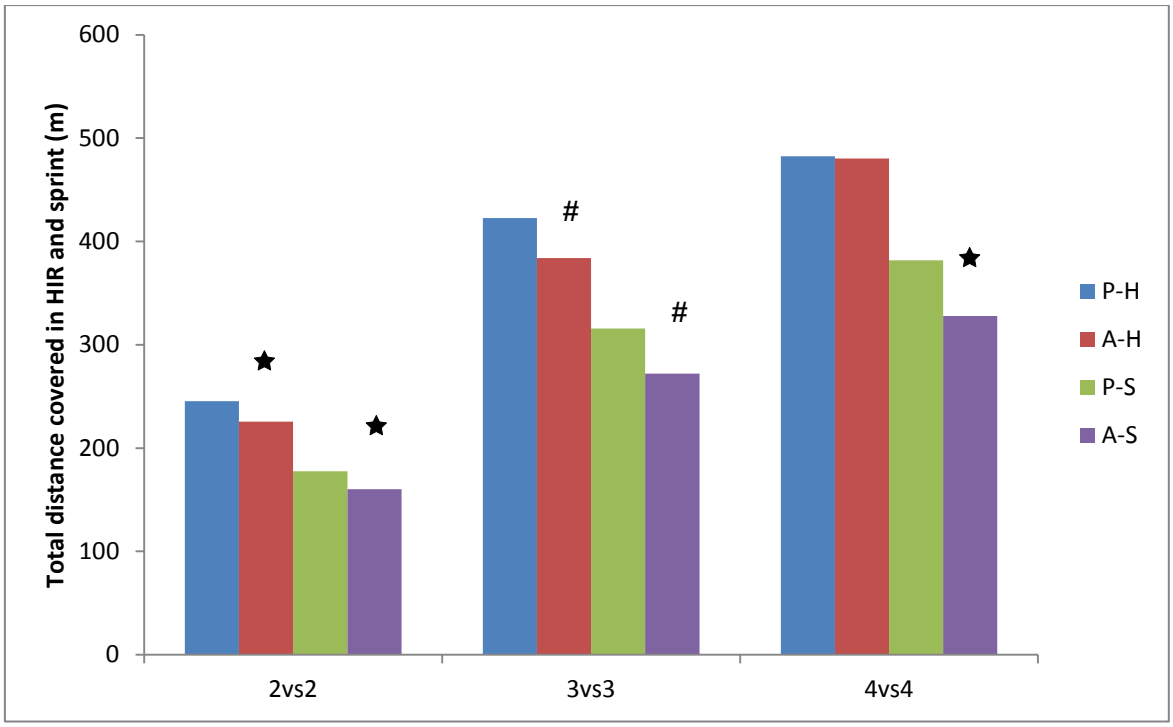

Figure 4: Time-motion characteristics between professional and amateur levels (Dellal et al., 2011, p. 2371)

P-H=professional players in HIR;
A-H= amateur players in HIR;
P-S= professional players in sprints;
A-S= amateur players in sprints.
★significantly lower than professional p<0.05;
significantly lower than professional<0.01.

For example, in contrast to amateur level, the professional players have to perform much more distance covered in sprint obviously (177.6 ± 21.9m, 315.6 ± 51.6m, 381.8 ± 56.6m and 160.2 ± 19.7m, 272.2 ± 46.8m, 327.8 ± 47.7m, respectively). These results reflect that the enhancements of effects by SSGs are different for players at different levels.

Discussion

The main finding of the experiment 1 (Hill-Haas, et al. 2009a, p. 1) and experiment 2 (Casamichana & Castellano, 2010, p. 1615) shows that the quality (maximum duration and distance) and quantity (frequency) of sprints are related to the absolute size of playing fields. It's understandable that the relationship between players in competition is dynamic and complex. In order to win more time and space for possessions and passing, players must try to lose their direct opponents. It's necessary for players always to run to create more appropriate opportunities. Thus, more high-quality sprints are needed. With the increasing number of players, the absolute sizes of playing field are simultaneously increased according to certain proportion. In the context of less involvement with ball in larger playing formats, players have to spend more time working "off the ball" to create more space for opportunity. Thus, SSGs provide more chances for sprints.

The result of experiment 2 (Casamichana & Castellano, 2010, p. 1615) shows that on the basis of maintaining the number of players, the pitch ratio per player is promoted through the increase on absolute playing field. This result shows that high-intensity activities (HIR and sprints) are promoted significantly with the increase of the available pitch per player.

Moreover, the results of experiment 2 demonstrate that effective playing times are significantly related to sizes of playing fields, and the strong positive correlation between effective playing times and physical loads, especially for high-intensity activities. It's also understandable that more effective playing times in competition mean fewer interruptions for players. Thus, the process of trainings or matches is smoother, in this sense, more high-intensity activities are possible. In terms of the fact that more effective times are produced by larger formats of SSGs, compared to the smaller formats of SSGs. These characteristics that larger formats of SSGs can significantly provide more high-intensity activities, which can be confirmed from another aspect.

The finding in experiment 3 (Dellal et al., 2011, p. 2371) is in line with the report by Barbero-Alvarez et al. (2007, p. 63), which supports also the finding from experiment 2, but more than those findings (Casamichana & Castellano, 2010, p. 1615; Barbero-Alvarez et al., 2007, p. 63). Dellal et al. indicate that not only the effectiveness of SSGs for high-intensity training at all levels, but also through the comparison of the results between professional and amateur players, so as to demonstrate that professional players perform more movements than amateur players, especially for the high-intensity running (HIR and sprints). This fact reflects the essential differences between professional and amateur levels of the ability to repeat high-intensity running to implement. This result also confirms the previous finding, which indicates the key difference between professional and amateur

players is related to the high-intensity efforts (Kaplan et al., 2009, p. 774). In the context of these findings, the effect of SSGs for high-intensity activities is significantly associated with the level of players. In other words, the higher level, the more obvious effects can be achieved.

In summary, these results of above experiments indicate that the altering of playing field of SSGs can effectively influence the high-intensity activities of players at all levels. Although the sizes of playing fields in these attempts are changed with various numbers of players in terms of different proportion, the trend indicates that high-intensity activities of players will increase with the expansion of playing field, in particular the enhancements of quality and rise of quantity for sprints are more obvious. Thus, the altering of playing areas in SSGs can be applied to improve for the specific fitness training. In addition, the differences of results between different levels are found. The higher the level is, the more obvious effects can be found.

3.1.2 Modified rules

Experiment 4

In order to examine the effect of the modified rules (number of ball touches authorized per possession) on physical loads of players, Dellal et al. (2011, p. 322) carry out a special experiment, which is divided in four bouts separated with modified rules. The results can be seen in table 13.

Tab. 13: Physical performance with modified rules (Dellal et al., 2011, p. 322)

Variables	Bout 1	Bout 2	Bout 3	Bout 4
Total distance covered (m)				
1 touch★★	835.7 ± 61.1	793.6 ± 61.2	759.8 ± 69.3	668.7 ± 73.9
2 touches	711.9 ± 65.5	689.2 ± 71.1	667.8 ± 74.0	604.9 ± 55.2
Free play	726.3 ± 65.4	679.4 ± 66.1	659.5 ± 66.2	597.6 ± 56.7
Total distance covered in sprinting (m)				
1 touch★	140.7 ± 20.4	130.5 ± 17.5	119.8 ± 14.3	102.1 ± 12.6
2 touches★	103.6 ± 14.6	95.5 ± 12.4	89.3 ± 12.7	76.5 ± 13.4
Free play	107.3 ± 15.6	100.1 ± 15.1	93.4 ± 14.3	80.9 ± 13.4
Total distance covered in HIR (m)				
1 touch★	195.7 ± 14.9	166.9 ± 18.2	143.8 ± 19.8	132.0 ± 16.6
2 touches★★	169.8 ± 20.5	144.8 ± 17.1	130.5 ± 16.6	107.7 ± 13.2
Free play	107.3 ± 15.6	100.1 ± 15.1	93.4 ± 14.3	80.9 ± 13.4
% of total distance covered in low and moderate intensity				
1 touch	59.6	62.5	65.2	65.0
2 touches	61.6	65.2	67.2	69.6
Free play	65.7	66.9	68.6	69.5

★Significant difference between rules of game; ★ P<0.05;
★★Significant difference between rules of game, ★★ P<0.001

Results

The results show that according to bouts there is a significant trend that the intensity of all analyzed variables (total distance covered and total distance covered in sprints as well as total distance covered in HIR) is gradually reduced, whereas it seems there are lots of significant differences, if these variables are compared to each other in the same bout.

Total distance covered in sprints:

In comparison with free touch rule, players have to perform more sprints with 1 touch rule (140.7 ± 20.4m, 130.5 ± 17.5m, 119.8 ± 14.3m, 102.1 ± 12.6m and 107.3 ± 15.6m, 100.1 ± 15.1m, 93.4 ± 14.3m, 80.9 ± 13.4m, respectively), whereas they execute less sprints with 2 touches rule (103.6 ± 14.6m, 95.5 ± 12.4m, 89.3 ± 12.7m, 76.5 ± 13.4m).

Total distance covered in HIR:

In contrast to free play rule, more high speed running (13.0-17.9 km/h) are obviously generated by 2 touches rule (169.8 ± 20.5m, 144.8 ± 17.1m, 130.5 ± 16.6m, 107.7 ± 13.2m vs 107.3 ± 15.6m, 100.1 ± 15.1m, 93.4 ± 14.3m, 80.9 ± 13.4m, respectively) in each bout, but significantly less than 1 touch rule (169.8 ± 20.5m, 144.8 ± 17.1m, 130.5 ± 16.6m, 107.7 ± 13.2m and 195.7 ± 14.9m, 166.9 ± 18.2m, 143.8 ± 19.8m, 132.0 ± 16.6m, respectively) too.

% of the total distance covered in low and moderate intensity:

The results are completely opposite to those above. The percent of proportions of total distance covered in low and moderate intensity by 1 touch rule is the lowest in each bout. This result reflects that players perform fewer activities at low and moderate intensity with 1 touch rule. In most bouts (the first, second and third), the percent of proportions by 2 touches rule is higher than that by free touch rule. The percent of proportions in the last (fourth) bout by 2 touches and free touch are very close. For free touch rule, the percent of proportions of total distance covered in low and moderate intensity are the highest in each bout in contrast to 1 touch and 2 touches rules.

Based on these data, the results of this experiment (Dellal et al., 2011, p. 322) demonstrate that the modified rules (number of ball contact authorized per individual possession) can affect the physical activities of players, in particular for high-intensity activities (HIR and sprints). In comparison with 2 touches rule, SSGs playing with 1 touch rule can obtain more obvious effects.

Experiment 5

The study (Dellal et al., 2012, p. 957) has the aim at comparing the influence on physical loads of elite players between 4-a-side SSGs with modified touch rules and 11-a-side matches for all positions. Results of this study can be seen in table 14.

