UNIVERSIDADE BEIRA INTERIOR

Ocupação espacial e comportamento tático no futebol de formação: Implicações para a manipulação e controle de jogos reduzidos

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Nuno és a minha INSPIRAÇÃO…….

Resumo

A presente tese teve como objetivo uma melhor compreensão do efeito da idade na variação do espaço de jogo dos jogadores e implicações para a manipulação das tarefas de treino. Para isso, procurámos em primeiro lugar, através de uma revisão sistemática descrever e analisar sistematicamente os sistemas de rastreamento, as variáveis e os métodos estatísticos usados para avaliar o comportamento tático de jogadores e equipas nos jogos reduzidos condicionados (JRC); em segundo lugar descrever a área individual por jogador, de acordo com a idade, relações numéricas e a zona do campo no futebol de formação (sub 15, sub 17 e sub 19), e posteriormente caracterizar os padrões de passe que suportam o comportamento tático coletivo nos jogadores de futebol de diferentes idades (sub 15, sub 17 e sub 19) nas diferentes zonas do campo. Os resultados do primeiro estudo, revelaram que os GPS são os sistemas de rastreamento mais utilizados para avaliar o comportamento tático através de diferentes métricas espaciais que derivam do posicionamento dos jogadores. Os resultados do segundo estudo mostraram, em todas as relações numéricas, que as áreas de jogo foram superiores nas zonas próximas das balizas e no escalão sub 15. Outro dado interessante, as diferenças tiveram maior expressão entre escalões etários quando as relações numéricas incluíram dez ou mais jogadores. No terceiro estudo, os resultados revelaram que os passes médios foram mais utilizados nas zonas próximas das balizas e os passes curtos na zona média do campo em todas as idades. A análise da distância relativa entre o portador da bola e o receptor indicou que os jogadores mais velhos (sub 17 e sub 19) utilizaram jogadores mais distantes para passar a bola nos passes médios e longos. Em suma, a presente tese contribuiu para aumentar o conhecimento do comportamento tático individual e colectivo do jogo no futebol jovem para auxiliar os treinadores a desenhar os jogos reduzidos condicionados de acordo com o ambiente competitivo.

Palavras-chave

Futebol jovem; jogos reduzidos condicionados; comportamento tático; variáveis posicionais; sistemas de rastreamento; zonas do campo; áreas de jogo; relações numéricas; passes

Abstract

The present thesis aimed to achieve a better understanding of the effect of age on the variation of players' playing space and implications for the manipulation of training tasks. For this, we sought, first, through a systematic review, to describe and systematically analyze the tracking systems, variables and statistical methods used to evaluate the tactical behavior of players and teams in the small-sided conditioned games (SSCGs); secondly, we intended to describe the individual area per player, according to age, numerical relationships and the field area in youth football (under 15, under 17 and under 19) and, later, characterize the passing patterns that support the collective tactical behavior in soccer players of different ages (under 15, under 17 and under 19), in different areas of the field. The results of the first study revealed that GPS are the most used tracking systems to evaluate tactical behavior, through different spatial metrics that derive from the positioning of players. The results of the second study showed, in all numerical relationships, that the playing areas were larger in the areas close to the goals and in the under 15 level. Another interesting fact is the fact that the differences were more expressive between age groups when the numerical relationships included ten or more players. In the third study, the results revealed that the medium passes were more used in the areas close to the goals, and the short passes in the medium area of the field, in all ages. The analysis of the relative distance between the ball carrier and the receiver indicated that the older players (under 17 and under 19) used more distant players to pass the ball, in medium and long passes. In short, the present thesis contributed to increase the knowledge of the individual and collective tactical behavior of the game in youth football, in order to help coaches to design small-sided conditioned games according to the competitive environment.

Keywords

Youth football; small-sided conditioned games; tactical behavior; positional variables; tracking systems; field zones; game areas; numerical relationships; passing

Publicações

Foram realizados os seguintes artigos como parte dos trabalhos de doutoramento:

Coito, N., Davids, K., Folgado, H., Bento, T. & Travassos, B. (2020). Capturing and Quantifying Tactical Behaviors in Small-Sided and Conditioned Games in Soccer: A Systematic Review. *Research Quarterly for Exercise and Sport, 1-15.* https://doi.org/10.1080/02701367.2020.1823307

Coito, N., Folgado, H., Romero, F., Loureiro, N. & Travassos, B. (2022). Variations in individual player area in youth football matches: the effects of changes of players' age, numerical relations, and pitch zones. *International Journal of Performance Analysis in Sport*, 1-13. https://doi.org/10.1080/24748668.2022.2025713

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Foram ainda realizadas as seguintes apresentações em congressos técnico científicos:

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Coito, N., Folgado, H. & Travassos, B. (2019). Determinação do Espaço em Jogos Reduzidos. Ocupação Espacial e Relação Numérica em Jogos Formais de Futebol 11. 8º Congresso Internacional de Atividade Física e Desporto. Instituto Politécnico de Beja

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Coito, N., Folgado, H., Romero, F., Loureiro, N. & Travassos, B. (2021). Variations in individual player area in youth football matches: the effects of changes of players' age, numerical relations, and pitch zones. XXII Jornadas da Sociedade Portuguesa de Psicologia do Desporto. Escola Superior de Educação e Ciências Sociais do Politécnico de Leiria

Coito, N., Folgado, H., Romero, F., Loureiro, N. & Travassos, B. (2022). Variações na área individual do jogador no futebol jovem: os efeitos das mudanças na idade dos jogadores, relações numéricas e zonas do campo. Conferência Internacional Ciência e Futebol. Portugal Football School. Federação Portuguesa de Futebol

Coito, N., Folgado, H., Romero, F., Loureiro, N. & Travassos, B. (2022). Variations in Individual Player Area in Youth Football Matches: The Effects of Changes of Players' Age, Numerical Relations, and Pitch Zones". Conferência CIDESD/Creative Lab Seminar UTAD. Universidade de Trás-os-Montes e Alto Douro

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JRC	Jogos Reduzidos Condicionados
GPS	Global position system
Gr	Guarda-Redes
SSCGs	Small sided and conditioned games
LPM	Local position measurement
ApEn	Approximate entropy
SampEn	Sample entropy
CP	Centroid position
TS	Team separateness
SI	Stretch index
RSI	Relative stretch index
SR	Spread rate
RC	Running correlations
IPA	Individual player area
U	Under
Z	Zone
P	Player
X^2	Teste qui quadrado

Capítulo 1 – Introdução

O desporto em geral e, concretamente, o futebol tem revelado uma grande evolução nas leis do jogo, nos estilos de jogo, na metodologia de treino e nos métodos e meios para controlo e monitorização do treino.

O futebol é considerado um sistema complexo em que os comportamentos observados resultam da constante interação entre jogadores para a exploração das relações espaço-tempo em diferentes contextos de jogo para a identificação de possibilidades de ação, isto é, comportamentos táticos individuais e coletivos (Silva et al., 2015). Tendo como objetivo o desenvolvimento da ação tática individual e coletiva, assente na ligação com os fatores de rendimento físicos, técnicos, e psicológicos, o recurso a jogos reduzidos e condicionados (JRC) nos diferentes níveis competitivos e idades tem sido uma tendência nos últimos anos. A sua utilização permite o desenvolvimento, de forma conjugada, dos fatores de rendimento, referidos anteriormente, tendo por base os objetivos que o treinador pretenda dar a cada exercício de treino (Davids, Araújo, Correia, & Vilar, 2013). Os JRC são exercícios que pela manipulação dos constrangimentos da tarefa (espaço, relação numérica, número de balizas, regras, entre outros) permitem recriar contextos de jogo com complexidade reduzida ou aumentada em relação ao jogo formal (Sarmento et al., 2018). Desta forma, os JRC permitem criar contextos de prática que potenciam a exploração orientada de possibilidades de ação tática tendo por base a variação nas pistas informacionais que sustentam a ação dos jogadores (Davids et al., 2013). Uma vez que os comportamentos dos jogadores não são prescritos mas emergem da relação que estes estabelecem com o contexto de prática, tendo por base a variação nas pistas informacionais, tal como ocorre em jogo, a transferência para o contexto de competição tende a ser mais efetivo na promoção de adaptabilidade individual e colectivas (Davids et al., 2013) sendo fundamental para o desenvolvimento do talento nos jovens futebolistas (Sarmento et al., 2018).

Efeitos da manipulação JRC no comportamento físico e tático

Os JRC foram propostos no futebol nos finais da década de 60 (Wade, 1967), tendo a sua análise para quantificação sobretudo das suas exigências físicas e fisiológicas sido reportada a partir da década de 80 (MacLaren, Davids, Isokawa, Mellor, & Reilly, 1988). Com o aumento dos meios tecnológicos para a monitorização e recolha de dados (cardiofrequencímetros, medidores do lactato, GPS, entre outros), verificou-se na década de 2000 um grande aumento da análise dos JRC e consequentemente uma maior compreensão da sua utilização (Gabbett & Mulvey, 2008; Impellizzeri et al., 2006). De entre os estudos realizados com foco nos aspetos fisiológicos da manipulação de JRC, verificou-se que, tendencialmente, a intensidade nos jogos reduzidos aumenta com a redução do número de jogadores (Owen et al., 2015) com o acréscimo das dimensões do espaço (Casamichana & Castellano, 2010; Dellal et al., 2012; Tessitore, Meeusen,

Piacentini, Demarie, & Capranica, 2006) e com a remoção das balizas (González-Rodenas, Calabuig, & Aranda, 2015; Mallo & Navarro, 2008).

Mais recentemente, a compreensão dos efeitos das manipulações dos jogos reduzidos nos comportamentos táticos de jogadores e equipas, bem como a sua comparação com as exigências da competição tem revelado alguma consistência (Clemente et al., 2020; Ometto et al., 2018; Sarmento et al., 2018). Diversos estudos sugerem que os jogadores de ambas as equipas em formatos de igualdade numérica (2x2 a 5x5) tendem a aumentar a distância entre si e a equilibrar o espaço de jogo com o aumento do número de jogadores envolvidos (Aguiar, Gonçalves, Botelho, Lemmink, & Sampaio, 2015; Folgado, Lemmink, Frencken, & Sampaio, 2014; Silva, Vilar, Davids, Araujo, & Garganta, 2016). Segundo Silva et al (2015) os formatos 4x4 e 5x5 são os mais indicados para potenciar a ocupação equilibrada do espaço de jogo e distribuição espacial equilibrada por jogador. É ainda referido que o aumento do número de jogadores seguido do acréscimo das dimensões do campo tende a promover menor variabilidade no espaço ocupado. Neste sentido, enquanto a utilização de um reduzido número de jogadores tende a potenciar uma maior exploração das ações táticas individuais, um maior número de jogadores deve ser utilizado para potenciar o desenvolvimento de ações táticas colectivas (Aguiar, Botelho, Lago, Maças, & Sampaio, 2012).