Tab. 14: Physical variables associated with SSGs and match-play (Dellal et al., 2012, p. 957)

			Total distance covered (m)★	Total distance covered in sprint (m)★	% of total distance covered in sprint★	Total distance covered in HIR (m)★	% of total distance covered in HIR★
Match play	CD		10671±301	232±52.1	2.1	315±61.2	2.9
	FB		11217±405	309±70.0	2.7	374±55.0	3.3
	CDM		11885±546	317±63.1	2.6	371±64.2	3.1
	WM		11301±623	303±51.7	2.6	357±60.0	3.1
	FW		10790±746	315±69.3	2.9	351±55.3	3.2
	Mean		11173±524	295±61.2	2.6	353±59.1	3.2
SSGs	CD	1T	2950±163	463±59.3[b]	15.6[b]	593±57.1[a]	20.0[a]
		2T	2691±187	309±61.6	14.4	530±62.1[a]	19.6[a]
		FP	2467±192	350±55.3	14.2	424±67.2	17.2
	FB	1T	3050±237	488±60.9[a]	16.0[a]	622±54.2[a]	20.3
		2T	2867±192	453±61.3[a]	15.8[a]	565±63.3	19.7[a]
		FP	2691±210	385±54.1	14.3	479±69.8	17.8
	CDM	1T	3144±299	519±61.1[a]	16.5[a]	673±56.1[a]	21.4[a]
		2T	2902±252	467±62.8[a]	16.1[a]	580±67.2[b]	20.0[b]
		FP	2904±275	427±57.3	14.7	531±70.5	18.2
	WM	1T	3112±287	513±60.7[a]	16.5[a]	660±56.3[a]	21.2[a]
		2T	2851±241	456±62.9[a]	16.0[a]	584±68.5[b]	20.5[b]
		FP	2802±251	403±55.2	14.4	521±73.8	18.6
	FW	1T[a]	3032±262	509±60.5[a]	16.8[a]	664±57.3[a]	21.9[a]
		2T[b]	2760±229	444±62.9[b]	16.1[b]	569±70.9[b]	20.6[b]
		FP	2456±256	366±61.1	14.9	481±74.7	19.6
	Mean	1T	3057±250	493±60.5	16.1	639±56.2	21.0
		2T	2815±220	438±62.3	15.6	563±66.4	20.0
		FP	2664±237	382±56.6	14.3	483±71.2	18.1

CD: central defenders; FB: full-backs; CDM: central defensive midfielders; WM: wide midfielders; FW: forwards
1T: 1 touch authorized per individual possession;
2T: 2 touches authorized per individual possession;
FP: free play rule
★Significant differences for each playing position between match-play and SSGs p<0.001
[a]Significant differences compare to the FP rules; p<0.001
[b]significant differences compare to the FP rules; p<0.01

Results

Many significant differences are observed for most variables between three SSGs formats and match-play.

Total distance covered in HIR:

Within SSGs, players perform with a much higher intensity running with modified touch rules (1 touch and 2 touches rules) than in free play for all playing positions. And the values are more obvious, when they perform with 1 touch rule, such as the position FW (664 ± 57.3m in 1 touch rule, 569 ± 70.9m in 2 touches rule and 481 ± 74.7m in free play rule). These differences are even greater, when these values are shown in relation to percentage, such as the same position FW (21.9% in 1 touch rule, 20.6% in 2 touches rule and 19.6% in free touch rule).

In addition, the percentages of proportion of total distance covered in HIR within SSGs are ranging from 17.2% (CD) to 21.9% (FW). The values of the same variable in match-play only range from 2.9% (CD) to 3.3% (FB).

Based on these values, greater total distances covered in HIR are observed during SSGs in comparison to the match-play. Thus, more total distances covered in HIR are presented by SSGs with modified touch rules (e.g.1 touch rule and 2 touches rule), particularly with the 1 touch rule. These differences are demonstrated in figure 5.

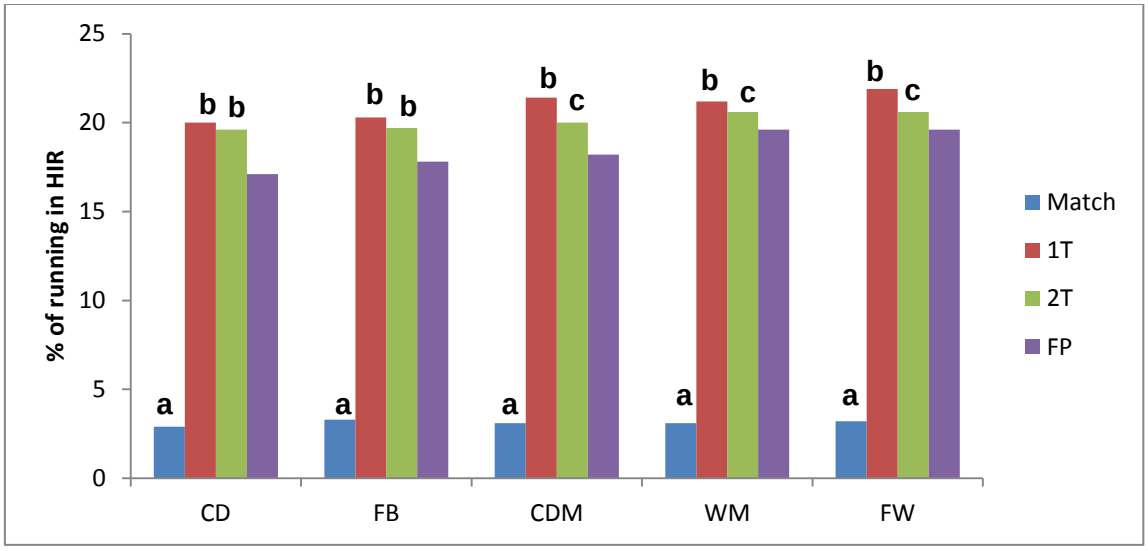

Fig. 5: Percentage of running in HIR between SSGs and match (Dellal et al., 2012, p. 957)

Match= match-play;
1T= 1 touch rule;
2T= 2 touches rule;
FP= free play rule;
[a]significantly lower total distance covered during match-play compared to SSGs. p<0.001;
[b]significantly higher percentage of the total distance covered compared to free play rule in SSGs. P<0.001;
[c]significantly higher percentage of the total distance covered compared to free play rule in SSGs. P<0.01.

Total distance covered in sprints:

Many differences are also found, which are similar to HIR. In contrast to free play rule, players have to perform significantly more sprints with modified touch rules for all playing positions too, such as the position FW (509 ± 60.5m in 1 touch rule, 444 ± 62.9m in 2 touches rule and 366 ± 61.1m in free play rule). These different values are also even greater, when they are expressed as percentage of proportion, for the same position FW (16.8% in 1 touch, 16.1% in 2 touches and 14.9% in free play rule).

Moreover, the percentages of proportion of total distance covered in sprints within SSGs, which are ranging from 14.2% (CD) to 16.8% (FW), are significantly greater than the same variable in match-play, ranging only from 2.1% (CD) to 2.9 (FW).

In terms of these values, compared to match-play, greater total distances covered in sprints are also found during SSGs. It's similar to HIR, more total distances covered in sprints are also presented by SSGs with modified touch rules (e.g. 1 touch rule and 2 touches rule), especially with the 1 touch rule. These different values are obviously demonstrated in figure 6.

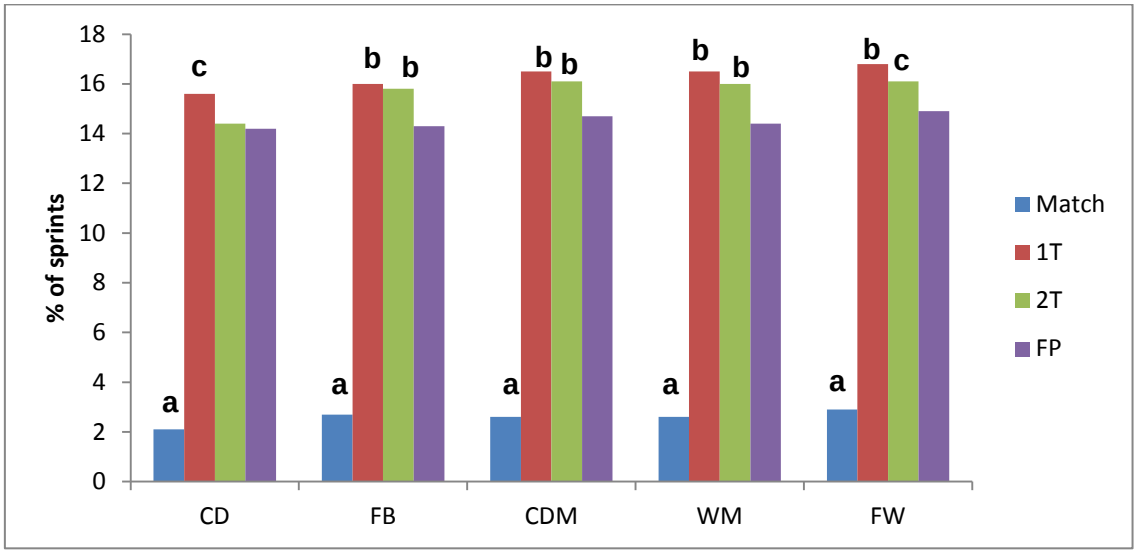

Fig. 6: Percentage of sprints between SSGs and match (Dellal et al., 2012, p. 957)

Match= match-play;
1T= 1 touch rule;
2T= 2 touches rule;
FP= free play rule;
[a]significantly lower total distance covered during match-play compared to SSGs. p<0.001;
[b]significantly higher percentage of the total distance covered compared to free play rule in SSGs. P<0.001;
[c]significantly higher percentage of the total distance covered compared to free play rule in SSGs. P<0.01.

On the basis of these data, the results of this experiment (Dellal et al., 2012, p. 957) demonstrate that the high-intensity activities (HIR and sprints) are obviously affected with the modified touch rule (1 or 2 ball touches authorized per possession) within SSGs. In contrast to free play rule, more high-intensity activities are induced with modified touch rules, especially when players perform with 1 touch rule. Players carry out much more high-intensity activities (HIR and sprints) by 4-a-side SSGs in comparison to 11-a-side match.

Experiment 6

Dellal et al. (2011, p. 2371) are engaging themselves in examining the physical loads during various formats of SSGs (2vs.2, 3vs.3, and 4vs.4) at different levels (professional and amateur) according to modified touch rules. The results are described in table 15.

Tab.15: Physical activities of players at professional and amateur levels (Dellal et al., 2011, p. 2371)

Form	Touch rules	Total distance covered (m)	Total distance covered in sprint (m)	% of total distance covered in sprint	Total distance covered in HIR (m)	% of total distance covered in HIR
professional						
2vs2	1T	1305.6±62.0	232.3±19.5	17.8±1.6	330.1±29.5	24.7±2.0
	2T	1211.8±72.1	195.2±20.0	16.1±1.8	271.3±38.9	21.9±3.2
	FP	1157.7±83.0	177.6±21.9	15.4±2.2	245.5±37.9	21.3±3.7
3vs3	1T	2247.6±157.0	397.0±33.9	17.7±1.9	523.2±56.1	23.4±2.8
	2T	2124.7±172.1	351.2±48.4	16.6±2.3	473.9±46.5	22.4±2.8
	FP	2014.0±154.5	315.6±52.6	15.7±2.4	422.5±33.4	21.1±2.1
4vs4	1T	3057.4±249.8	493.2±60.5	16.3±2.7	639.0±56.2	21.0±2.3
	2T	2814.7±220.3	438.0±62.3	15.7±3.0	562.9±66.4	20.1±2.8
	FP	2663.7±236.7	381.8±56.6	14.5±2.6	482.7±71.2	18.3±3.3
Amateur						
2vs2	1T	1201.8±101.8[a]	188.9±27.5[b]	15.8±2.4	309.6±41.5[a]	25.9±4.2
	2T	1130.8±121.2[a]	174.7±22.6[a]	15.5±2.0	242.0±32.8[a]	21.5±3.1
	FP	1086.7±106.4[a]	160.2±19.7[a]	14.8±1.9	225.7±34.6[a]	20.8±2.6
3vs3	1T	2182.9±169.2[a]	354.1±39.0[a]	16.3±1.8	480.7±49.1[b]	22.1±2.3
	2T	2045.5±139.9[a]	315.2±42.9[a]	15.4±2.0	417.6±42.5[b]	20.5±2.5
	FP	1861.0±154.7[a]	272.2±46.8[b]	14.6±2.0	383.9±51.9[b]	20.7±2.7
4vs4	1T	2860.8±202.2[a]	399.3±57.4[b]	14.0±1.8	583.4±42.9[a]	20.5±1.9
	2T	2672.2±257.2[a]	362.1±51.0[c]	13.6±1.9	552.9±60.8	20.8±2.6
	FP	2419.8±272.5[a]	327.8±47.8[a]	13.7±2.1	480.4±50.5	20.0±1.9

1T: 1 touch authorized per individual possession;
2T: 2 touches authorized per individual possession;
FP: free play rule
[a]significantly lower than professional $p<0.05$;
[b]significantly lower than professional $p<0.001$;
[c]significantly lower than professional $p<0.01$

Results

Many significant differences are observed for most variables between professional and amateur levels within SSGs.