O recurso a JRC em desigualdade numérica tende a promover maiores exigências físicas, sobretudo aos jogadores em inferioridade numérica (Hill-Haas, Dawson, Impellizzeri, & Coutts, 2011) do mesmo modo que potenciam o desenvolvimento da coordenação interpessoal entre companheiros da equipa para a ocupação equilibrada do espaço face à equipa em superioridade (Gonçalves, Esteves, et al., 2016; Travassos, Gonçalves, Marcelino, Monteiro, & Sampaio, 2014). Noutro estudo com três formatos (gr+4x3+gr, gr+4x5+gr e gr+4x7+gr) os resultados sugerem que o aumento da desigualdade numérica entre equipas potencia uma coordenação mais funcional entre os elementos da equipa em desvantagem numérica e jogam mais próximo da sua baliza, face à necessidade de suplantarem a inferioridade numérica com o adversário (Gonçalves, Esteves, et al., 2016; Vilar, Esteves, et al., 2014). De forma interessante, verificou-se ainda um efeito da variação da relação numérica na distância entre os jogadores para a intercepção do passe e remate. Os resultados mostraram que a distância entre o atacante e o defensor mais próximo é significativamente mais baixa em igualdade numérica do que em inferioridade numérica. A distância do defensor para intercetar a trajectória do remate e do passe foi também mais reduzida em igualdade numérica do que em inferioridade numérica (Vilar, Esteves, et al., 2014), realçando as linhas de passe e remate para os atacantes em superioridade numérica enquanto promovem maior exigência aos defensores na ocupação do espaço e capacidade de deslocação para intercepção (Silva, Travassos, et al., 2014; Travassos, Vilar, Araújo, & McGarry, 2014; Vilar, Esteves, et al., 2014).

A manipulação das balizas (número, tamanho, localização), face à sua importância na atracção dos comportamentos individuais e colectivos das equipas é outro dos constrangimentos que tem sido estudado evidenciando resultados interessantes para a prática (Davids et al., 2013). A manipulação

das balizas podem surgir de diferentes formas, tais como: presença ou ausência do guarda-redes (Casamichana, Castellano, Arturo, Hugo, & Garcia-Lopez, 2011; González-Rodenas et al., 2015; Riboli, Coratella, Rampichini, Cé, & Esposito, 2020), dimensões (Travassos, Coutinho, Gonçalves, Pedroso, & Sampaio, 2018), número e localização (Castellano, Silva, Usabiaga, & Barreira, 2016). Diversos estudos, na comparação da presença ou ausência de balizas nos JRC sugerem maior intensidade nos jogos sem guarda-redes, enquanto, a presença do guarda-redes as equipas tendem a aumentar a organização defensiva para proteger a baliza (Castellano, Casamichana, & Dellal, 2013; Clemente, Martins, & Mendes, 2014). Quanto à manipulação das dimensões das balizas (3x2m, 6x2m e 7,32x2,44m) os resultados revelaram que a utilização de balizas maiores potenciou maior número de remates de mais zonas do campo (Castellano et al., 2016). Do mesmo modo, Silva et al (2011) verificou que as balizas de futsal (3x2m) potenciam um jogo mais apoiado com remates a ocorrerem predominantemente na zona frontal mais próxima da baliza, enquanto o recurso a balizas oficiais de futebol (7,32mx2x44m) tende a promover o jogo mais direto com ocorrência de maior número de remates em diferentes zonas do campo. A comparação da utilização do JRC 5x5 com balizas formais ou três mini-balizas em cada equipa revelou que o recurso a mini-balizas sem GR promoveu maior equilíbrio no espaço ocupado entre equipas (menor diferença de espaço ocupado entre equipa atacante e defensora) e quanto maior o número de balizas pequenas, maior a tendência da equipa defensora para reduzir o espaço às suas balizas (Travassos, Gonçalves, et al., 2014). Concomitantemente, a colocação das mini balizas reduzidas nas zonas laterais da linha de fundo ao invés de nas zonas centrais, potenciou maior volume de jogo pelos corredores laterais do campo, obrigando o comportamento da equipa defensora a centrar-se em zonas mais próximas da bola (Travassos, Gonçalves, et al., 2014).

Face ao exposto, a manipulação do número de balizas, tamanho e localização parece ter um impacto no comportamento tático sobretudo na equipa defensora, semelhante ao observado com a manipulação da relação numérica. Através da manipulação das balizas, a equipa defensora tem que se ajustar continuamente de modo a obter comportamentos funcionais e ajustados às exigências do jogo, nomeadamente em termos de compactação ou pressão sobre a bola para defesa das suas balizas (Almeida, Volossovitch, & Duarte, 2017; Olivares, Víllora, & García López, 2015). Estudos sugerem que enquanto uma única baliza tende a potenciar a irregularidade nos comportamentos táticos dos jogadores, a utilização de duas balizas tende a promover a dispersão da equipa e potencia uma maior regularidade nos comportamentos individuais e coletivos (Travassos et al., 2018).

Outra variável que consideramos fundamental realçar para um melhor entendimento das manipulações dos jogos reduzidos, diz respeito ao espaço de jogo, pois esta variável revelou dependência da idade / nível de expertise dos jogadores (Hill-Haas et al., 2011). Desta forma, deve ser uma das variáveis a considerar pelos treinadores para promover a exploração de comportamentos mais ajustados às suas características e aos seus objetivos táticos e físicos (Guard, McMillan, & MacFarlane, 2022; Sannicandro & Cofano, 2017). Diversos estudos definiram a área

de jogo em função do número de jogadores envolvidos e da dimensão pretendida em função dos objetivos (pequeno, médio e grande) (tabela 1) (Little, 2009).

Tabela 1. Dimensões do espaço nos JRC

Metros (m)	1x1	2x2	3x3	4x4	5x5	6x6
Pequeno	10 x 5	15 x 10	20 x 12	24 x 16	28 x 20	32 x 24
Médio	15 x 10	20 x 15	25 x 15	30 x 20	35 x 25	40 x 30
Grande	20 x 15	25 x 20	30 x 18	36 x 24	42 x 30	48 x 36

Outros estudos utilizaram a referência das dimensões do jogo formal (105x68m) para a definição dos espaços de jogo nos JRC (Silva, Aguiar, et al., 2014). Por exemplo, na relação numérica (gr+4x4+gr) que constitui 45 % do número de jogadores no jogo oficial, o espaço de jogo com a mesma percentagem é de 47,3x 30,6 metros sendo considerado o espaço intermédio. Para definir as dimensões pequenas ou grandes utiliza-se a referência de 10 % para reduzir ou ampliar o espaço de jogo (Silva, Aguiar, et al., 2014) (tabela 2).

Tabela 2. Construção das dimensões do espaço nos jogos reduzidos

Metros (m)	Comprimento	Largura	Área individual de jogo
Pequeno (35%)	36,8 m	23,8 m	88 m²
Médio (45%)	47,3 m	30,6 m	145 m²
Grande (55%)	57,8 m	37,4 m	216 m²

Frencken etal. (2013) sugerem que uma redução de cerca de 20 % na profundidade (30x20 vs 24x20) no JRC no formato gr+4x4+gr diminuiu a distância entre jogadores na mesma equipa em cerca de 15 %. Por seu lado, a redução de cerca de 20 % da largura (24x20 vs 24x16) promoveu a diminuição da distância entre as equipas no sentido lateral. Contudo, de forma interessante, os valores da área ocupada observados foram proporcionais à diminuição do campo. Por seu lado, o recurso a diferentes orientações do campo (40x30 m e 30x40 m) mostrou que os jogadores variam as distâncias percorridas a alta intensidade, as ações técnicas e a sua ocupação espacial em função da orientação de campo adotada (Folgado, Bravo, Pereira, & Sampaio, 2019). De forma semelhante, a exploração de diferentes configurações do campo ("Standard", 53x38 m; "Long", 63 x 32 m and "Wide", 43 x 47 m) revelou que a configuração "Long" e "Wide" potencia mais contra-ataques e mais situações de finalização, enquanto, o formato "Standard" emerge maior sincronização coletiva e uma maior organização defensiva (González-Rodenas, Aranda-Malavés, Tudela-Desantes, de Matías-Cid, & Aranda, 2021).

Quanto à variação do tamanho das áreas de jogo, os resultados de estudos anteriores sugerem que o seu aumento tende a revelar maior distância entre os jogadores da própria equipa e do adversário (Folgado et al., 2019; Frencken, Van Der Plaats, Visscher, & Lemmink, 2013; Santos et al., 2018; Silva, Duarte, Esteves, Travassos, & Vilar, 2016) permitindo aos jogadores terem mais tempo para a tomada de decisão e para executar as ações técnico-táticas (Nunes, Gonçalves, Coutinho, & Travassos, 2020). Assim, áreas de jogo maiores tende a potenciar a manutenção da posse de bola e a obtenção de maior número de golos devido aos defesas terem menos possibilidades de intercetar a bola (Vilar, Esteves, et al., 2014). Em sentido contrário, a redução da área de jogo tende a promover o aumento de número de perdas de bola, mais contactos físicos, mais duelos individuais e "tackles" e potencia o surgimento de maior número de ações individuais (Dellal et al., 2012; Owen, Wong, McKenna, & Dellal, 2011).

Apesar de todas as informações sobre a manipulação de diferentes áreas de campo nos JRC seja adaptada da área de campo ou com base na área individual por jogador, o formato do campo a utilizar tendo por base a idades dos jogadores tem sido pouco estudado (Folgado et al., 2019).

Efeitos da idade / capacidades individuais no comportamento físico e tático

A manipulação do espaço dos JRC desenvolve diferentes adaptações em função da idade (Barnabé, Volossovitch, Duarte, Ferreira, & Davids, 2016; Olthof, Frencken, & Lemmink, 2015). De facto, a variação na idade ou nas suas capacidades individuais e conhecimento do jogo tendem a promover variação na exploração dos contextos de jogo e consequentemente nas ações táticas, técnicas e exigências físicas para a manipulação dos mesmos constrangimentos de tarefa (López-Fernández, Sánchez-Sánchez, García-Unanue, Hernando, & Gallardo, 2020; Olthof, Frencken, & Lemmink, 2019; Silva, Aguiar, et al., 2014).

Diversos estudos revelaram que os jogadores mais velhos tendem a realizar mais passes durante o jogo e apresentar mais tempo de posse de bola utilizando mais a largura do campo, enquanto os jogadores mais jovens tendem em jogar mais no sentido longitudinal em espaços similares e um jogo mais direto (Almeida et al., 2017; Barnabé et al., 2016; Folgado et al., 2014; Olthof et al., 2015). Assim, os jogadores mais velhos e habilidosos revelaram maior capacidade de adaptação à variação do espaço de jogo existente (Sampaio & Maçãs, 2012; Silva, Aguiar, et al., 2014), permitindo o surgimento de maior coordenação da equipa na exploração do espaço de jogo (Sampaio & Maçãs, 2012). No momento da posse de bola, os jogadores mais jovens tenderam a apresentar irregularidade na circulação da bola (Mendes, Clemente, & Maurício, 2018), uma grande centralização de passes em torno de jogadores específicos e uma diminuição da eficácia do passe em comparação com os jogadores mais velhos (Grund, 2012). Desta forma, o modo como os jogadores exploram as possibilidades de ação do jogo, e o modo como a bola circula em campo parece ter por base as capacidades de ação dos jogadores (Folgado et al., 2014; Olthof et al., 2015). Os estudos sugerem ainda que o aumento da idade promove uma ocupação do espaço mais

equilibrada na relação largura e profundidade, suportando a existência de um jogo mais apoiado (Barnabé et al., 2016; Folgado et al., 2014; Olthof et al., 2015).