Total distance covered:

In 2-a-side SSGs, in contrast to free touch rule (1157 ± 83m), professional players perform greater total distance covered with 2 touches rule (1211.8 ± 72.1m), whereas fewer than 1 touch rule (1305.6 ± 62.0m). It's similar to professional level, for amateur players, in comparison to free touch rule (1086.7 ± 106.4m), more total distance covered is generated by 2 touches rule (1130.8 ± 121.2m), but significantly fewer than 1 touch rule (1201.8 ± 101.8m), when they play in 2-a-side SSGs.

The trend of gradual increasing for physical loads with modified touch rules appears also significantly in 3-a-side (2247.6 ± 157.0m, 2124.7 ± 172.1m, and 2014.0 ± 154.5m) and 4-a-side SSGs (3057.4 ± 249.8m, 2814.7 ± 220.3m and 2663.7 ± 236.7m) for both levels.

Additionally, through comparison with results between both levels, a significant difference is found. Compared to the amateur level, more total distances covered are generated by players at professional level for all SSGs. These differences can be seen in figure 7.

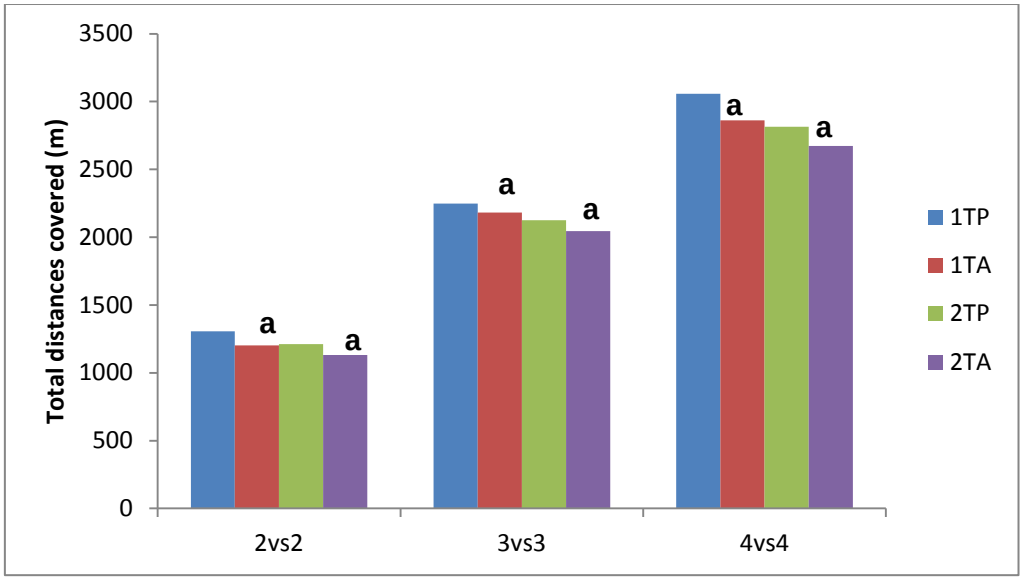

Fig. 7: Total distances covered of players with modified touch rules (Dellal et al., 2011, p. 2371).

1TP= 1 touch playing at professional level;
1TA= 1 touch playing at amateur level;
2TP= 2 touches playing at professional level;
2TA= 2 touches playing at amateur level;
[a]significantly lower than professional $p<0.05$;
[b]significantly lower than professional $p<0.001$;
[c]significantly lower thant professional $p<0.01$

Total distance covered in HIR:

Based on the fact that the total distance increases with the rising number of the players, the percentage of proportion is as an appropriate parameter, which is more objective for reference. In contrast to free play rule, more high speed running (13.0-17.9 km/h) is generated by 2 touches rule (21.9% vs. 21.3%) at professional level in 2-a-side SSGs, but significantly fewer than 1 touch rule (24.7%). It's similar to professional level, in comparison to free touch rule (20.8%), more total distances covered in HIR are performed with modified touch rules (21.5% and 25.9%), especially with 1 touch rule (25.9%).

The same trend like 2-a-side format of SSGs can be observed in 3-a-side (23.4%, 22.4 %, 21.1% and 22.1%, 20.5%, 20.7%, respectively) and 4-a-side (21.0% 20.1%, 18.3% and 20.5%, 20.8%, 20.0%, respectively).

Moreover, significant differences exist between professional and amateur players in total distances covered in HIR. Compared to the amateur level, more total distances covered in HIR are obviously executed by professional players at all SSGs. These differences are shown in figure 8.

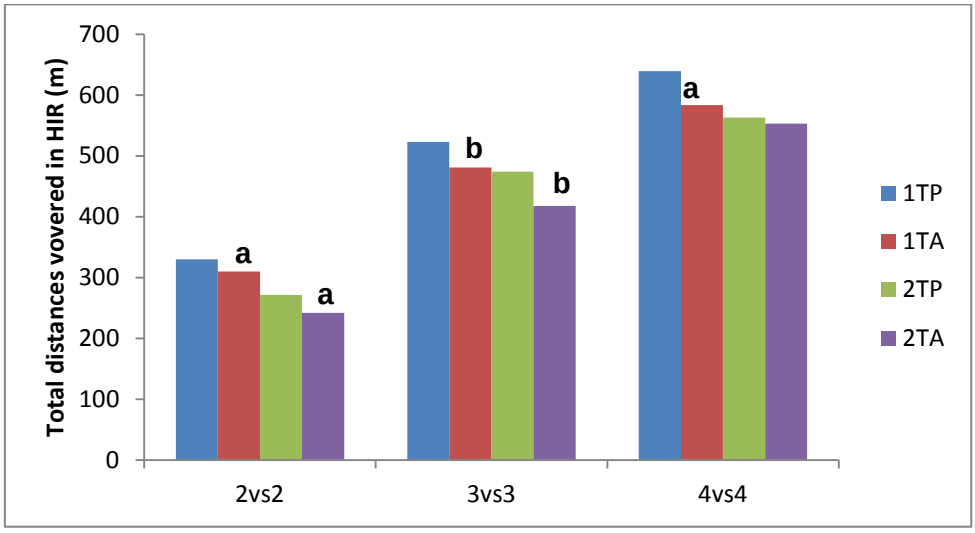

Fig. 8: Total distances covered in HIR of players with modified touch rules (Dellal et al., 2011, p. 2371).

1TP= 1 touch playing at professional level;
1TA= 1 touch playing at amateur level;
2TP= 2 touches playing at professional level;
2TA= 2 touches playing at amateur level;
[a]significantly lower than professional p<0.05;
[b]significantly lower than professional p<0.001;
[c]significantly lower thant professional p<0.01

Total distance covered in sprints:

Compared to free touch rule, more total distances covered in sprints are recorded with modified touch rules at professional level for all SSGs, especially with the 1 touch rule. For example, in 2-a-side SSGs, professional players have to carry out 17.8% sprints with 1 touch rule and 16.1% sprints with 2 touches rule as well as 15.4% with free touch rule. It's also similar to professional level. In comparison to free touch rule (14.8%), more total distances covered in sprints are significantly performed by amateur players with 2 touches rule (15.5%) and with 1 touch rule (15.8%) in 2-a-side SSGs.

Furthermore, significant differences exist in total distances covered in sprints between professional and amateur levels. Compared to the amateur level, more sprints are significantly executed by professional players. These differences are obviously demonstrated in figure 9.

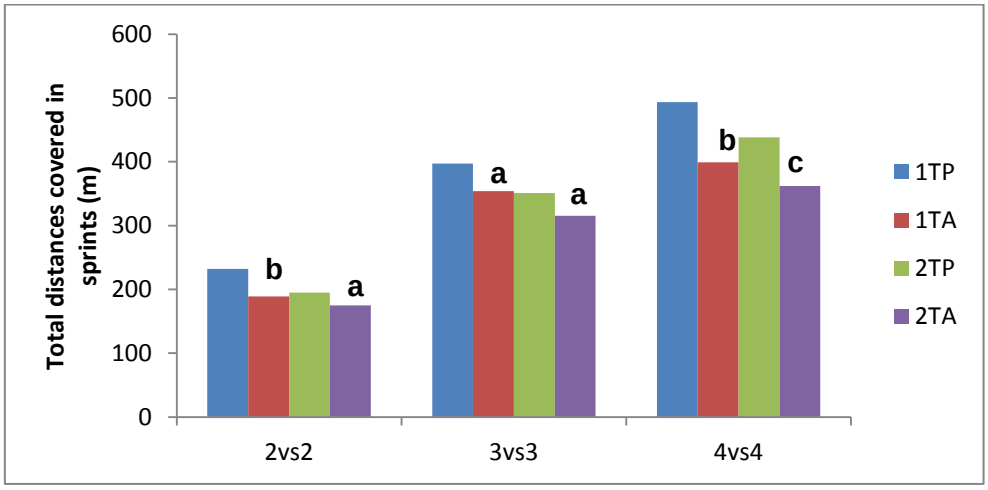

Fig. 9: Total distances covered in sprints of players with modified touch rules (Dellal et al., 2011, p. 2371)

1TP= 1 touch playing at professional level;
1TA= 1 touch playing at amateur level;
2TP= 2 touches playing at professional level;
2TA= 2 touches playing at amateur level;
[a]significantly lower than professional $p<0.05$;
[b]significantly lower than professional $p<0.001$;
[c]significantly lower than professional $p<0.01$

Based on these data, the time-motion results demonstrate that the physical loads of players at all levels can be affected with modified touch rule, especially high-intensity activities. Compared with 2 touches rule, more increases of high-intensity activities (HIR and sprints) are generated with 1 touch rule. In addition, the time-motion characteristics differ significantly between professional and amateur levels for all SSGs formats. For all analyzed parameters, in contrast to amateur players, the physical loads for professional

players are much higher, especially for the total distance covered in high-intensity activities (HIR and sprints).

Discussion

According to the finding in experiment 5 (Dellal et al., 2012. p. 957) more high-intensity activities (HIR and sprints) are significantly generated within SSGs, compared to sport matches. This finding complies with the report by Dellal et al. (2011, p. 322), which shows that the percentage of proportion for total distances covered in sprints during SSGs are from 13.6% to 16.3 for amateur players and from 14.5% to 17.8% for professional players. It's reported that the percentage of proportion for sprints ranges usually from 1.8% to 2.6% of total distances covered during a match (Dellal et al., 2011, p. 51). In terms of these reports, high-intensity activities are greater during SSGs in comparison to match. Thus, SSGs are able to meet the requirements of high-intensity activities for matches.