Quando o efeito da manipulação do espaço foi estudado na análise das exigências físicas em diferentes formatos dos JRC (3x3,4x4,5x5,6x6) e idades (sub 14, sub 16 e sub 18) os dados indicaram que no formato 3x3, os jogadores sub 16 tendem a percorrer maiores distâncias de alta intensidade que os sub 14 e sub 18. Enquanto, os sub 14 tendem a revelar maiores acelerações de alta intensidade que os sub 16 e sub 18 (López-Fernández et al., 2020). Outro estudo com a mesma relação numérica (4x4) com diferentes idades (U11, U15 e U23) revelaram que os jogadores mais jovens percorreram maiores distâncias em corridas de baixa e alta intensidade (Nunes, Gonçalves, Coutinho, et al., 2020). Quando comparado com os jogadores mais jovens e devido ao maior nível de experiência, os jogadores mais velhos tendem a preservar algumas capacidades físicas, por exemplo, distância total de baixa e alta intensidade, acelerações e desacelerações) (Buchheit, Mendez-Villanueva, Simpson, & Bourdon, 2010).

Desta forma, os JRC devem ser manipulados tendo por base os seguintes pressupostos (Torrents et al., 2017):

- serem ajustados às capacidades de ação dos jogadores envolvidos

- não serem demasiado complexos que não lhes permita foco na informação relevante que sustenta a sua ação

- serem desenhados de acordo com os objetivos do treinador e as suas expetativas para o desenvolvimento dos jogadores e das equipas.

Assim, os JRC devem estar ajustados com as competências técnico-táticas dos jogadores e da equipa e de modo a projetar tarefas de treino que se ajustem aos objetivos associados às suas capacidades de ação potenciando a exploração jogador-ambiente (Machado, 2019). Desta forma, a construção dos JRC devem ser planeados de acordo com as competências dos jogadores, das equipas, do tipo de interações táticas pretendidas de acordo com a zona do campo, da proximidade da própria baliza ou do adversário (Headrick et al., 2012; Laakso, Travassos, Liukkonen, & Davids, 2017) e da localização do companheiro que pode receber a bola durante um determinado espaço-tempo (Travassos, Duarte, Vilar, Davids, & Araújo, 2012). Assim, surge a necessidade de analisar sistematicamente os resultados obtidos, bem como as variáveis a utilizar para promover uma maior justificação entre as manipulações em treino face ao que ocorre em competição.

Capítulo 2- Objetivos

Nos últimos anos, os jogos reduzidos condicionados têm sido um tema de estudo amplamente investigado, nomeadamente o efeito das manipulações nos fatores de rendimento. No entanto, procuramos através desta tese algumas respostas que não conseguimos encontrar nos estudos acerca dos JRC, nomeadamente qual a variação do espaço de jogo utilizado em competição em função da idade.

Face ao exposto, os objetivos do presente trabalho foram:

a) Descrever e analisar sistematicamente os sistemas de rastreamento, as variáveis e os métodos estatísticos usados para avaliar o comportamento tático de jogadores e equipas nos JRC.
b) Descrever a área individual por jogador, de acordo com a idade, relações numéricas e a zona do campo no futebol de formação (sub 15, sub 17 e sub 19).
c) Caracterizar os padrões de passe que suportam o comportamento tático coletivo nos jogadores de futebol de diferentes idades (sub 15, sub 17 e sub 19) nas diferentes zonas do campo.

Capítulo 3 - Capturing and quantifying tactical behaviours in small-sided and conditioned games in soccer: A systematic review

Abstract

Purpose: To systematically describe and analyse the tracking systems, the variables, and the statistical methods used to evaluate the players and teams' tactical behaviour in small sided and conditioned games (SSCGs). Methods: A search was done in Web of Science, PubMed, Science Direct and Scielo databases to identify manuscripts published between 2008 and 2019 that manipulated small sided and conditioned games (SSCGs) and analysed tactical behaviours of players and teams. Results: From 349 articles identified, 31 were selected for review. To collect positional data, the global positioning system (GPS), the local position measurement (LPM) system and TACTO were identified as reliable tracking systems. Twenty-one positional variables were identified to evaluate tactical behaviours, grouped into four main categories: Team balance, playing space, width and length of playing space, and interpersonal distance. Tactical behaviours patterns were analysed using approximate entropy, sample entropy, Shannon entropy and patterns of coordination between players and teams were analysed using relative phase and running correlation. Discussion: The tracking systems analysed were reliable but revealed different advantages and disadvantages of its use. Authors should define the use of each tracking system based on their purpose and level of precision required for analysis. A great duplication was observed on the variables used with similar purposes of tactical analysis. The identification of the variables according to its purpose of analysis will allow a better understanding of its use in the future.

Keywords: small-sided and conditioned games, football, tactical behaviours, performance analysis

Introduction

Team sports, such as soccer, are open dynamic environments in which players are required to adjust their individual actions according to the constantly emerging dynamics in the spatial-temporal relations of teammates and opponents. That is, individual performances emerge from continuous interactions with other players to ensure a balance in team behaviours, based on their capabilities and collective performance, opportunities in competitive performance or training environments (Silva, Vilar, et al., 2016). From these interactions, tactical behaviours emerge as players explore individual and collective possibilities for action when seeking functional performance behaviours in competitive games or practices (Araujo et al., 2010; Grehaigne, Bouthier, & David, 1997).

In line with this idea, small sided and conditioned games (SSCGs) have been widely used in soccer practice aiming to develop physical, physiological, technical, and tactical behaviours at the same time (Ometto et al., 2018; Sarmento et al., 2018). These types of practice task designs seek to potentiate several performance factors, while maintaining the representativeness of training exercises, ensuring a greater specificity of transfer between training and competition (Davids et al., 2013). For example, previous research has emphasized the analyses of the effects on physical and technical actions of players when manipulating key task constraints in SSCGs such as playing area dimensions, number of players involved, type and number of target goals or the number of touches allowed when in possession of the ball (Silva et al., 2015; Silva, Vilar, et al., 2016; Travassos, Gonçalves, et al., 2014). In recent years, there has also been a growing interest in understanding the effects of SSCGs manipulations on tactical behaviours of players and teams, using positional data to study the coordinated behaviours of players with and without the ball (Memmert, Lemmink, & Sampaio, 2017; Sarmento et al., 2018; Travassos, Davids, Araujo, & Esteves, 2013). To perform the tactical analysis, most of the studies used global positioning (GPS) (Coutinho et al., 2018; Gonçalves, Marcelino, Torres-Ronda, Torrents, & Sampaio, 2016; Praça, Folgado, Andrade, & Greco, 2016), local position measurement systems (LPM) (Olthof et al., 2015; Olthof, Frencken, & Lemmink, 2018; Olthof et al., 2019), or manual tracking systems based on video analysis (TACTO) (Duarte et al., 2012; Vilar, Esteves, et al., 2014). All of the systems revealed good reliability values in tracking players' trajectories. For example, Linke et al. (2018) revealed good reliability values registering player positioning on the field for LPM (23 cm), for manual tracking systems based on video analysis (TACTO) (56 cm) and for GPS (96 cm) with similar levels of error sensitivity with increases in players' speed during performance (Linke, Link, & Lames, 2018). The analysis of positional data to capture the effects of the manipulation of SSCGs in tactical behaviours of players and teams have reported several different variables (e.g., centroid position, surface area, effective area play, stretch play or the lpwratio), and used different methodologies(e.g., identification of patterns of coordination, spatial-temporal relations between players, analysing behavioral variability) (Ometto et al., 2018; Sarmento et al., 2018).

To summarize, due to a rapid increase in the volume of research studies on the different kinds of variables and methods used to measure the tactical behaviours of players during training, there is a need to systematically review the results obtained, as well as the variables assessed, and methodologies used that best fit the specific objectives of the academic research. Thus, the aim of this systematic review was to systematically describe and analyse the error margins of the systems, the variables recorded, and the statistical methods used to evaluate and monitor the players' and teams' tactical behavior in SSCGs.

Methods

Search Strategy

This systematic review was conducted following the PRISMA protocol (Moher, Liberati, Tetzlaff, & Altman, 2009). The researchers examined the Web of Science, PubMed, Science direct and Scielo databases by using the following keywords "small sided soccer games" and "small sided football games", and by associating the terms "tactical", "behaviours", "tactical behaviours" and "effects of manipulations". Bibliography lists were also consulted in order to identify potential studies to be included in the review. All data were exported to the EndNote X6 software for further analysis.

The analysis selected experimental, descriptive, or review studies, that complied with the following inclusion criteria: 1) articles published between 2008 to 2019; 2) articles written in English; 3) took into account the positional data of individual players and teams in order to analyse tactical behaviours or 4) revealed effects of task constraints manipulations in SSGs with detailed statistical analyses, and 5), identified the tracking systems used with detailed descriptions of reliability levels.

The exclusion criteria were set for articles analysing performance: 1) in formal (full-sided) games; 2) in sports other than soccer; 3) studies only reporting physiological data; 4) studies only reporting technical performance; and 5) systematic review; 6) studies focused on the manipulation of coaches' instructions; 7) articles only composed of abstracts.

Once the articles were selected they were analysed and the data was related to sample characteristics, players' ages, the task constraints manipulated (e.g., changing playing area dimensions, the number of players involved, types of scoring targets used), the tracking systems used (GPS, LPM, Tacto Software), the variables measured (e.g., team balance, playing space, width and length playing space, interpersonal distances) and methodologies used for analysis. For the purpose of the study each article was categorized according to the tracking systems used, the positional variables studied, as well as the methods of analysis used.

Risk of bias

For the article evaluation, the Law scale was used (Law et al., 1998) consisting of 15 items, including: purpose of the study (item 1), literature relevance (item 2), study design (item 3), sample (items 4 and 5), results (items 6,7,11,12 and 13), intervention (items 8,9 and 10), dropouts description (item 14), and conclusions and implications (item 15). Articles reporting these items were classified with a value of 1 and those articles in which these items were not reported were given a value of 0. The final score is the sum of the items (1 to 15). Additionally, we estimated, on a percentage scale, the methodological quality of each specific study. The studies were classified as follows: low methodological quality ≤ 50% of items reported in an article, good methodological quality rated between 51 to 75 %, and excellent methodological quality above 75 % of items reported (Sarmento et al., 2018). Two independent evaluators (NC, MM) reviewed the selected studies and any discrepancy in article categorisation was resolved by consensus. Only four studies required additional revision by the evaluators.

Results

Study selection and methodological quality

An initial survey identified 349 articles in the database. Figure 1 illustrates the selection process of the articles included for systematic review. In total, 31 articles were included in the study.

The average value of article methodological quality rating was 80,4 %, with twenty-one articles rated above 75 % and ten articles between 51 and 75 % (see Table 1). In the thirty-one articles analysed, possible gaps were identified in two items. None of the studies justified the sample size selected, nor reported the number of players dropping out during data collection. The objectives and the design of each study were rated as 'good quality' according to the "*Law scale"*. The statistical methods were valid and in general were well described. Almost all of the conclusions revealed implications for coaching practice.