Based on these results of these studies (Dellal et al., 2011, p. 322; Dellal et al., 2011, p. 2371; Dellal et al., 2012, p. 957), the intensity of trainings session with using SSGs can be promoted with the modified touch rules (e.g. 1 touch and 2 touches). The main finding of the experiment 5 (Dellal et al., 2012, p. 957) is consistent with experiment 6 (Dellal et al., 2011, p. 2371). In contrast to 2 touches rule, more high-intensity activities are induced with 1 touch rule. However, the effect of 2 touches rules does not conform obviously the report of experiment 4 (Dellal et al., 2011, p. 322). It's attributed to the relatively very poor reliability of GPS device for speed > 20 km/h, probably (Hill-Haas et al., 2009a, p. 1). In the context of these findings, the modification of the number of touch rules can enhance the high-intensity activities during SSGs, the effects of 1 touch rule is most obvious.

In addition, on the basis of the improvements of high-intensity activities with the modified touch rules for players at all levels, the wide effectiveness of SSGs are confirmed. Through the comparisons of the improvements at both levels (professional- and amateur players), the results demonstrate that, in comparison with amateur players, professional players perform more total distance covered in HIR and sprints during SSGs with modified touch rules. This finding is consistent with the results of discussion in chapter 3.3.1 that professional players can perform significantly more high-intensity running (HIR and sprints) than amateur players for all formats of SSGs. This finding is also in agreement with previous studies (Della, 2008; Rampinini et al., 2009, p. 1048) that report the requirements in physical aspect for elite players is substantial running in HIR and the ability to complete repeated sprints can be seen as a key physical factor to identify fitness

of players. In the context, the effects with using SSGs for physical trainings session are pronounced for players in higher level.

In summary, these results indicate that SSGs as a means can induce more high-intensity activities than adult matches. Changing the number of touches can influence the physical loads of players at all levels. With modified 1 touch rule, more high-intensity activities (HIR and sprints) of players are significantly improved. In addition, in comparison with amateur players, the effects with using SSGs for fitness training are more obvious for players in professional level, independently of the number of ball touches.

3.1.3 Time regimes

Experiment 7

In order to examine the time-motion characteristics between different time regimes of SSGs, Hill-Haas et al. (2009c, p. 111) carry out the experiment, consisting of two (intermittent and continuous) regimes across three formats (2-a-side and 4-a-side as well as 6-a-side) severally. The results are shown in table 16.

Tab. 16: Time-motion characteristics between two time regimes (Hill-Haas et al., 2009c, p. 111)

	Regime	
Time-motion variable	Continuous	Intermittent
Total distance (m)	2596 ± 18	2621 ± 19
Total distance for 0-6.9 km/h (m)	1143 ± 10	1150 ± 10
Total distance for 7.0-12.9km/h (m)	975 ± 25	950 ± 22
Total distance for 13.0-17.9 km/h (m)	417 ± 13[a]	444 ± 15
Total distance for sprints >18km/h (m)	53 ± 3[b]	67 ± 4
Sprints duration (s)	1.69 ± 0.04	1.67 ± 0.04
Maximum sprints duration (s)	2.93 ± 0.10	2.91 ± 0.11
Sprints distance (m)	8.0 ± 0.3	7.9 ± 0.2
Maximum sprints distance (m)	15.2 ± 0.6	15.4 ± 0.7
Sprints activity ratio (AU)	5.0 ± 0.4[c]	8.4 ± 0.4
Total number of sprints	6 ± 0.4[d]	8 ± 0.4
Time at >18km/h (s)	10.9 ± 0.7[e]	16.9 ± 2.8

[a]significant difference between regimes, p=0.01
[b]significant difference between regimes, p=0.007
[c]significant difference between regimes, p=0.001
[d]significant difference between regimes, p=0.002
[e]significant difference between regimes, p=0.044

Results

No significant differences are observed between two time regimes for total distance covered and total distance covered at 0-6.9km/h as well as total distance covered at 7.0-12.9km/h. However, players perform significantly more activities within intermittent regime of SSGs in total distance covered at 13.0-17.9km/h (417 ± 13m and 444 ± 15m) and sprints >18.0km/h (53 ± 3m and 67 ± 4m) than within the continuous regime of SSGs.

For sprints duration and distance, it appears that no observably differences exist regardless of whether average sprints or maximum values.

In contrast to the continuous regime, significantly more sprint activity ratio (AU) (5.0 ± 0.4 and 8.4 ± 0.4) and total number of sprints (6 ± 0.4 and 8 ± 0.4) as well as time spend at sprints (10.9 ± 0.7s and 16.9 ± 2.8s) are elicited within intermittent regime.

The results demonstrate that player perform significantly more high-intensity (HIR and sprints) activities within intermittent regime of SSGs, especially the frequency of repeated sprints, compared with continuous regime of SSGs.

Discussion

Considering the fact that players perform significantly greater high-intensity activities, there are in particular more repeated sprints within intermittent regime than continuous regime. It's understandable that the additional passive rest periods between each playing bouts during the intermittent regime of SSGs can cause more physiological recovery than "no" rest time continuous regime of SSGs (Bangsbo et al., 2007, p. 111; Gaitanos et al., 1993, p. 712). Although significantly higher frequency of sprints activities during the intermittent regime are found, either average or maximum values for sprints duration and distance do not exist obviously between two regimes of SSGs. It means that the number of sprints increases significantly, whereas the quality of sprints is not obviously improved. This result is in line with the report (Little & Williams, 2007, p. 646), which indicates that sprints distance and exercise rest ratio affect are not dependent on the degree of fatigue.

In summary, in contrast to continuous regime, more high-intensity activities and sprints frequency of players are elicited significantly within intermittent regime of SSGs.

3.2 Conclusion

Due to the findings above, SSGs can meet requirements of high-intensity activities of players in matches, and, SSGs are effective for players, particularly for players at elite level.

Altering of playing fields and using of modified touch rules as well as different time regimes can influence significantly physical loads of players, especially high-intensity activities. Thus, according to the findings mentioned, practical applications for effective using with SSGs in fitness training sessions are listed.

Practical applications

With the expansion of playing field per player, the percentages of proportion for high-intensity activities will be increased, in particular the enhancements of quality and quantity for sprints.

With modified 1 touch rule, more high-intensity activities (HIR and sprints) are significantly improved.

With appropriate short break (intermittent regime), more high-intensity activities and sprints frequency are elicited significantly in SSGs.

4 Role of SSGs for technical training

Modern sport matches require that players present the ability to skillfully execute a large number of technical actions, such as more than 700 turns and 30-40 tackles in a match (Bloomfield et al., 2007, p. 63). Moreover, modern elite players are essentially characterized with the capacity with the smallest touch number per possession to win more times and spaces for better opportunities in competition. For example, the average number of ball touches per possession is lying between 1.74 (central defenders) and 2.26 (central attacking midfielders) touches in the Spanish and English first division (Dellal et al., 2011, p. 51).

Many previous researches point out that the similar technical needs of competition should be induced by training sessions, in order to optimize the performance of players in match-play (Dellal, Wong, Moalla & Chamari, 2010, p. 278; Dellal et al., 2011b, p. 353). Hence, in order to develop these capabilities, some specific training exercises should be considered. As described in chapter 2.4.1, considering the fact that SSGs can cause far more high-frequency technical behaviors (e.g. more touches, more passes, etc.), SSGs can be recommended as a suitable means for technical training. Thus, if the application of SSGs is regarded as an effective tool in technical training sessions, it's necessary to develop a better understanding for their expectant effects at various levels.

Many researchers concern the effect with using SSGs for technical training (Owen, et al., 2004, p, 50; Duarte, et al., 2009, p, 37; Casamichana & Castellano, 2010, p, 1615; Dellal et al., 2011a, p, 341; 2011, p, 2371). However, to the best of author's knowledge, the role of SSGs for technical training is also lacking a full understanding.

In this context, due to the necessity, the aim of this chapter is to examine the role of SSGs for technical training. In terms of all published literature, the focus is the relationship between frequencies of technical behaviors and formats of SSGs, that is, which SSGs is suitable for which technical actions. How to effectively apply SSGs for ball possessions?

4.1 Analyses to the results

At present, researches focus mainly on the following two aspects, the dimension of field and modified rule.

All published literature to the best of author's knowledge will be enumerated in detail.

4.1.1 Pitch dimension

Experiment 8

In order to examine the influence of various formats by SSGs on technical demands of players, Duarte et al. (2009, p. 37) carry out an experiment, consisting of three formats of SSGs (2-a-side, 3-a-side and 4-a-side). The results can be seen in table 17.

Tab. 17: Technical data in all drill conditions (Duarte et al., 2009, p. 37)

	4 min		
	4v4	3v3	2v2
Number of ball possessions	2.47 ± 0.2	2.62 ± 0.3	3.31 ± 0.5
Number of contacts	2.16 ± 0.2★	2.58 ± 0.1★	3.85 ± 0.4
Number of dribbles	0.47 ± 0.13★	0.50 ± 0.1★	1.31 ± 0.1
Number of correct passes	1.41 ± 0.2	2.00 ± 0.1	2.1 ± 0.4
Number of wrong passes	0.28 ± 0.1	0.29 ± 0.1	0.19 ± 0.1
Number of shots on goal	0.38 ± 0.2	0.58 ± 0.3	0.56 ± 0.3
Number of tackles	0.25 ± 0.1	0.08 ± 0.1	0.13 ± 0.1
Number of interceptions	0.16 ± 0.1	0.17 ± 0.1	0.41 ± 0.1

★Statistical differences in the number of players' variation, $p<0.05$

Results

It seems that there are no significant differences for most variables between three SSGs formats. Significant differences for number of contacts and number of dribbles exist between three SSGs formats (2.16 ± 0.2, 2.58 ± 0.1, 3.85 ± 0.4 and 0.47 ± 0.13，0.50 ± 0.1, 1.31 ± 0.1, respectively).

Number of contacts:

In contrast to 4-a-side SSGs format (2.16 ± 0.2), significantly more ball contacts are generated in 3-a-side SSGs format (2.58 ± 0.1), but obviously less than in 2-a-side SSGs format (3.85 ± 0.4).

Number of dribbles:

The situation is similar to the number of ball contacts, in comparison with larger (4-a-side) SSGs format (0.47 ± 0.13), significantly more number of dribbles are generated in medium (3-a-side) SSGs format (0.50 ± 0.1), whereas less obviously than in smaller (2-a-side) SSGs format (1.31 ± 0.1).

The results demonstrate that with the reduction in the number of players, more individual technical actions (e.g. dribbles) are significantly generated.

Experiment 9

The study (Casamichana & Castellano, 2010, p. 1615) has the aim to examine technical responses during different SSGs consisting of three different individual playing areas (275 m^2, 175 m^2, and 75 m^2). Results of this experiment can be seen in table 18.