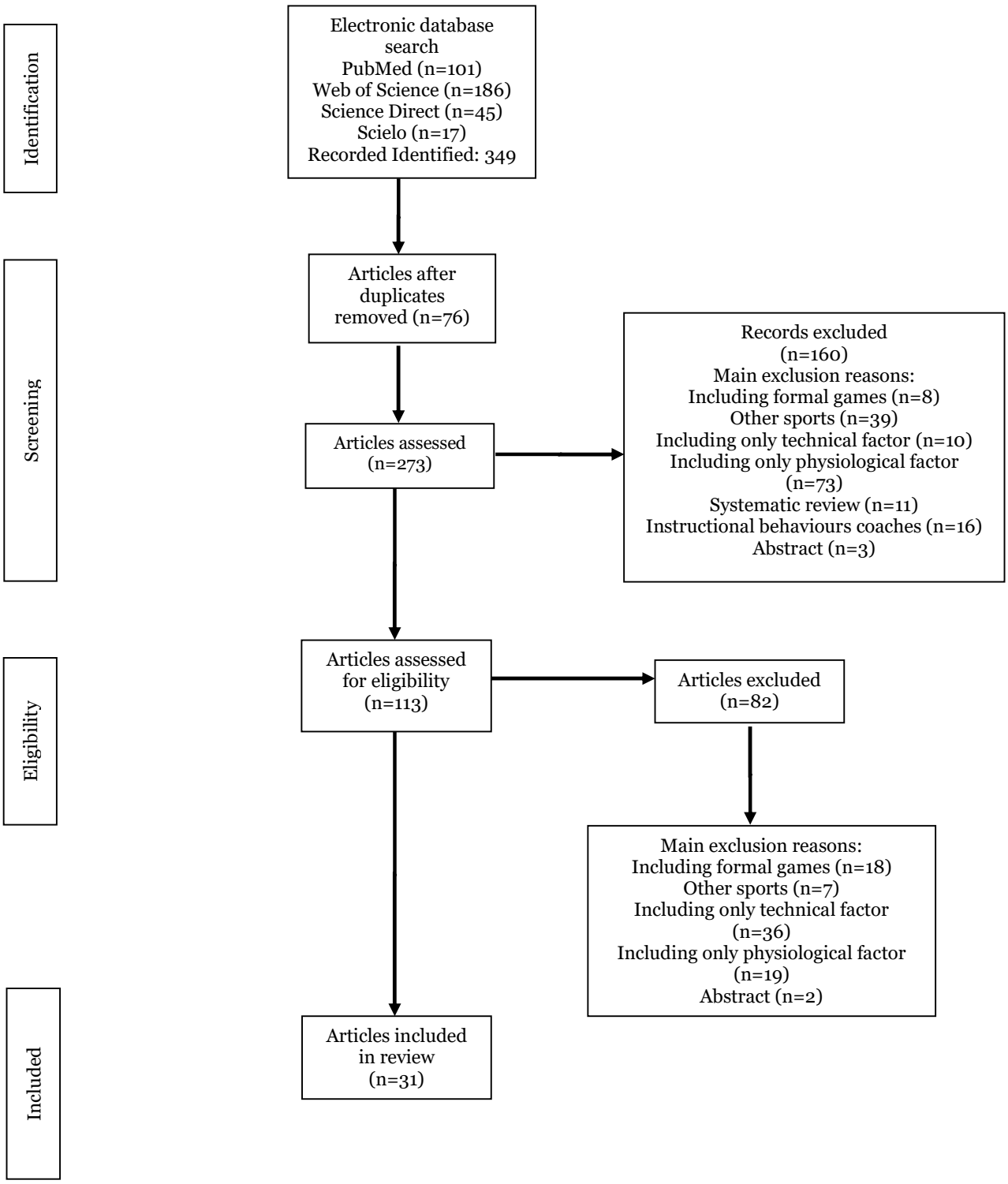


Figure 1. Article selection process flowchart

Analysis of tactical behaviours in SSCGs in soccer

Table 3 describes the main characteristics of the thirty-one articles considered for analysis. The studies were published between the years 2011 to 2019, involving a total of 1035 players.

Table 3. Article characterization in the systematic review

Studies	Tracking system	Measures	Methodologies	SSCGs Constraints	Number	Field	Area per player	Quality Score (%)
Canton et al, 2019	GPS 5hz	Width Length Centroid Position Spread Rate Stretch Index	Mean SD Magnitude Based inference	Player number Age	Gk+4v4+Gk Gk+5v4+Gk Gk+6v4+Gk	40x45 m	180 m² 163,6 m² 150 m²	86,7
Coutinho et al, 2019	GPS 5 hz	Effective playing space Distance between teammates	Mean SD Magnitude Based inference Relative Phase	Age Pitch designs	Gk+5v5+Gk	36x25 m	75 m² 58 m² 29 m²	86,7
Coutinho et al, 2019	GPS 5 hz	Stretch index Distance between teammates	Mean SD T-Test ApEn CV Relative Phase	With spatial references Without spatial references	Gk+6v6+Gk	62x43 m	190,4 m²	86,7
Folgado et al, 2019	GPS 10 hz	Width Length Centroid Position Gk- defender distance	Mean SD Magnitude Based inference Relative Phase	Field	Gk+4v4+Gk	40x30 m 30x 40 m	120 m²	86,7
Olthof et al, 2019	LPM 34-91 hz	Width Length Surface area	Mean SD Mixel model approach Pearson Correlations CV	Age Player number Field	Gk+4v4+Gk Gk+6v6+Gk Gk+8v8+Gk	68x47 m 80x56 m 91x63 m	320 m²	86,7
Batista et al, 2018	GPS 5hz	Width Length Centroid Position Surface area	Mean SD ApEn Magnitude Based Inference	Playing formation	Gk+7v7+Gk	62x50 m	194 m²	86,7
Olthof et al, 2018	LPM 42-100 hz	Centroid Position Lpwratio Surface Area Stretch index Gk- defender distance	Mean SD Manova CV	Age Field	Gk+4v4+Gk	40x30 m 68x47 m	120 m² 320 m²	86,7
Santos et al, 2018	GPS 5 hz	Distance between teammates Distance team's own target	Mean SD Ancova ApEn	Age	Gk+5v5+Gk	36x 25 m	75 m²	86,7

		Distance opponent team target						
Castellano et al, 2017	GPS 10hz	Width Length Effective playing space Centroid Position Stretch index	Mean SD ApEn	Age Field	Gk+6v6+Gk	60x40 m 50x40 m 40x40 m 30x40 m	200 m² 166,7 m² 133,3 m² 100 m²	80
Gonçalves et al, 2017	GPS 5 hz	Spatial exploration index Distance between teammates	Mean SD Magnitude based inferences ApEn CV Relative Phase	Pitch designs	9x10+Gr	58,5x64 m	187,2 m²	86,7
Barnabé et al, 2016	GPS 15 hz	Surface area Stretch index Width Length	Mean SD SampEn Cross-sample entropy Anova	Age	Gk+6v6+Gk	60x33 m	141, m²	73,3 %
Castellano et al, 2016	GPS 10 hz	Width Length Lpwratio Team Separateness	Mean SD Magnitude based inferences	Goal	GK+4V4+GK 2(7G) GK+4V4+2+GK (SG) GK+4V4+GK (7GF)	40x25 m	100 m²	73,3 %
Gonçalves et al, 2016	GPS 5 hz	Centroid Position Effective playing space	Mean SD Magnitude based inferences ApEn	Player number	Gk+4v3+Gk Gk+4v5+Gk Gk+4v7+Gk	40x30 m	133,3 m² 109 m² 92,3 m²	86,7 %
Praça et al, 2016	GPS 15 hz	Centroid Position Lpwratio	Kolmogoro-Smirnov test	Player number	Gk+3v3+Gk Gk+4v3+Gk Gk+3v3+2+Gk	36x27 m	121,5 m² 108 m² 97,2 m²	80 %
Silva, Vilar et al, 2016	GPS 15 hz	Centroid Position Stretch index	Mean SD ICC	Player number	3v3 4v4 5v5	36x28 m	168 m² 126 m² 100 m²	73,3 %
Aguiar et al, 2015	GPS 5 hz	Centroid Position	Mean SD ApEn	Player number Field	2v2 3v3 4v4 5v5	28x21 m 35x26 m 40x30 m 44x34 m	150 m²	60 %
Olthof et al, 2015	LPM 43 hz	Centroid Position Stretch index	Mean SD RC CV Pearson Correlations	Age	Gk+4v4+Gk	40x30 m	120 m²	86,7%
Silva et al, 2015	GPS 10 hz	Effective relative space per player Radius of free movement Players spatial distribution variability	Mean SD Magnitude based inference Shannon Entropy	Player number Field	6v6 7v7 8v8 9v9	52,9x34x4 m 49,5x32x2 m 46,7x30,3 m 57,3x37,1 m	152 m² 133 m² 118 m²	73,3 %
Folgado et	Tacto Software	CentroidPosition Lpwratio	Mean SD	Playernumber	Gk+3v3+Gk Gk+4v4+Gk	30x20 m	75 m² 60 m²	86,7 %

al, 2014			RepeatedMeasures					
Silva, Aguiar et al, 2014	GPS 15 hz	Player to locus distance variability Spatial distribution variability Lpwratio	Mean SD Anova CV SampEn Shannon Entropy	Field	Gk+4v4+Gk	36,8x23x8 m² 47,3x30,6 m² 57,8x37,4 m²	216,2m² 144,7m² 87,5 m²	86,7 %
Silva, Duarte et al, 2014	GPS 15 hz	Effective playing space Stretch index Team Separateness	Mean SD Anova CV SampEn	Field	Gk+4v4+Gk	36,8x23x8 m² 47,3x30,6 m² 57,8x37,4 m²	216,2m² 144,7m² 87,5 m²	86,7 %
Silva, Travassos, et al, 2014	GPS 15hz	Centroid Position Stretch index Surface area	Mean SD Anova	Player number Skill level	3 SG+5V5+Gk 3 SG+5V4+Gk 3 SG+5V3+Gk	47,3x30,6 m	131,6 m² 144,7m² 160,8 m²	73,3 %
Travassos, Gonçalves, et al 2014	GPS 15 hz	Stretch index Centroid Position Relative stretch index between teams (RelSTI)	Mean SD Pooled variance Magnitude effects	Goal	Gk+5v5+Gk 3SG+5v5+3SG	30x25 m	75 m² 62,5 m²	86,7 %
Travassos, Vilar, et al 2014	Tacto Software	Centroid Position Surface area	Anova Mauchly's test Paired T-Test Relative Phase	Player number	Gk+4v4+Gk Gk+4v3+Gk	40x20 m	80 m²	86,7 %
Vilar, Duarte et al 2014	Tacto Software	Relative distance to intercept a shot Attacker-defender distance Relative distance to intercept a pass	Mean SD Anova CV	Field	5v5	28x14 m 40x20 m 52x26 m	39,2m² 80m² 135 m²	86,7 %
Vilar, Esteves et al 2014	Tacto Software	Relative distance to intercept a shot Attacker-defender distance Relative distance to intercept a pass	Anova	Player number	5v5 5v4 5v3	40x20 m	100 m² 89 m² 80 m²	86, 7 %
Sampaio et al, 2013	Centroid Position	Mean SD Anova ApEn	Player number	Gk+5v5+Gk During the game a player was removed	60x40 m		200 m²	73 %
Frencken et al, 2013	LPM 100 HZ	Centroid Position Surface area Tean length Tean width	Mean SD Pearson correlation Manova RC	Field	Gk+4v4+Gk	24x20 m 30x20 m 30x16 m 20x16 m	48 m² 60 m² 32 m²	86,7 %
Duarte et al, 2012	Tacto Software	Centroid Position Surface Area	Anova Turkey's HSD test RC	Creation of scoring	Gk+3v3+Gk	49x20 m	122,5 m²	60 %
Sampaio & Maças,	GPS 5 hz	Centroid Position	Relative phase ApEn Paired-Test		Gk+5v5+Gk	60x40 m	200 m²	73,3 %

2012 Frencken et al, 2011	LPM 45 hz	Centroid Position Surface Area	Pearson Correlation	Gk+4v4+Gk	36x28 m	100,8 m^2	53,3 %

According to the purposes of the studies, it was possible to organize the articles according to the tracking systems used, the positional variables studied, as well as the methods of analysis used (see Figure 2).

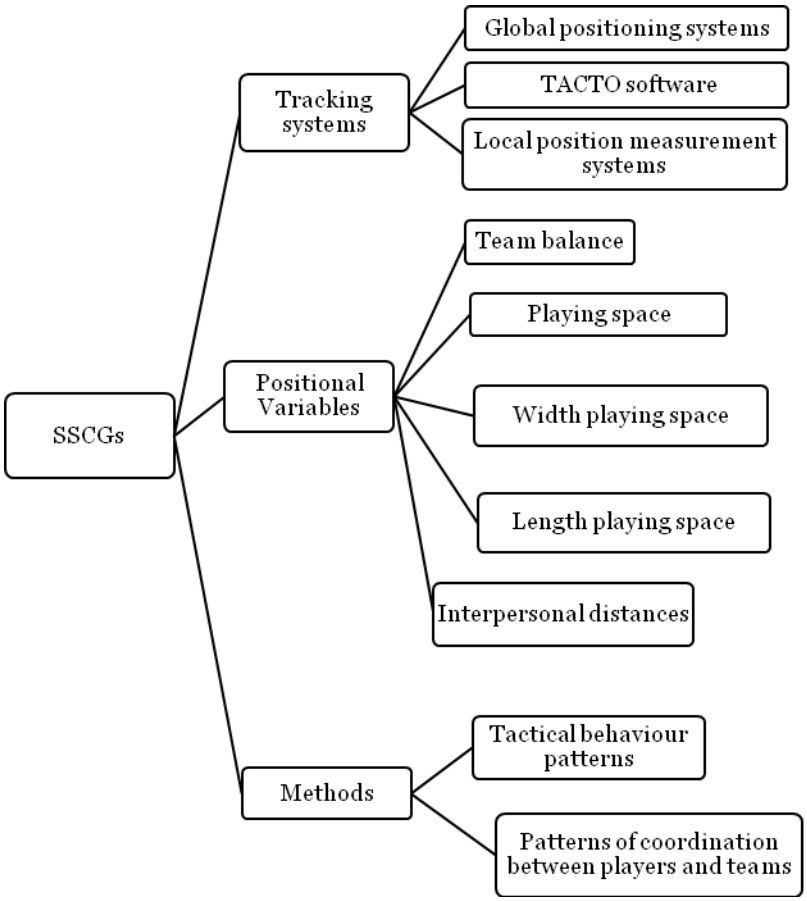


Figure 2. Study structure analysis

To collect positional data on participant movement, the global positioning system (GPS) was used in twenty-one studies. The SPI-Pro, GPSports (Canberra, ACT, Australia) was used in seventeen studies, the minimax 4.0 Catapult Innovations in three studies and the Qstarz Model: BT-Q1000Ex in one. The local position measurement (LPM) system (Inmotio Object Tracking BV Amsterdam, The Netherlands) was used in five studies. At the end, the software package Tacto ("Tool for Applied and Contextual Time-series. To collect positional data on participant movement, the global positioning system (GPS) was used in twenty-one studies. The SPI-Pro, GPSports (Canberra, ACT, Australia) was used in seventeen studies, the minimax 4.0 Catapult Innovations in three studies and the Qstarz Model: BT-Q1000Ex in one. The local position measurement (LPM) system (Inmotio Object Tracking BV Amsterdam, The Netherlands) was used in five studies. At the end,

the software package Tacto ("Tool for Applied and Contextual Time-series Observation") (Fernandes, Folgado, Duarte, & Malta, 2010) was used in five studies (see Table 4).

Table 4. Description of tracking systems

Tracking systems	Study	Sampling rate	Reliability
GPS (SPI-Pro, GPSports, Canberra, ACT,Australia	(Barnabé et al., 2016; Praça et al., 2016; Silva, Aguiar, et al., 2014; Silva, Duarte, et al., 2014; Silva, Travassos, et al., 2014; Silva, Vilar, et al., 2016; Travassos, Gonçalves, et al., 2014)	15	5% (total distance covered) 5 a 10 % (peak speed
	(Aguiar et al., 2015; Baptista et al., 2020; Canton et al., 2019; Coutinho et al., 2018; Coutinho, Gonçalves, Travassos, Abade, et al., 2019; Gonçalves et al., 2017; Gonçalves, Esteves, et al., 2016; Sampaio, Lago, Gonçalves, Maçãs, & Leite, 2013; Sampaio & Maçãs, 2012; Santos et al., 2018)	5	
GPS (Minimax 4.0. Catapult Innovations)	(Castellano, Fernández, & Echeazarra, 2017; Castellano et al., 2016; Folgado et al., 2019)	10	
GPS (Qstarz, Model:BT-Q1000Ex)	(Silva et al., 2015)		
Local position measurement (LPM)	(Frencken et al., 2013)	100	1,6 % (total distance covered) 5% (average speed)
	(Frencken, Lemmink, Delleman, & Visscher, 2011)	45	
	(Olthof et al., 2015)	43	
	(Olthof et al., 2018)	42-100	
	(Olthof et al., 2019)	34-91	
Tacto Software	(Duarte et al., 2012; Folgado et al., 2014; Travassos, Vilar, et al., 2014; Vilar, Duarte, Silva, Chow, & Davids, 2014; Vilar, Esteves, et al., 2014)	25	< 5%

Regarding the variables considered for analysis, twenty-one positional variables were identified to evaluate tactical behaviours. The team centroid position was evaluated in nineteen studies, the stretch index in ten studies, the surface area in nine, the width and length in eight, the lpwratio in five, effective playing space and distance between teammates were assessed in four studies. Relative distance to intercept a pass, distance to intercept a shot, attacker-defender distance, team separateness, goalkeeper defender distance were used twice. The following variables were also analysed: effective relative space per player, radius of free movement, relative stretch index and

player to locus. Spread rate, distance to team's own target, distance to opponent team's target, and spatial exploration index were considered just once each. All the variables were grouped into categories of variables according to their main purpose of analysis: Team balance (variables that allow to analyse the individual or team balance on the field in relation to opponent team for the exploration of possibilities for action), playing space (variables that allow to analyse the covered space of a team or the used space in relation to the field references), width and length of playing space (variables that allow to measure lateral and longitudinal spatial occupation and relations between teams), and interpersonal distance (variables that allow to measure player-to-play or player to ball distances) (see Table 5).

Table 5. Variables used for analysis of tactical behaviours in SSCGs

Categories	Calculation	Study
Team Balance		
Centroid Position		(Aguiar et al., 2015; Baptista et al., 20 Castellano et al., 2017; Duarte et al., 2012; Folgado et al 2019; Folgado et al., 2014; Frencken et al., 2011; Frencker al., 2013; Gonçalves, Esteves, et al., 2016; Olthof et al., 20 2018; Praça et al., 2016; Sampaio et al., 2013; Sampaio Maçãs, 2012; Silva, Travassos, et al., 2014; Silva, Vilar, et 2016; Travassos, Gonçalves, et al., 2014; Travassos, Vilar, al., 2014)
Team Separateness		(Castellano et al., 2016; Silva, Duarte, et al., 2014)
Strech Index		(Barnabé et al., 2016; Canton et al., 2019; Castellano et a 2017; Coutinho, Gonçalves, Travassos, Abade, et al., 201 Olthof et al., 2015, 2018; Silva, Duarte, et al., 2014; Silva Travassos, et al., 2014; Silva, Vilar, et al., 2016; Travasso Gonçalves, et al., 2014)
Relative stretch index		(Travassos, Gonçalves, et al., 2014)
Spread Rate		(Canton et al., 2019)
Playing space		
Surface area		(Baptista et al., 2020; Barnabé et al., 2016; Duarte et al 2012; Frencken et al., 2011; Frencken et al., 2013; Olthof al., 2018, 2019; Silva, Travassos, et al., 2014; Travassos Vilar, et al., 2014)
Effective playing space		(Castellano et al., 2017; Coutinho et al., 2018; Gonçalves Marcelino, et al., 2016; Silva, Duarte, et al., 2014)
Distance team's own target		(Santos et al., 2018)
Distance opponent team's		(Santos et al., 2018)

target

Width and length playing space	
Width and Length	(Baptista et al., 2020; Barnabé et al., 2016; Canton et al 2019; Castellano et al., 2017; Castellano et al., 2016; Folga et al., 2019; Frencken et al., 2013; Olthof et al., 2019)
Lpwratio	(Castellano et al., 2016; Folgado et al., 2014; Olthof et al 2018; Praça et al., 2016; Silva, Duarte, et al., 2014)
Interpersonal distances	
Distance to intercept a pass	(Vilar, Duarte, et al., 2014; Vilar, Esteves, et al., 2014)
Distance to intercept a shot	(Vilar, Duarte, et al., 2014; Vilar, Esteves, et al., 2014)
Attackers-defenders distance	(Vilar, Duarte, et al., 2014; Vilar, Esteves, et al., 2014)
Goalkeeper defender distance	(Folgado et al., 2019; Olthof et al., 2018)
Distance between teammates	(Coutinho et al., 2018; Coutinho, Gonçalves, Travassos Abade, et al., 2019; Gonçalves et al., 2017; Santos et al., 20
Effective space per player	(Silva et al., 2015)
Radius of free movement	(Silva et al., 2015)
Player to locus distance	(Silva, Aguiar, et al., 2014)
Spatial exploration index	(Gonçalves et al., 2017)

The methods used for analysis of tactical behaviours in SSCGs can be grouped according to the purpose of the studies. With the purpose of describing and characterizing tactical behaviour patterns using linear methods of analysis, identifying the dynamics of tactical behaviour patterns or accessing the interpersonal patterns of coordination that sustain tactical behaviour between players and teams using non-linear methods of analysis. In this section, more than to describe the linear methods of analysis generally used to characterize tactical behaviour patterns, a focus on the non-linear methods of analysis was made. In line with that, to access the dynamics of tactical behaviour patterns, approximate entropy (ApEn) was used in nine studies, sample entropy (SampEn) was used in three, and Shannon entropy was used in two studies. To access the interpersonal patterns of coordination that sustain tactical behaviour between players and teams, relative phase was used in six studies, and the running correlation technique was used in three studies (see Table 6).