Tab. 18: Motor behaviors of players in the different SSGs formats (Casamichana & Castellano, 2010, p. 1615)

Technical behaviors	SSGL	SSGM	SSGS
Tackle	6.3 ± 1.5	8.3 ± 2.6	11.2 ± 3.1[ab]
Control	1.7 ± 1.7	1.8 ± 1.3	2.8 ± 0.9
Control and dribble	1.7 ± 0.8	4.5 ± 1.5[c]	5.2 ± 1.7[a]
Control, dribble and pass	14.2 ± 4.2	13.8 ± 5.5	10.2 ± 6.5
Control and pass	18.7 ± 4.3	16.8 ± 6.1	14.5 ± 6.6
Control and shoot	2.2 ± 1.7	1.8 ± 1.6	5.0 ± 2.4[ab]
Control, dribble and shoot	1.0 ± 0.6	1.5 ± 1.97	2.5 ± 0.5
First-touch pass	9.0 ± 5.6	11.3 ± 2.9	10.3 ± 3.3
Clearance	2.3 ± 1.0	3.8 ± 2.6	8.0 ± 2.9[ab]

SSGL (large pitch), SSGM (medium pitch), SSGS (small pitch)
[a]SSGS > SSGL P<0.05;
[b]SSGS> SSGM P<0.05;
[c]SSGM> SSGL P<0.05

Results

It appears there are no significant differences between any formats of SSGs in control, control dribble and pass, control and pass, control dribble and shoot, as well as first-touch pass in table 18.

But there are significant differences between the small SSGs format and others formats (medium and lager) for tackle (6.3 ± 1.5, 8.3 ± 2.6 and 11.2 ± 3.1, respectively). Compared to medium and larger format of SSGs, the small format cause significantly more tackles.

Significant differences also appear between larger format and others formats (medium and small) for control and dribble (1.7 ± 0.8, 4.5 ± 1.5 and 5.2 ± 1.7, respectively). Both formats of SSGs generate obviously more technical combinations of control and dribble in comparison with larger SSGs format.

It's similar to control, there are significant differences between small SSGs format and others two formats (medium and lager) for control and shoot (2.2 ± 1.7, 1.8 ± 1.6 and 5.0 ± 2.4, respectively) and clearance (2.3 ± 1.0, 3.8 ± 2.6 and 8.0 ± 2.9, respectively).

Compared to both medium and larger formats of SSGs, obviously more key actions (e.g. control and shoot, clearance) appear in the small SSGs format.

The results demonstrate that significantly more individual technical actions (e.g. tackle and dribble as well as shoot etc.) are generated, when less individual playing area is available for players.

Discussion

The main finding in experiment 8 (Duarte et al., 2009, p. 37) lies in the decrease in the playing field, significantly more dribbles are generated. In agreement with this finding, more advanced findings are reported by experiment 9 (Casamichana & Castellano, 2010, p. 1615). They show that significantly more tackles and dribbles as well as shootings are performed, when the individual available playing space for players is less.

Besides, there are also many researchers concerning the influence of altering playing field on technical actions. According to the report (Owen et al., 2004, p. 50) that more turns and dribbles are performed by 1-a-side and 2-a-side formats of SSGs, in comparison to 4-a-side and 5-a-side formats of SSG. And the main finding of the study (Katis & Kellis, 2009, p. 374) is that 3-a-side SSGs cause more short passes, tackles, dribbles, scoring goals, whereas, significantly more long passes and headers are generated in 6-a-side format of SSGs. Da Silva et al. (2011, p. 2746) indicate that compared to 4-a-side and 5-a-side formats of SSGs, players perform significantly more dribbles and shots during 3-a-side format of SSGs. It's similar to the report by Da Silva, but higher than those found by Owen et al. (2011, p. 2104). They report that more offensive actions such as dribble, tackles and ball contacts as well as more shots are generated by smaller formats of SSGs, and larger formats of SSGs induce more defensive actions (e.g. headers, blocks and interceptions).

Although the sizes of playing fields in the attempts above change with various numbers of players in terms of different proportion, the trend is that players perform more dribbles and tackles as well as shooting individual technical actions, when they play in smaller formats of SSGs with small number of participants. In contrast, diversified technical-tactical actions (e.g. long passes, blocks and interceptions etc.) are caused significantly more by formats of SSGs with larger number of participants. On one hand, it could be attributed to the lower available number of choices for players with balls, when they can cooperate only with fewer teammates. In this context, technical actions which they can choose are limited, such as long pass and header. Players tend to look for individual solutions (e.g. dribble) in

such a competitive situation (Owen et al., 2004, p. 50). On the other hand, due to the increased pitch dimension during larger formats of SSGs (5-a-side and 6-a-side etc.), more technical choices are available. For example, in contrast to smaller pitches, players in larger formats of SSGs can perform more long passes. In turn, more headers are required to receive and pass ball quickly. This could be explained that more headers, interceptions and blocks are observed by larger pitches in comparison with smaller formats of SSGs (Platt et al., 2001, p. 23; Katis & Kellis, 2009, p. 374.).

In summary, these results of the experiments indicate that altering of playing field of SSGs can effectively influence technical actions of players. Smaller formats can cause significantly more individual technical movements, such as dribbles and tackles as well as shootings. In comparison, significantly more diversified technical-tactical actions (e.g. long pass, block and interception etc.) are caused by larger pitches. Thus, the altering of playing formats of SSGs can be effectively applied as a tool for specific technical trainings.

4.1.2 Modified rules

In chapter 2.4.3.1, it's discussed that the essence of effective skills application training is lying in a great amount of repeated for already acquired skills for performing in variable situations. Thus, according to the principles of technical training in chapter 2.4.3.2.2, many researchers try to increase the number of ball possessions in specific technical training sessions with limited touch rule for players.

Experiment 10

In order to examine the effects of the modified touch rules (number of ball touches authorized per possession) on technical performances of elite players. Dellal et al. (2011, p. 322) carry out a special experiment divided in four bouts separated with modified rules. Results of the experiment can be seen in table 19.

Results

The results show that according to bouts there is a significant trend that the activities of all analyzed technical performances are reduced gradually (more number of ball losses, less number of duels and number of ball possessions as well as quality of passes), whereas significant differences are observed for most variables between three formats of SSGs (1

touch, 2 touches and free play), if these variables are compared with each other in same bout.

Tab. 19: Technical performance with modified touch rules (Dellal et al., 2011, p. 322)

Variables	Bout 1	Bout 2	Bout 3	Bout 4
Number of Duels				
1 T★	5.3 ± 1.1	5.0 ± 0.9	4.4 ± 1.1	3.3 ± 0.9
2 T★	5.7 ± 1.1	4.6 ± 1.0	4.1 ± 0.9	3.0 ± 0.8
FP	7.7 ± 1.2	7.1 ± 1.3	5.9 ± 1.2	4.1 ± 0.9
Percent of successful passes				
1 T★★	53.1 ± 5.3	51.9 ± 5.7	49.5 ± 5.3	44.7 ± 5.6
2 T	70.8 ± 5.1	69.3 ± 4.9	67.0 ± 5.1	63.7 ± 5.6
FP	75.9 ± 6.7	74.2 ± 7.5	73.2 ± 7.1	69.9 ± 7.8
Number of ball losses				
1 T	2.5 ± 0.9	3.0 ± 0.9	3.5 ± 1.2	5.7 ± 1.9
2 T	2.6 ± 0.9	3.7 ± 1.1	4.2 ± 1.2	6.0 ± 1.7
FP	2.4 ± 1.2	3.0 ± 1.2	3.3 ± 1.2	4.4 ± 1.5
Total number of ball possessions				
1 T★	12.6 ± 2.1	9.8 ± 1.9	10.1 ± 2.9	9.1 ± 2.8
2 T	8.7 ± 2.4	8.6 ± 2.5	8.9 ± 2.0	8.5 ± 2.1
FP	7.7 ± 1.7	7.3 ± 1.4	8.2 ± 1.7	8.3 ± 2.1

1T: 1 touch authorized per individual possession;
2T: 2 touches authorized per individual possession;
FP: free play rule
★Significant difference compare to the FP rules; ★ P<0.05;
★★Significant difference compare to the FP rules; ★★ P<0.001

Number of duels:

There are significant differences between both modified touch rules (1 touch and 2 touches) and free play for number of duels from bout 1 to bout 4 (5.3 ± 1.1, 5.0 ± 0.9, 4.4 ± 1.1, 3.3 ± 0.9 and 5.7 ± 1.1, 4.6 ± 1.0, 4.1 ± 0.9, 3.0 ± 0.8 as well as 7.7 ± 1.2, 7.1 ± 1.3, 5.9 ± 1.2, 4.1 ± 0.9, respectively). In contrast to free play rule, significantly less individual duels are performed for players with limited touch rules (1 touch and 2 touches).

% of successful passes:

There is a significant difference for the quality of passing (% of successful passes) between 1 touch rule and free play during all bouts of SSGs (53.1 ± 5.3 %, 51.9 ± 5.7 %, 49.5 ± 5.3 %, 44.7 ± 5.6 % and 75.9 ± 6.7 %, 74.2 ± 7.5 %, 73.2 ± 7.1 %, 69.9 ± 7.8 %). The 1 touch rule significantly reduces the quality of passing, in comparison with free play.

Number of ball possessions:

There is also a significant difference between 1 touch rule and free play for total number of ball possessions during all bouts (12.6 ± 2.1, 9.8 ± 1.9, 10.1 ± 2.9, 9.1 ± 2.8 and 7.7 ± 1.7, 7.3 ± 1.4, 8.2 ± 1.7, 8.3 ± 2.1, respectively). Compared to free play, a large number of ball possessions are generated with using modified 1 touch rule.

The results demonstrate that compared to free play, with the modified limited touch rules player perform significantly less duels and % of successful passes, whereas they execute more total number of ball possessions, in particular with using the 1 touch rule.

Experiment 11

The study (Dellal et al., 2012, p. 957) has the aim to compare the influence on technical demands of elite players with modified touch rules for all playing positions. Results of this experiment can be seen in table 20.

Tab. 20: Technical variables associated with SSGs and match-play (Dellal et al., 2012, p. 957)

Position	Rule	Number of duels	Percent of successful passes	Total number of ball losses	Total number of ball possessions
CD	1T	19.9 ± 3.4[a]	45.2 ± 4.8[a]	15.8 ± 4.0[b]	38.5 ± 4.0[b]
	2T	19.0 ± 2.9[a]	61.6 ± 4.2[b]	15.3 ± 3.7	32.4 ± 3.3
	FP	27.2 ± 3.0	70.9 ± 6.6	14.3 ± 4.5	30.1 ± 3.4
FB	1T	19.1 ± 3.5[a]	49.1 ± 5.0[a]	16.2 ± 4.1[b]	42.3 ± 4.4[a]
	2T	18.2 ± 3.0[a]	68.2 ± 4.7	14.7 ± 3.6	33.8 ± 3.5
	FP	29.8 ± 3.1	73.0 ± 7.0	13.9 ± 4.6	30.5 ± 3.2
CDM	1T	17.0 ± 3.6[b]	52.1 ± 4.1[a]	13.9 ± 4.0	42.8 ± 4.3[a]
	2T	12.8 ± 3.4[a]	72.5 ± 4.0	13.1 ± 4.3	36.1 ± 3.6
	FP	22.2 ± 3.5	73.2 ± 7.0	13.1 ± 4.8	32.6 ± 3.6
WM	1T	18.9 ± 3.7[a]	49.3 ± 6.4[a]	15.1 ± 4.9[b]	42.6 ± 4.5[a]
	2T	18.3 ± 3.6[a]	69.5 ± 6.0	13.8 ± 4.8	35.3 ± 3.9
	FP	27.0 ± 4.1	72.9 ± 7.6	13.4 ± 4.9	31.9 ± 3.7
FW	1T	15.1 ± 3.9[b]	53.3 ± 6.7[a]	13.0 ± 5.0[b]	41.8 ± 4.8[b]
	2T	14.7 ± 3.6[b]	73.2 ±6.1	11.6 ± 5.1	35.9 ± 4.2
	FP	19.3 ± 4.3	77.5 ±7.8	11.3 ± 5.2	32.4 ± 4.1

CD: central defenders; FB: full-backs; CDM: central defensive midfielders; WM: wide midfielders; FW: forwards
1T: 1 touch authorized per individual possession;
2T: 2 touches authorized per individual possession;
FP: free play rule
[a]Significant differences compare to the FP rules; $p<0.01$
[b]significant differences compare to the FP rules; $p<0.05$

Results

Many significant differences are observed for most variables between the three formats of SSGs (1 touch, 2 touches and free play).

Number of duels:

Significant differences exist between free play rule and modified touch rules (1 touch and 2 touches) for number of duels for all playing positions (such as at the playing position FB (full-backs), 19.1 ± 3.5, 18.2 ± 3.0 and 29.8 ± 3.1). Players perform obviously less individual duels with modified touch rule during SSGs, in comparison with free play rule.

% of successful passes:

For the quality of passing (% of successful passes), a significant difference exists between 1 touch rule and free play rule for all playing positions (such as at the playing position FB (full-backs) (49.1 ± 5.0 and 73.0 ± 7.0), but no significant difference is observed between 2 touches rule and free play rule except at the playing position CD (central defenders) (61.6 ± 4.2). Compared to free play rule, 1 touch rule cause a great reduction for the quality of passing.

Number of ball losses:

There is a significant difference for total number of ball losses between 1 touch and free play rule at most playing positions except CDM (central defensive midfielders). 1 touch rule leads to an obvious increase in the number of ball losses.

Number of ball possessions:

Significant differences are also observed for total number of ball possessions between 1 touch rule and free play rule at all playing positions (38.5 ± 4.0, 42.3 ± 4.4, 42.8 ± 4.3, 42.6 ± 4.5, 41.8 ± 4.8 and 30.1 ± 3.4, 30.5 ± 3.2, 32.6 ± 3.6, 31.9 ± 3.7, 32.4 ± 4.1, respectively). In contrast to free play rule, a large number of ball possessions can be generated with 1 touch rule.

Based on these data, the results of this experiment demonstrate that the modified touch rules (number of ball contact authorized per individual possession) can influence the technical performances of players at all playing positions during the three formats of SSGs.

With the modified touch rules, players perform significantly more number of ball possessions and ball losses than with free touch rule. At the same time, the number of duels and percent of successful passes are also reduced significantly. Compared to 2 touches rule, the changes with 1 touch rule can be more obviously.

Experiment 12

Dellal et al., (2011a, p. 341) try to examine the technical performances during various formats of SSGs (2vs.2, 3vs.3, and 4vs.4) at elite level according to modified touch rules. The results of these experiments are shown in table 21.

Tab. 21: Technical performances at elite level with modified touch rules (Dellal et al., 2011a, p. 341)

Form	Rules	Percent of successful passes	Number of ball losses	Ball losses per minute of play	Total number of ball possessions
2vs2	1T	42.5 ± 4.7**	23.5 ± 4.4**	2.9 ± 0.5**	50.6 ± 5.0**
	2T	60.5 ± 4.2$^{\#}$	14.1 ± 2.6	1.8 ± 0.3	41.4 ± 3.8
	FP	66.4 ± 4.1	13.9 ± 2.4	1.7 ± 0.3	40.9 ± 4.4
3vs3	1T	52.0 ± 3.9**	17.1 ± 3.6**	1.4 ± 0.3**	51.8 ± 7.1**
	2T	69.9 ± 2.1	15.1 ± 2.7	1.3 ± 0.2	43.7 ± 5.0
	FP	71.0 ± 2.6	14.3 ± 5.2	1.2 ± 0.4	41.7 ± 6.1
4vs4	1T	49.8 ± 5.3**	14.8 ± 4.4***	0.9 ± 0.3*	41.6 ± 4.4**
	2T	68.9 ± 4.9$^{\#}$	13.6 ± 4.2	0.8 ± 0.3	34.7 ± 3.7$^{\#}$
	FP	73.4 ± 7.2	13.2 ± 4.8	0.8 ± 0.3	31.5 ± 3.6

1T: 1 touch authorized per individual possession;
2T: 2 touches authorized per individual possession;
FP: free play rule
*Significant differences from two touches and free play ($p<0.01$);
**Significant differences from two touches and free play ($p<0.001$);
***Significant differences from two touches ($p< 0.01$) and free play ($p<0.001$);
$^{\#}$Significant differences from free play ($p<0.05$)

Results

The results show that in accordance with modified touch rules great differences are observed for most analyzed variables during three SSGs.

Quality of passes:

There are significant differences between 2-a-side and 4-a-side formats of SSGs. In contrast to free play rule (66.4 ± 4.1 and 73.4 ± 7.2), significantly less % of successful passes are performed with 2 touches rule (60.5 ± 4.2 and 68.9 ± 4.9), whereas more than with 1 touch rule (42.5 ± 4.7 and 49.8 ± 5.3). It seems that a significant difference exists in 3-a-side format of SSGs too, much lower % of successful passes are executed with 1 touch rule (52.0 ± 3.9), in comparison with free touch rule (71.0 ± 2.6).

Number of ball losses:

Performed technical actions with 1 touch rule are consistently different from 2 touches and free play rule for all formats of SSGs. It is clear that more number of ball losses are generated with 1 touch rule (23.5 ± 4.4, 17.1 ± 3.6, 14.8 ± 4.4), compared to 2 touches (14.1 ± 2.6, 15.1 ± 2.7, 13.6 ± 4.2) and free play (13.9 ± 2.4, 14.3 ± 5.2, 13.2 ± 4.8) rules, respectively.

Ball losses per minute of play:

It's similar to number of ball losses that there are significant differences between 1 touch rule and others (2 touches and free play rules) at all formats of SSGs. Players perform highly more ball losses per minute with 1 touch rule (2.9 ± 0.5, 1.4 ± 0.3, 0.9 ± 0.3) than in 2 touches (1.8 ± 0.3, 1.3 ± 0.2, 0.8 ± 0.3) and free play (1.7 ± 0.3, 1.2 ± 0.4, 0.8 ± 0.3) rules, respectively.

Total number of ball possessions:

In 2-a-side and 3-a-side formats of SSGs, more total number of ball possessions are executed with 1 touch rule (50.6 ± 5.0, 51.8 ± 7.1), in comparison with 2 touches (41.4 ± 3.8, 43.7 ± 5.0) and free touch (40.9 ± 4.4, 41.7 ± 6.1) rules, respectively. In 4-a-side, in contrast to free play rule (31.5 ± 3.6), more total number of ball possessions are performed for players with 2 touches rule (34.7 ± 3.7), whereas less than with 1 touch rule (41.6 ± 4.4).

Based on the data mentioned above, the results of this experiment demonstrate that in comparison to free touch rule, more number of ball possessions for players are executed with the modified touch rules (number of ball contact authorized per individual possession). However, more number of ball losses as well as reduced percent of successful passes is generated simultaneously. Compared to 2 touches rule, the influences of 1 touch rule on technical actions are stronger.

Experiment 13

On the basis of the experiment (Dellal et al., 2011a, p. 341), a try (Dellal et al., 2011, p. 2371) is executed with the aim at examining the differences of technical performances between professional and amateur levels with modified touch rules. The results are shown in table 22.

Tab. 22: Technical performances at different level with modified touch rules (Dellal et al., 2011a, p. 341; 2011, p. 2371)

Form	Rules	Percent of successful passes	Number of ball losses	Ball losses per minute of play	Total number of ball possessions
Professional					
2vs2	1T	42.5 ± 4.7	23.5 ± 4.4	2.9 ± 0.5	50.6 ± 5.0
	2T	60.5 ± 4.2	14.1 ± 2.6	1.8 ± 0.3	41.4 ± 3.8
	FP	66.4 ± 4.1	13.9 ± 2.4	1.7 ± 0.3	40.9 ± 4.4
3vs3	1T	52.0 ± 3.9	17.1 ± 3.6	1.4 ± 0.3	51.8 ± 7.1
	2T	69.9 ± 2.1	15.1 ± 2.7	1.3 ± 0.2	43.7 ± 5.0
	FP	71.0 ± 2.6	14.3 ± 5.2	1.2 ± 0.4	41.7 ± 6.1
4vs4	1T	49.8 ± 5.3	14.8 ± 4.4	0.9 ± 0.3	41.6 ± 4.4
	2T	68.9 ± 4.9	13.6 ± 4.2	0.8 ± 0.3	34.7 ± 3.7
	FP	73.4 ± 7.2	13.2 ± 4.8	0.8 ± 0.3	31.5 ± 3.6
Amateur					
2vs2	1T	39.2 ± 3.4[c]	30.7 ± 2.4[d]	3.8 ± 0.3[d]	57.9 ± 3.8[f]
	2T	58.3 ± 4.3[c]	21.1 ± 3.5[d]	2.6 ± 0.4[d]	46.5 ± 3.3[f]
	FP	62.0 ± 3.4[c]	16.0 ± 2.1[d]	2.0 ± 0.3[d]	41.6 ± 4.8[f]
3vs3	1T	47.5 ± 6.5[b]	22.5 ± 5.5[e]	1.9 ± 0.5[e]	50.8 ± 6.0[a]
	2T	66.6 ± 4.3[b]	19.1 ± 6.1[e]	1.6 ± 0.5[e]	41.3 ± 5.6[b]
	FP	70.0 ± 4.1[a]	16.8 ± 4.6[f]	1.4 ± 0.4[f]	37.4 ± 4.6[c]
4vs4	1T	45.3 ± 8.5[a]	20.0 ± 6.5[e]	1.3 ± 0.4[e]	41.4 ± 3.8
	2T	67.7 ± 5.0	16.8 ± 4.2[f]	1.0 ± 0.3[d]	34.2 ± 4.8
	FP	70.7 ± 5.2[a]	15.8 ± 4.6[f]	1.0 ± 0.3[d]	31.1 ± 5.1

1T: 1 touch authorized per individual possession;
2T: 2 touches authorized per individual possession;
FP: free play rule
[a]significantly lower than professional $p<0.05$;
[b]significantly lower than professional $p<0.01$;
[c]significantly lower than professional $p<0.001$;
[d]significantly greater than professional $p<0.05$;
[e]significantly greater than professional $p<0.001$;
[f]significantly greater than professional $p<0.01$

Results

Many significant differences are observed for most variables between professional and amateur levels within SSGs.

Quality of passes:

In 2-a-side format of SSGs, for professional level, compared to free play rule (66.4 ± 4.1 %), less % of successful passes are performed with modified touch rule, particularly with 1 touch rule (42.5 ± 4.7 %). The results of amateur players are similar to professionals, the highest value is obtained with free play rule (62.0 ± 3.4 %), and whereas, the lowest value is reached when they play with 1 touch rule (39.2 ± 3.4 %).

The trend of descent for percent of successful passes with modified touch rules occurs in 3-a-side as well as 4-a-side formats of SSGs at amateur levels (70.0 ± 4.1 %, 66.6 ± 4.3 %, 47.5 ± 6.5 % and 70.7 ± 5.2 %, 67.7 ± 5.0 %, 45.3 ± 8.5 %, respectively).