Table 6. Non-linear methods used for analysis of tactical behaviours in SSCGs

Methods	Study
	Dynamics of tactical behaviours patterns
Approximate entropy	(Aguiar et al., 2015; Baptista et al., 2020; Castellano et al., 2017; Coutinho, Gonçalves, Travassos, et al., 2019; Gonçalves et al., 2017; Gonçalves et al., 2016; Sampaio et al., 2013; Sampaio & Maçãs, 2012; Santos et al., 2018)
Sample entropy	(Barnabé et al., 2016; Silva, Aguiar, et al., 2014; Silva, Duarte, et al., 2014)
Shannon entropy	(Silva, Aguiar, et al., 2014; Silva et al., 2015)
	Interpersonal patterns of coordination
Relative phase	(Coutinho, Gonçalves, Santos, et al., 2019; Coutinho, Gonçalves, Travassos, et al., 2019; Folgadoet al., 2019; Gonçalves et al., 2017; Sampaio & Maçãs, 2012; Travassos, Vilar et al., 2014)
Running correlation	(Duarte, Araújo, Freire, et al., 2012; Frencken et al., 2013; Olthof et al., 2015)

Discussion

Tracking systems

The Global Position System (GPS) was the most frequently used system to collect the positional data of players. Players wear a vest in which a sensor can be placed located in the upper back between the shoulder blades. Regarding the different GPSs used, the SPI-Pro, GPSports (Canberra, ACT, Australia) uses a sampling rate between 5 and 15 hz**,** while the minimax 4.0 Catapult Innovations and Qstarz Model:BT-Q1000Ex used a sampling rate of data collection of 10 hz. In general the systems reveals a margin of error less than 5% (in measuring total distance covered), which can increase to about 10% in high intensity actions (Johnston et al., 2012)(see Table 2). The 10 hz GPS were up to six times more reliable in measuring the instantaneous speed, than systems operating at 5 hz (Varley, Fairweather, & Aughey, 2012).

The local position measurement (LPM) is a system that uses radio frequency technology to record players' positioning through triangulation between the device and at least 10 fixed stations placed around the field (Frencken et al., 2011; Frencken et al., 2013; Olthof et al., 2019). The sampling rate values ranged from 34 to 100 hz considering the reciprocal relationship between the sampling frequency and the number of devices (e.g. 10 players, the sampling frequency is 100 Hz (1000/10) (see Table 2), with an estimation error of less than 1,6 % (distance covered) and 5% (relative average speed) (Frencken, Lemmink, & Delleman, 2010).

The Tacto software is a video-based system that collects players' positions through manual digitization, with a sampling rate of data collection of 25 hz. Through manual scanning, using a mouse, virtual coordinate data (pixel units) were collected and later transformed into real coordinates (metric units), using the two-dimensional Direct Linear Transformation Method DLT-

2D (Serrano, Shahidian, & Fernandes, 2014). The TACTO software revealed a reliability of more than 95% (Fernandes et al., 2010).

In comparing the three types of tracking systems used, the advantages of GPS are that system is portable, reliable, simple to use and to extract data live or in a short period of time. The disadvantage is that the precision and reliability of the system depends of the number of satellites detected (Colino et al., 2019). The LPM is also reliable, simple to use and to extract data from in a short period of time. The disadvantage is that the LPM system is a fixed system that can only be used in one field. TACTO software is also a reliable system to collect positional data and is the unique system identified to track the position of players and the ball. The disadvantage is that it is a very time-consuming method.

Despite the reported decrease in the reliability of GPS and LPM position data in high intensity actions, no study was developed to understand the impact of such variations in the reliability of tactical variables. Further research is required on this issue to clearly identify possible errors of measurement in different tactical variables. Any decrease in reliability of measurement was reported in TACTO software according to intensity of actions.

Variables for tactical behaviour analysis

Team balance

To analyse team balance, different variables were identified: centroid position (CP), team separateness (TS), stretch index (SI), relative stretch index (RSI) and spread rate (SR).A great number of studies considered had analysed centroid position (CP). CP represents the (gravitational) midpoint of the team of players and is calculated by recording the mean position of the outfield players for each time stamp in which all team players were considered (Frencken et al., 2011). The CP is a useful measure to evaluate the dynamics of a team in relation to the opponent team or to a specific location on the field. Indeed, the isolated analysis of CP cannot contribute for a deeper understanding of team balance due to the lack of references for comparison. The CP revealed to be sensitive to the manipulation of the number of players and the numerical relation between teams, the manipulation of the number and position of goals, and even the age of the players. Particularly, differences on the distance between teams (Duarte et al., 2012; Frencken et al., 2011), on the distance of each team from the goal (Frencken et al., 2011) were observed between manipulations. CP can also be used to analyse the balance of attacking and defending teams in relation to the attacking and defending goal. The distance between the teams' CPs can also be used to understand the balance or the proximity between teams in different game moments or spaces on the field (Frencken et al., 2013). In addition, it seems that the CP can be used to capture the adaptive behaviours of teams according to the manipulations of the numerical unbalance between teams, number of players, field space, number of targets. Thus, the CP seems to be a relevant positional variable that facilitates reductions in game complexity and a characterization of the dynamic interactions between competing teams over the games (Frencken et al., 2011; Silva, Vilar, et al., 2016; Vilar, Araújo, Davids, & Travassos, 2012).

Similarly, the team separateness measure (TS) has units of meters and can be interpreted as the overall radius of action free of opponents. TS is calculated by recording the sum of distances between each team player and the closest opponent (Castellano et al., 2016). A measure of TS was preferred to other metrics, such as the centroids' distance, to measure the closeness of the team's players since the latter does not account for the teams' dispersion differences which may impact on the players' radius of free movement. A value of TS close to 0 indicates that all players are closely marked, while a high value indicates more freedom of movement. Thus, while the CP allow to understand the general balance between teams, the TS capture the individual balance on space occupation between attacker-defender players for the exploration of tactical behavior. TS significantly increased with pitch size regardless of players and team's level (Silva, Duarte, et al., 2014).

The SI expresses the dispersion of the team players during a game, by considering the distance of each player to the CP. SI is calculated by computing the mean of the distances between each player and the CP for that team. The SI proved to be sensitive to the effects of players' ages and skill level, with the older and more skilled practitioners revealing higher SI and more variable values (Barnabé et al., 2016; Canton et al., 2019; Olthof et al., 2015). When the game is played by teams with high levels of practice, there is a tendency for higher values of dispersion in the lateral rather than the longitudinal axis (Olthof et al., 2015).

Relative stretch index (RSI) is a relational variable that results from the analysis of the relationship of the SI of both teams. It seems that RSI is a useful variable to pick up information about the free-space between attacker and defender teams. It reveals sensibility to measure variations in the available space between teams according to the position of the ball in the field (Travassos, Gonçalves, et al., 2014). Higher RSI values were observed in SSCGs with two scoring targets in comparison with six scoring targets (Travassos, Gonçalves, et al., 2014).

The Spread Rate is also a derivative variable from SI that analyses the rate of change of the stretch index of teams over time. This variable is calculated as the rate of change of SI and expresses the speed of contraction and expansion of the teams over time and could be related to the rate of exploration and adaptation of teams to the game environment (Canton et al., 2019). Changes were observed on the Spread Rate according to changes in numerical relationship between teams. It seems that numerical unbalance promoted higher spread rate, and consequently more variability in patterns of play explored by players. However, further research is required to improve the understanding of the use of this variable to explain game dynamics.

Playing Space

To analyse the playing space, the following variables were identified: surface area, the effective playing space, distance team's own and opponent target.

The surface area is the total space covered by a team, and is calculated as the perimeter of the space occupied by the outermost players or the greater area containing players from one or two teams (Frencken et al., 2011; Gonçalves, Esteves, et al., 2016; Olthof et al., 2018), and also defined as the area within the convex hull of the team or the teams (Frencken & Lemmink, 2009; Moura et al., 2013). The surface area measurement can be used to improve understanding about the area of play of each team or the effective area of play between both teams (Frencken et al., 2011; Gonçalves, Esteves, et al., 2016). It is important to note that the surface area behaviour is dependent of the number of players involved. That is, the increase in the number of players involved increases its predictability and distance in surface area, inhibiting the successful description of teams playing space dynamics (Gonçalves, Esteves, et al., 2016; Olthof et al., 2019). Also, it was reported that the surface area provides an evaluation of the space occupation of the teams, but it did not reveal the sensitivity to discriminate instabilities in the relations between sub-groups of players (Duarte et al., 2012).

The effective playing space variable is also frequently used to measure the smallest space that contains all outfield players of a team (Gonçalves, Esteves, et al., 2016). Indeed, the method of calculation and the results were quite broad across the studies. It is not clear why the same variable was defined with different names in different studies.

The variables, distance team's own target, and distance team's opponent target were calculated as variables that represent the spatial occupation of teams in relation to specific spatial references such as the goal or the goalkeeper position. Such variables were calculated as the Euclidean distance between a player and each target. Due to the reference to the targets, based on the changes in results observed due to the manipulation of small sided and conditioned games, the authors considered that these variables help to understand the effectiveness of adaptations of team's tactical behaviour to specific game demands (Folgado et al., 2019; Olthof et al., 2018; Santos et al., 2018).

Length and Width Playing space

To analyse the length and width playing space three related variables were identified: team length, team width and the length per width ratio (lpwratio).

The length and width of a team represents the longitudinal and lateral dispersion of players in a team and are calculated as the longitudinal or lateral distance between the most distant players of a team. The lpwratio represents the balance between longitudinal and lateral positioning of players (Folgado et al., 2014) and is calculated as a ratio between lateral and longitudinal values of a team. Values between 0 and 1 of lpwratio indicates superior positioning in width. Values greater than 1 suggest the prevalence of longitudinal occupation. The length and width playing space, but specially the lpwratio revealed sensitivity to the influence of players' ages (Folgado et al., 2014; Olthof et al., 2015). The low variation in the lpwratio variable tends to reflect the positional stability of players (Folgado et al., 2014), while the larger variations in lpwratio seem to represent a more

individualized attacking game, with great variations in players' actions (Folgado et al., 2014; Praça et al., 2016). Also, the increase in space occupied in length and a reduction in width seems to promote large variability in lpwratio (Olthof et al., 2018).

Interpersonal distances

Regarding the analysis of interpersonal distances, nine different variables were identified: distance to intercept a pass, distance to intercept a shot, attacker-defender distance, goalkeeper defender distance, distance between teammates, effective space per player, radius of free movement, player to locus distance, spatial exploration index. Such variables represent the spatial-temporal relationships between players (attacker-attacker, defender-defender or attacker-defender) to perform, in opposition to previous categories of variables that capture the collective dimension of the game. Interestingly it is the category that revealed a higher number of variables. However, with some differences in the methods of calculation, some of them were used with similar purposes.

The distance to intercept a pass or a shot represents the shortest distance of defenders to the passing or shooting lines (Vilar, Duarte, et al., 2014) and allows for an understanding of how the manipulation of SSCGs constrains the possibilities of defenders to intercept the ball or the attacker to ensure a pass or a shot. Such variables proved to be of a good informative value for coaches' understanding of the manipulation of the numerical relationship between players on passing and shooting actions, or on defending the defenders' behaviour (Vilar, Esteves, et al., 2014). Both variables revealed significantly higher values in numerical unbalance between teams in comparison with numerical balance (Vilar, Esteves, et al., 2014).