In addition, great differences between professional and amateur levels are observed. Compared to professional players, more mistakes are executed with modified touch rules (1 touch and 2 touches rules) by amateur players in 2-a-side format (42.5 ± 4.7 %, 39.2 ± 3.4 % and 60.5 ± 4.2 %, 58.3 ± 4.3 %) and 3-a-side format (52.0 ± 3.9 %, 47.5 ± 6.5 % and 47.5 ± 6.5 %, 66.6 ± 4.3 %) as well as 4-a-side format of SSGs with the modified 1 touch rule (49.8 ± 5.3 % and 45.3 ± 8.5 %), respectively. These differences can be seen in figure 10.

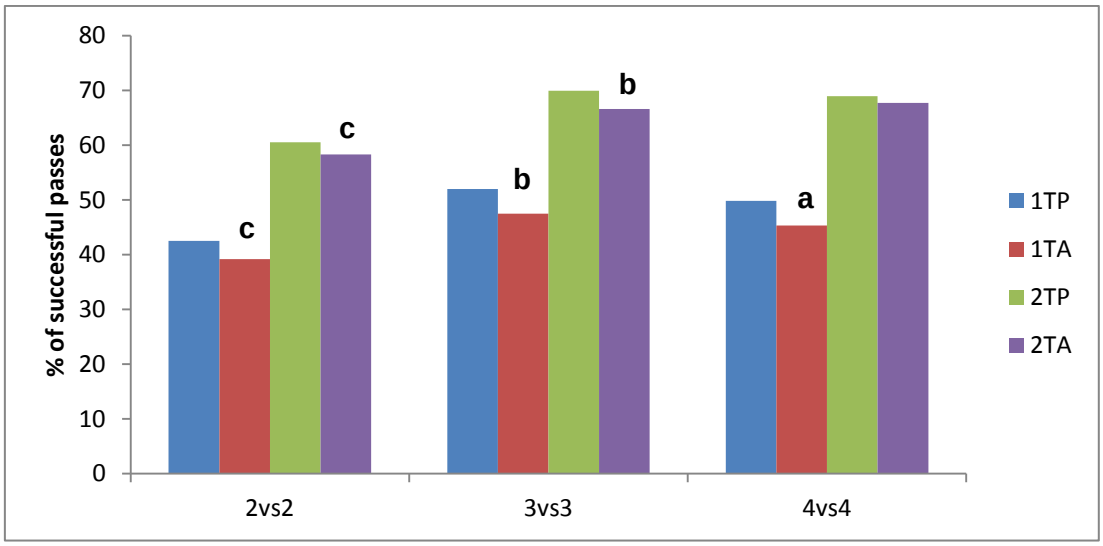

Fig. 10: Percent of successful passes of players with modified touch rules

1TP= 1 touch playing at professional level;
1TA= 1 touch playing at amateur level;
2TP= 2 touches playing at professional level;
2TA= 2 touches playing at amateur level;
[a]significantly lower than professional p<0.05;
[b]significantly lower than professional p<0.01;
[c]significantly lower than professional p<0.001

Number of ball losses:

As described in experiment 12, for professional players, 1 touch rule can cause obviously more number of ball losses, compared to 2 touches and free play rules. The same trend is also found for amateurs. For example, in 2-a-side format, the lowest value is obtained when they play with free play rule (16.0 ± 2.1), whereas higher values are obtained with modified touch rules, in particular with 1 touch rule (30.7 ± 2.4).

The trend of gradual increasing for number of ball losses with modified touch rules are also observed for players at amateur levels in 3-a-side (16.8 ± 4.6, 19.1 ± 6.1, 22.5 ± 5.5) as well as 4-a-side (15.8 ± 4.6, 16.8 ± 4.2, 20.0 ± 6.5) formats of SSGs, respectively.

Moreover, through the comparison with results, significant differences between players at professional and amateur levels are observed. Compared to professional players, a high number of ball losses with modified touch rules (1 touch and 2 touches) occur by amateur players for 2-a-side format (23.5 ± 4.4, 30.7 ± 2.4 and 14.1 ± 2.6, 21.1 ± 3.5) and 3-a-side format (17.1 ± 3.6, 22.5 ± 5.5 and 15.1 ± 2.7, 19.1 ± 6.1) as well as 4-a-side (14.8 ± 4.4, 20.0 ± 6.5 and 13.6 ± 4.2, 16.8 ± 4.2), respectively. These differences can be seen in figure 11.

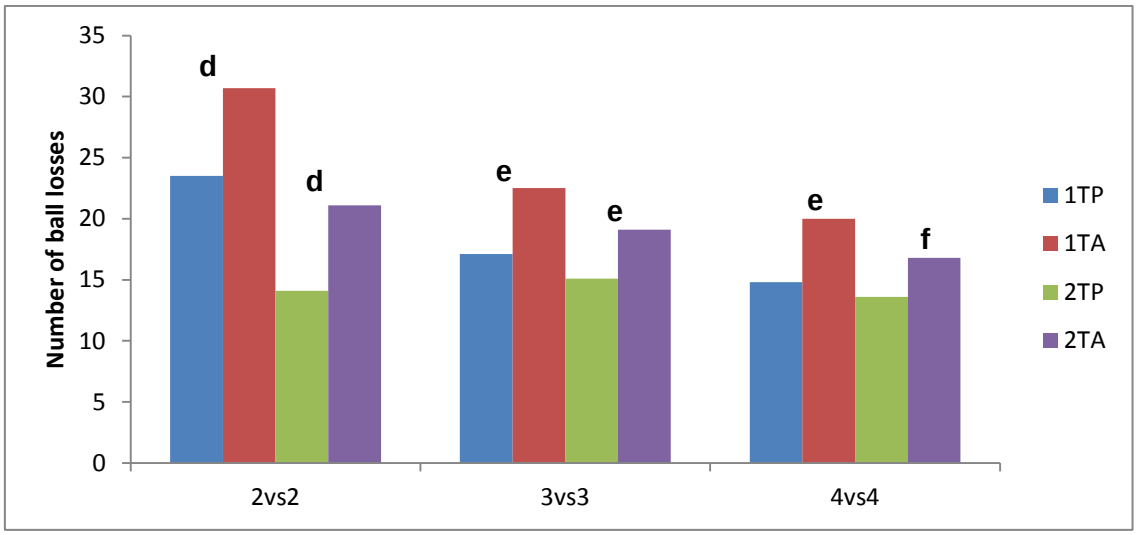

Fig. 11: Number of ball losses of players with modified touch rules

1T: 1 touch authorized per individual possession;
2T: 2 touches authorized per individual possession;
FP: free play rule
[d]significantly greater than professional p<0.05;
[e]significantly greater than professional p<0.001;
[f]significantly greater than professional p<0.01

Ball losses per minute of play:

Ball losses per minute of play are specific performances for ball losses. The trend of ball losses per minute is similar to ball losses with a gradual increasing observed with modified touch rules.

The difference between professional and amateur levels of ball losses per minute is the same as in ball losses. These differences can be seen in figure 12.

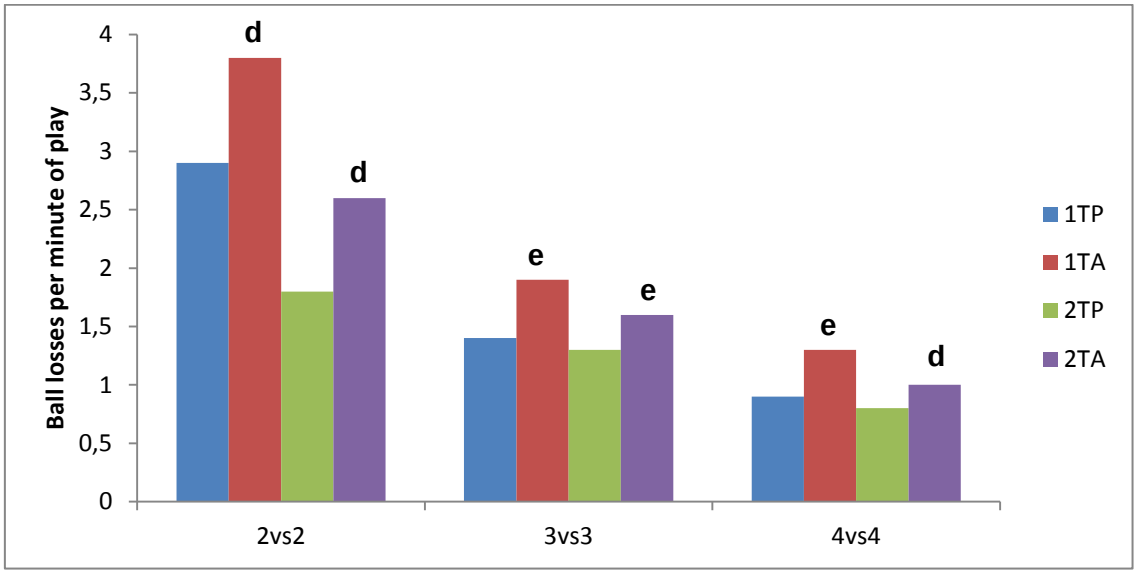

Fig. 12: Number of ball losses per minute of play with modified touch rules

1T: 1 touch authorized per individual possession;
2T: 2 touches authorized per individual possession;
FP: free play rule
[d]significantly greater than professional p<0.05;
[e]significantly greater than professional p<0.001

Total number of ball possessions:

As described in experiment 12 that in comparison with 2 touches and free play rules, obviously more total number of ball possessions for professional players can occur with the modified 1 touch rule. The same trend is also observed at amateur level, such as, in 2-a-side format, the lowest value is obtained with free play rule (41.6 ± 4.8), whereas higher values are obtained with modified touch rules, especially with the 1 touch rule (57.9 ± 3.8). More total number of ball possessions is executed with 1 touch rule (50.8 ± 6.0, 41.4 ± 3.8), in comparison with 2 touches (41.3 ± 5.6, 34.2 ± 4.8) and free touch (37.4 ± 4.6，31.1 ± 5.1) rules in 3-a-side and 4-a.side formats of SSGs.

However, no consistent trend for all SSGs appears through comparison between professional and amateur levels. No significant difference is observed between both levels in 4-a-side format of SSGs. In 2-a-side format, amateur players perform more ball possessions than professional players (57.9 ± 3.8, 46.5 ± 3.3 and 50.6 ± 5.0, 41.4 ±3.8, respectively) with all modified touch rules. In contrast, professional players gain more opportunities for ball possessions in 3-a-side format than amateurs (51.8 ± 7.1, 43.7 ± 5.0 and 50.8 ± 6.0, 41.3 ± 5.6, respectively). These differences can be seen in figure 13.