In line with previous variables, the attacker-defender distance variable represents, in the attack, the space available for the attacker to maintain ball possession or to define passing lines, and in the defence the capability of defenders to close spaces for attackers' action, to pressure the ball or to recover ball possession (Vilar, Duarte, et al., 2014). Goalkeeper defender distance represents the space between goalkeeper and defending line. Older players revealed higher values on a large pitch (Olthof et al., 2018).

The analysis of distance between teammates revealed how a pair of teammates share and create playing space. Interestingly, it seems that the distance between teammates tends to reveal differences between attacking and defending moments but reveal similarities between such moments even in different SSCGs (Gonçalves et al., 2017; Santos et al., 2018). Also, Coutinho, Gonçalves, Travassos, Abade, et al. (2019) advocated that distance between teammates is one of the key information variables that regulate sub-units and team behaviour.

The variables effective space per players, and radius of free movement revealed the amount of free space that each player has at each moment over the game. While effective space per player measures the amount of free space available for each player by dividing the area of the effective playing space delimited by the smallest rectangle encompassing all the players, the radius of free

movement evaluated the space free of opponents for each player by calculating the smallest distance to opponents at each instant (Silva et al., 2015). Similar tendencies on the results were observed for these variables. However, the effective space per players revealed higher values than radius of free movement.

Finally, the variables, players to locus distance and spatial exploration index revealed the space covered by each player in relation to their mean pitch position. Allowing for the identification of the predominant space covered by each player and its variability over the game (Gonçalves et al., 2017).

Methodologies of analysis

Dynamics of Tactical behaviour patterns

The analysis of tactical behaviour patterns through non-linear methods made it possible to evaluate the degree of regularity and unpredictability of spatial-temporal variables assessing performance at an individual and team level (Santos et al., 2018; Silva, Duarte, et al., 2016). ApEn and SampEn were used to measure the randomness of the series of data (Delgado-Bonal & Marshak, 2019) and to evaluate the variability in spatial-temporal relations of players and teams in SSCGs. ApEn numbers range from 0 to 2, while SampEn numbers range from zero to infinity (Silva, Duarte, et al., 2016). Low numbers indicate regularity, while high numbers indicate irregularities in time series (Sampaio et al., 2013; Silva, Aguiar, et al., 2014). ApEn can be used with signals of equal length, preferably with at least 50 data points (Yentes et al., 2012).SampEn could be used in short time-series (that is less than 50 data points) and consequently is considered more robust to calculate the variability of shorter time series than ApEn (Richman & Moorman, 2000).

Duarte, Araujo, et al. (2013) revealed three differences between ApEn and SampEn: 1) ApEn allows self-matches while SampEn does not; 2) ApEn showed less consistency about choices of input parameters; 3) ApEn revealed to be more sensitive to the length of the data series. SampEnshowed a higher consistency and ability to discriminate differences between groups than ApEn (Montesinos, Castaldo, & Pecchia, 2018). For example, they were used to evaluate the dynamics of the distances between each player to the nearest opponent (Silva, Duarte, et al., 2014), the dynamics of surface area, stretch index, team length, team width and centroid position (Duarte et al., 2012) or variability in distance between players (Coutinho, Gonçalves, Travassos, Abade, et al., 2019; Gonçalves et al., 2017; Santos et al., 2018).

In addition, Shannon entropy is another nonlinear method that was used to measure the regularity of the spatial distribution of players in the field (Silva, Duarte, et al., 2014; Silva et al., 2015). A low entropy number (near 0) indicates that the player's position can be easily predicted. A high number (near 1) indicates that the distribution is irregular and that the player's position is highly unpredictable (Sampaio & Maçãs, 2012; Silva et al., 2015). That is, the values near 1 reveal irregularity in players' behaviour related to performance in attacking phases of performance. The

values near 0 revealed regularity in the players who really spend more time in their positions in the defensive phase (Silva et al., 2015).

Shannon entropy was used to analyse the variability of the player behaviours during the manipulation of space (small, intermediate, large playing areas). Results showed that the increase in playing space provides players with greater stability in occupying their specific positions (defender, midfielders and forward) (Silva, Aguiar, et al., 2014). Also, the manipulation of space and number of players in small-sided games revealed changes in players' spatial distribution variability. That is, higher irregularity was registered when low numbers of players and small spaces were used (Silva, Duarte, et al., 2014; Silva et al., 2015). Authors considered that a more irregular spatial distribution is related to a higher tactical adaptability of players and teams to different game moments and dynamics.

Patterns of coordination between players and teams

Relative Phase is a non-linear statistical method that allows for the processing of signals and describes synchronization between, for example players displacements or teams' spatial-temporal relations, providing a quantitative measure of the coordination between the players or teams under analysis. The modes of coordination are expressed in angles (Galgon & Shewokis, 2016), and while the in-phase (0 ° and 360 °) represents a periodic symmetrical relationship between components, the anti-phase (180 °) coordination represents a periodical anti-symmetrical relationship (Travassos, Vilar, et al., 2014). This method evolves throughout the movement, promoting a detailed description of the emerging pattern coordination and the level of coupling between players and teams and the transition between the most prevalent stages of coordination (Lamb & Stöckl, 2014). For example, previous research compared interpersonal coordination between players in SSCGs with different numerical relations (Travassos, Vilar, et al., 2014) or in different practice tasks (Folgado et al., 2019).

The method of running correlations (RC) is a useful technique to explore the linear relationship between, for example, players displacements or between spatial-temporal relations of player movements in teams. The correlation coefficient at each instant represents the normalized sample covariance of data (Elias & de Artigas, 2006). The results of RC identify three types of coordination trends: i) a strong positive correlation, that represent a symmetrical relationship between variables, when results are positive and near 1; ii) a strong negative correlation, that represent an anti-symmetrical relationship between variables, when results are negative and near -1; iii) an irregular pattern of coordination, when results do not show any preferable pattern of coordination (Corbetta & Thelen, 1996; Duarte et al., 2012). RC method was used in a small number of studies.

Conclusions

The aim of this systematic review was to describe the tracking systems, positional variables and statistical methods used to characterize the tactical behaviours of players and teams in SSCGs. In general, the studies that used small-sided and conditioned games should improve their design in

the future. Particularly, it is suggested the inclusion of a rationale for the chosen sample size and players' drop-out in order to improve the article methodological quality for comparison purposes.

In this study it is possible to identify the most appropriate tracking systems, variables and methods of analysis that best fit the needs of further research. The tracking systems analysed were reliable but revealed different advantages and disadvantages of its use. Authors should define the use of each tracking system based on their purpose and level of precision required for analysis. Twenty-one positional variables were identified to evaluate tactical behaviours, grouped into five main categories: Team balance, playing space, width and length of playing space, and interpersonal distance. However, a great duplication was observed on the variables used with similar purposes of tactical analysis. Further comparisons are required to understand the similarity between them. Also, further research should be developed to compare the dynamics of each variable in small-sided and conditioned games and official games.

Tactical behaviours patterns were analysed using approximate entropy, sample entropy, Shannon entropy. Patterns of coordination between players and teams were analysed using relative phase and running correlations. Further research is required to improve the understanding of the changes on tactical behaviours patterns and patterns of coordination between players in the performance of players and teams.

Capítulo 4- Variations in Individual Player Area in Youth Football Matches: The Effects of Changes of Players' Age, Numerical Relations, and Pitch Zones

Abstract

The aim of the study was to quantify the individual player area (IPA) that emerges during football matches at youth levels, considering different numerical relations and pitch zones. Two hundred and twenty-eight players, divided by U15, U17 and U19, participated in the study. Jonckheete-Terpstra and Kruskal Wallis nonparametric tests were used to compare the IPA according to variations in players' age, numerical relations and pitch zones considered for analysis. All ages and numerical relation results revealed the highest IPA in the zones closer to the goal and were lower in the middle of the pitch. For 3x3 to 10x10 numerical relations, the IPA was higher in the U15 and lower in the U17. The greater differences between the age groups concerned numerical relations of 6x6 to 10x10 ($p \leq 0.001$). The effect size was moderate between the U15 and U17 in numerical relations of 8x8 to 10x10. Results suggest that the manipulation of IPA during training sessions should respect players' age and be adjusted considering the numerical relation and the tactical purpose of coaches.

Keywords: zone, individual player area, numerical relations, age, football

Introduction

In football, the use of small-sided and conditioned games (SSCG), for training and teaching at different competitive levels and ages, has been a trend in recent years. This practice has been accompanied and supported by scientific research that aims to identify the effects of different SSCG manipulations on players and teams performance, and compared them with the competition requirements (Aguiar et al., 2012; Sarmento et al., 2018). In this line, several studies have evaluated the effect of manipulations related to the playing area. Results showed that the increased dimension of the playing area often leads players to run more distances (Lemes et al., 2019) and to variations in their tactical behaviour, particularly in the increased spatiotemporal relation between teammates or opponents (Folgado et al., 2019; Frencken et al., 2013; Silva, Duarte, et al., 2014), with implications for the number of technical actions of players (Nunes, Gonçalves, Davids, Esteves, & Travassos, 2020). Conversely, the reduction in playing area tends to promote a greater number of ball losses, more physical contacts, more individual duels, and tackles (Dellal et al., 2012).

For the manipulation of playing areas in SSCG, the dimensions of the football pitch (105x68 meters) can be used as a reference, allowing for the classification in large (55%), medium (45%) and small (35%) pitch, according to the percentage of size decrease (Silva, Aguiar, et al., 2014). Similarly, the definition of the playing area can be achieved based on the individual playing area (IPA), which is calculated through the total area of the pitch divided by the number of players involved in the training or match situation (Aguiar et al., 2015; Olthof et al., 2019). However, many of the studies do not present any theoretical or practical reason such as for example the age or level of practice of players, for the manipulations carried out in the IPA (Caro, Zubillaga, Fradua, & Fernandez-Navarro, 2019).

In fact, previous studies using SSCG in youth football suggested that older players perform more passes during a game and present more time spent in ball possession, using a wider area of the pitch, while younger players tend to play lengthwise in similar playing areas (Folgado et al., 2014; Olthof et al., 2015). On the other hand, differences on the use of width and length in particular pitch zones have been revealed for players of different ages in SSCG and in official games (Caro et al., 2019; Fradua et al., 2013; Tenga, Zubillaga, Caro, & Fradua, 2015).

These studies suggest that the playing area used is influenced by the ball position on the pitch and can therefore vary depending on the game phase and on the ball location.

In view of the above stated, the analysis of the area occupied by players during the game, as well as its variation according to the pitch zones (defensive zone, middle zone and attacking zone), can make us think about the manipulation of the playing area in training tasks (Zubillaga et al., 2013). In football, the possibilities of individual and collective action (affordances) arise from the complementarity between the individual characteristics of the players and the spatiotemporal

dynamics between them on the pitch, enhanced by the competitive environment (Araújo, Davids, & Hristovski, 2006).

Therefore, a better understanding of the pitch areas manipulations to be used in training is needed in order to promote the adequate relationship between players and game environment (Travassos et al., 2013).

Thus, in this study we intend to describe the individual area per player, according to age, numerical relations, and the pitch zone. For this, the different individual areas per player in a recreated football match during normal training were quantified, considering different age groups (U15, U17, U19).

It was expected to measure changes in IPA according to different age groups. Also, it was expected to observe variations in IPA considering variations in numerical relationships and the location in the field.