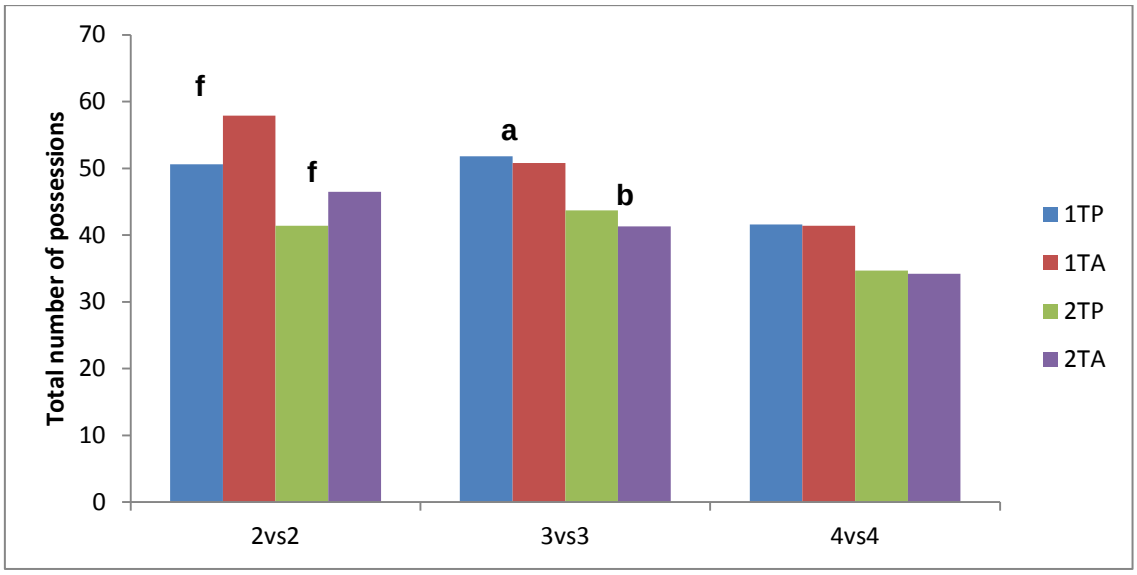

Fig. 13: Total number of ball possessions of players with modified touch rules

1T: 1 touch authorized per individual possession;
2T: 2 touches authorized per individual possession;
FP: free play rule
[a]significantly lower than professional p<0.05;
[b]significantly lower than professional p<0.01;
[f]significantly greater than professional p<0.01

The results of these experiments demonstrate that the effect with modified touch rules (number of ball contact authorized per individual possession) for players in different formats of SSGs is consistent at all levels (professional and amateur). More number of ball losses and number of ball possessions are generated for players, whereas the quality of passes is reduced. Compared to the modified 2 touches rule, the effect can be more obvious with the modified 1 touch rule. In addition, the quality of technical performances (percent of successful passes and number of ball losses) at amateur level is lower compared to professional players.

Discussion

The results of the experiments above are consistent with the conclusion that the modification of the number of ball contacts authorized per individual possession elicits more number of ball possessions and duels, whereas reduces the quality of technical performances (decreased percent of successful passes and increasing number of ball losses). Compared to the modified 2 touches rule, stronger influences can be observed

with the modified 1 touch rule. These results reflect the intrinsic relations between technical behaviors, which are based on the dynamic processes in competition.

As described in chapter 3.2, the modification of the number of ball touch rules can promote significantly physical loads of players, especially for high-intensity activities (HIR and sprints). It's attributed to the fact that due to the application of the modified touch rules, activities of players are increased. It causes that, on the one hand, individual technical actions are reduced, such as dribbling. On the other hand, with the increase of speeds in playing, the requirements to technical performances of players are also increased simultaneously. Players should analyze games quickly and make decisions in short time. For example, before players receive ball, they should observe all information about teammates and opponents as much as possible, in order to quickly decide and execute technical actions, as well as to be able to repeat high-intensity technical actions. Therefore, the degrees of difficulty increase obviously, which explains the lower quality of their technical performances (e.g. reduced percent of successful passes, greater number of ball losses) with modified touch rule in comparison with free play rule, in particular with the modified 1 touch rule. Thus, the number of rounds for offensive and defensive behaviors increases. The number of ball losses per minute of play reflects obviously this change. In this context, the total number of ball possessions increases due to the increase in the number of rounds (Dellal et al., 2011a, p. 2371; 2011b, p. 322; 2011, p. 341; Kaplan et al., 2009, p. 774; Reilly et al., 2000, p. 695).

In addition, based on the consistency of the changes at all levels, the wide effectiveness of modified touch rules within SSGs are confirmed. Through the comparisons of the differences at both levels (professional- and amateur), the results demonstrate that amateur players perform less quality of technical performances with modified touch rules in comparison with professional players. The differences of technical ability (reduced percent of successful passes, greater number of ball losses) are more obviously observed with 1 touch rule in contrast to 2 touches rule. This result is confirmed with the finding (Dellal et al., 2010, p. 278; Hughes, & Franks., 2005, p. 509; Oberstone, 2009) which indicates that the technical pattern is one of the key factors, which differentiates the playing levels (professional and amateur). In this sense, considering the balance between quantity and quality of technical performances, appropriate modified touch rules should be adopted due to corresponding technical ability. It's recommended for amateur players that too difficult rules (e.g. 1 contact authorized per individual possession) are not used. In this context, due to lower technical ability, the rule with at least 2 touches authorized per ball possessions should be used by technical training for amateur players, whereas for

professional level, coaches should be recommended to apply with maximum 2 touches authorized per ball possessions to simulate the technical requirements of elite match.

In summary, these results indicate that the modification of the number of ball contacts authorized per individual possession can influence the technical performances of players at all levels. With modified 1 touch rule, a high number of ball possessions are generated, whereas quality of passes is reduced, in comparison to 2 touches rule. In addition, compared to amateur players, professional players show a higher stability of technical performances, independently of the modification of the number of ball touch rules.

4.2 Conclusion

Based on the findings above, the altering of pitch dimension of SSGs can effectively influence technical actions of players. In contrast to larger formats, smaller formats can elicit obviously more technical actions (e.g. dribbling, tackles, shooting). Lager pitches can cause more diversified technical-tactical actions, such as block and interception as well as long passes. Consequently, altering of playing field of SSGs can be effectively applied for specific technical training.

The modification of the number of ball touch authorized per individual possession can raise the total number of ball possessions for players at all levels, especially with the modified 1 touch rule. In addition, with the increase of difficulty due to the application of modified touch rules, the qualities of technical performances of players at amateur level decrease significantly, in contrast to professional players.

Thus, according to the findings above, some practical applications for effective use of SSGs in technical training sessions are listed.

Practical applications

Smaller formats of SSGs are suitable for intensive technical training for offensive positions (e.g. midfielders and strikers), larger formats of SSGs can be applied for comprehensive technical training with simple tactics.

The modified touch rules can be used in specific training for ball possessions. It is recommended that 1-2 touches per individual possession is suitable for elite and at least 2 touches are authorized per ball possessions for amateur players.

5 Summary

The aim of this study is form a comprehensive understanding for SSGs and to search some effective practical applying measures for physical and technical trainings. According to the fact that SSGs with many benefits as well as physical loads and technical behaviors during SSGs can be affected by some altering factors (e.g. pitch dimension and number of players as well as modified touch rules), SSGs are suitable as a appropriate means for the development of youth players and can be effectively applied in physical and technical trainings sessions.

In chapter 2, some understandings for SSGs are summarized. SSGs is a broad concept that SSGs is an approach with fun and enjoyment for young players to join the adult game of 11 versus 11 through modified rule such as size of goalposts, ball and playing field as well as number of players etc (Moye & Parker, 2012, p. 11). Next, through the attentions to the scope of application, the invasive characteristics of SSGs are found. Thus, SSGs are suitable for being applied for invasion sports. Then, through the attentions to the forms of SSGs, it can be shown that the best form of SSGs for young players is age appropriate form, which is suitable for the stages of physical development of children. Moreover, in terms of many benefits (e.g. a large amount of repetitive technical behaviors and repeated experiences of making less–complicated decisions), SSGs are beneficial to enhance the effect of skills application training and promote the learning of cognitive process for players.

In chapter 3, through the analysis of the results of experiments, the universal effectiveness of SSGs for players at all levels demonstrates that SSGs are able to meet requirements of high-intensity activities in sport matches. In addition, with the modified rules (altering of playing fields and modified touch rules as well as different time regimes) SSGs can influence significantly physical loads of players, especially for high-intensity activities. In comparison with amateur level, the effects are more obvious for players at professional level. Thus, according to these findings, some practical applications for the use of SSGs in physical trainings session can be mentioned:

- With the expansion of playing field per player, the percentages of proportion for high-intensity activities will be increased, in particular the enhancements of quality and quantity for sprints.
- With modified 1 touch rule, more high-intensity activities (HIR and sprints) are significantly improved.
- With appropriate short break (intermittent regime), more high-intensity activities and sprints frequency are elicited in SSGs.

In chapter 4, through the analysis of the results of experiments, altering of pitch dimension of SSGs can significantly influence the configuration of technical actions of players. Smaller formats can cause obviously more technical actions (e.g. dribbling, tackles, shooting), compared to larger formats. In addition, the modified touch rules can raise the total number of ball possessions for players at all levels, especially with the modified 1 touch rule. However, the effects are different between elite and amateur levels, due to differences of their technical abilities. Compared to professional players, technical performances of players at amateur level decrease significantly, with the increase of difficulty due to the application of modified touch rules. It's attributed that, on one hand, there is a lack of their technical capabilities, such as accuracies of passes and receives, on the other hand, qualities of technical actions are closely linked with fitness condition in high-intensity competition (Dellal et al., 2011, p. 2371), based on the fact that the capacity of professionals for high-intensity activities is higher than amateurs. Thus, the significant decrease in technical performances of amateur players is due to the lack of their abilities to execute high-intensity activities. In this context, in order to ensure the effect of technical training sessions and to avoid excessive fatigue, SSGs should be used with caution for amateur players due to their lower technical abilities compared to professionals. Thus, according to the findings above, some practical applications for effective using with SSGs in technical training sessions are listed:

- Smaller formats of SSGs are suitable for intensive technical trainings for offensive positions (e.g. midfielders and strikers), larger formats of SSGs can be applied for comprehensive technical trainings with simple tactics.
- The modified touch rules can be used in specific training for ball possessions. It is recommended that 1-2 touches per individual possession are suitable for elite players and at least 2 touches authorized per ball possessions for amateur players.

This study concentrates on the role of SSGs for physical and technical training of game sports, and the role of SSGs for tactical training will be emphasized in the future.

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Abstract

Purpose

The study focuses on a comprehensive understanding for SSGs and analyses of the role of SSGs in physical and technical trainings to search some effective practical applying measures. The main objectives of research are how to effectively apply SSGs for high-intensity activities and for ball possessions.

Result

With some modified rules, the percentages of proportion for high-intensity activities will be increased, in particular the enhancements of quality and quantity for sprints. The modified touch rules can raise the total number of ball possessions for players at all levels, especially with the modified 1 touch rule.

Conclusion

SSGs are suitable as an appropriate means for the development of youth players and can be effectively applied in physical and technical trainings sessions.

Keywords

SSGs, high-intensity activities, time-motion, technical actions, modified rules

Zusammenfassung

Ziel

Die hier vorliegende Arbeit konzentriert sich auf ein umfassendes Verständis für SSGs und analysiert die Rolle der SSGs in physische und technische Trainings, um einige wirksame praktische Anwendung von Maßnahmen zu suchen. Ziel dieser Arbeit ist es, wie kann man effektiv SSGs für hoch intensiven Aktivität und Ball Besitz anwenden.

Ergebnis

Mit einigen modifizierten Regeln, die Prozentsätze der Anteil für hoch intensiven Aktivität erhöht werden, insbesondere die Verbesserungen von Qualität und Quantität für Sprints. Die modifizierten Ballberühren Regeln kann die Gesamtzahl der Ball Besitz für Spieler auf allen Ebenen zu erhöhen, insbesondere mit dem modifizierten 1 Ballberührung Regel.

Fazit

SSGs eignen sich als ein geeignetes Mittel für die Entwicklung der Nachwuchsspieler und werden effektiv in physische und technische Trainings angewendet.

Schlüsselwörter

SSGs, hoch intensiven Aktivität, Echzeit-Bewegung, technisch aktionen, modifizierten Regeln

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