Methods

A total of two hundred and twenty-eight male players who competed in the national championships, the highest competitive level for each age group, participated in the study, divided by U15 (n = 76, age 14.4 ± 0.4 years, height 1.61 ± 0.07 weight 52.2 ± 9.0); U17 (n = 76, age 15.6 ± 0.5 years, height 1.74 ± 0.05, weight 63.1 ± 7.5) and U19 (n = 76, age 17.7 ± 0.5 years, height 1.78 ± 0.09, weight 75.3 ± 9.3). Three different teams participated in each age group *(*Figure 3*)*. The team composition was defined by the head coach to ensure balanced and competitive matches. Each game had an average of 25 players. Each game had three to four players as substitutes who came in for other players. Each team had three training session, lasting ninety-minute, and one official game per week. Goalkeepers, despite being present during the situation, were not considered for the calculation of the indicators used in the study, given the specificity of their functions. All players' legal guardian were informed of the study and gave their written consent before the latter began. This study was approved by the Ethics Committee under the number CE-UBI-Pj-2020-043.

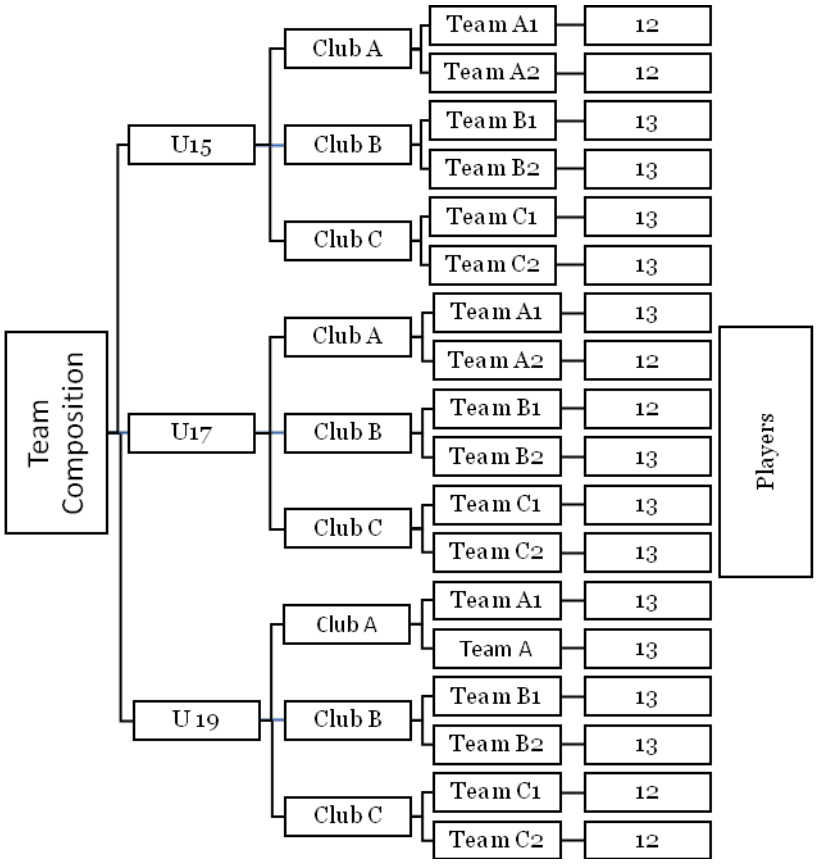


Figure 3. The Team Composition

Data collection

For each age group, a recreated football match in their normal training was played between each team, with a total of three matches per level. This situation was performed at the beginning of the session, after twenty minutes of warm-up, consisting of running and passing exercises. In each recreated match, the coaches distributed the players in two balanced teams, according to the coach perception, and considering players specific positions. The game length varied according to age and the official rules of the respective level: U15 – 2halves of 35 minutes; U17 – 2 halves of 40 minutes; and U19 – 2halves of 45 minutes. The rest time between the 1st and 2nd half was 10 minutes in all games. The games were played on artificial turf pitches with the official football measures. Positional data of all the players were collected using inertial WIMU TM devices (RealTrack Systems, Almeria, Spain). Data were analysed using the SPRO TM analysis program (RealTrack Systems, Almeria, Spain). Following the manufacturer guidelines, the units were turned on at least 30 minutes before the beginning of each session. Devices were placed on players, in appropriate vests, before the warm-up. All games were video recorded through a camera (Panasonic HC-V160) placed at a higher level in the middle zone of the pitch, for posterior notational analysis.

Data processing

Based on the collected video, notational analysis was performed considering the following ball related actions (Folgado et al., 2019): individual player gaining ball possession; individual player disposing the ball possession; player touching the ball; ball over the end line; ball over the side line; ball shooting; ball hitting crossbar/post; goal scoring; fouls. The software LongoMatch 1.3.7 (Fernandez, 2017) was used for this analysis, capturing the time of each action, for synchronizing the ball events with the GPS positional data (Figure 4). A visual representation of each simulated match was processed, presenting the ball position, displacement, and the time of each action. This representation was used for possible notational errors correction, by comparing it with the original video.

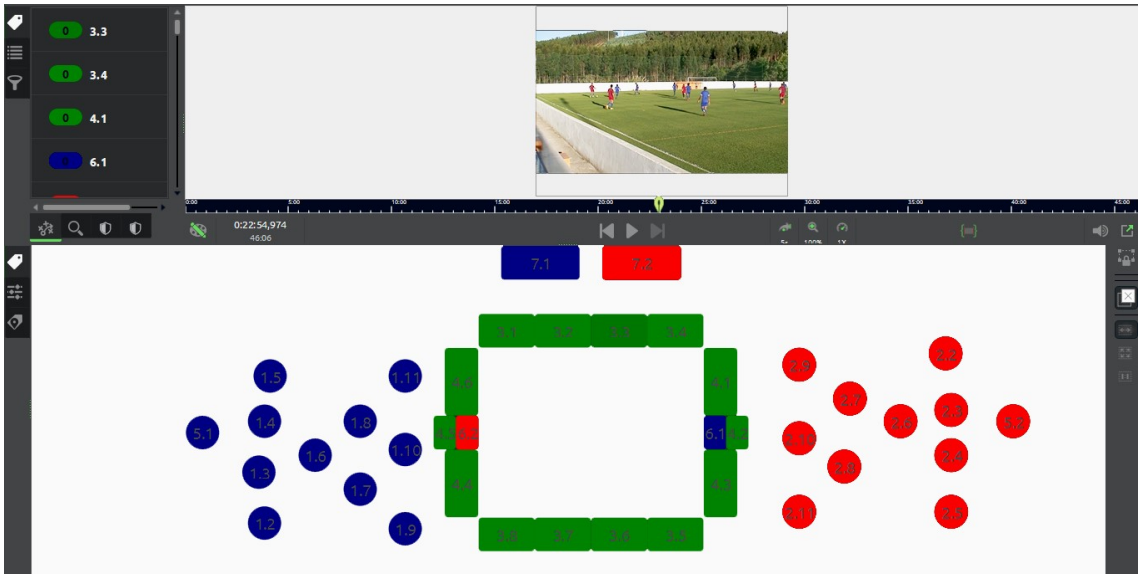


Figure 4. Notational analysis using the software LongoMatch for GPS and technical events synchronization

To calculate the IPA by different numerical relations, the rectangle formed by the players of each team closest to the ball at the time of the pass was considered. The players in the periphery of the ball area defined the limits (Caro et al., 2019) for each numerical relation, taking width as the shortest distance that allowed to include all the players of the numerical relation in the sideline-sideline axis, and length as the smallest distance that allowed all players to be included in the goal-goal axis (Figure 5). In this study, the IPA was determined by dividing the playing area by the number of players (Casamichana & Castellano, 2010). This means that, in a playing area with 4 players (the 2 players, from each team, closest to the ball), the division of the playing area by the 4 players was calculated, and so on, up to a 10x10 numerical ratio.

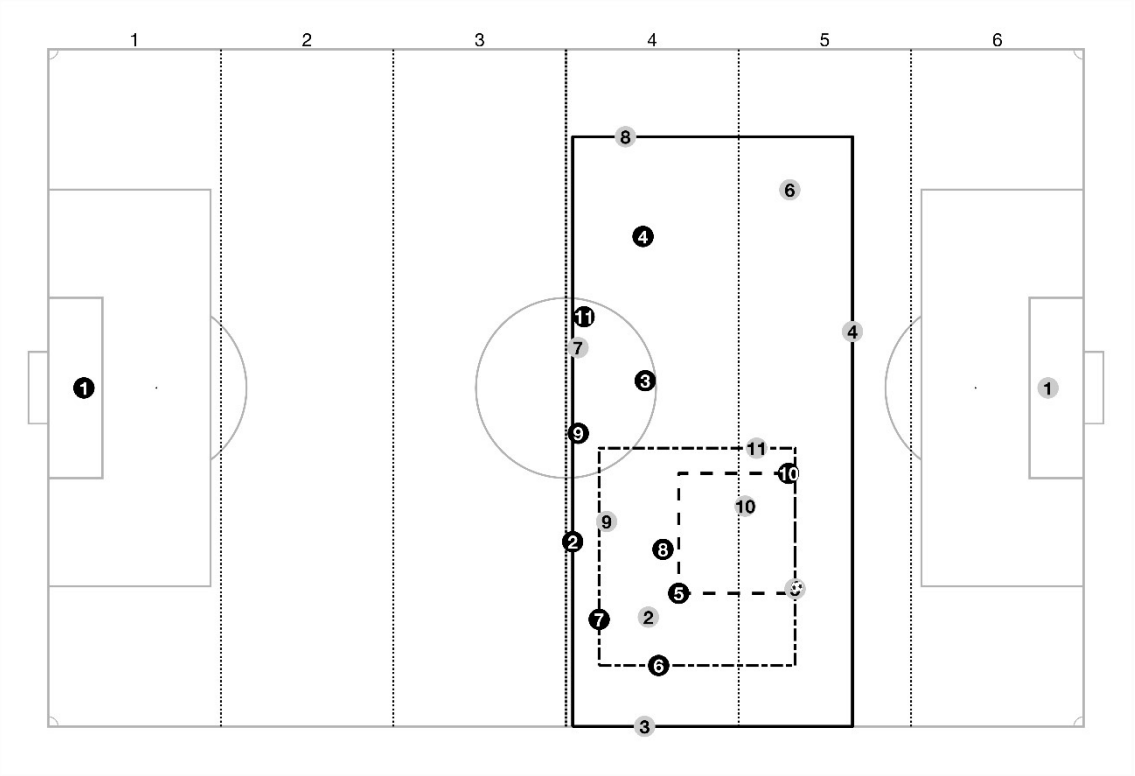


Figure 5. Example of playing area calculation involving2x2 (dashed line), 5x5 (dotted-dashed line) and 10x10 (solid line) players, according to the different six pitch zones.

For passing location, the pitch was divided into different six zones, following existing literature (Fradua et al., 2013) (Figure 6). Zone 1 (Z1) corresponds to the zone closest to the analysed team goal and zone 6 (Z6) corresponds to the zone closest to the opponent's goal. The IPA was calculated according to the passing location. Five thousand and seventy-six game situations were recorded (1379 - U15, 2182 - U17 and 1515 - U19).

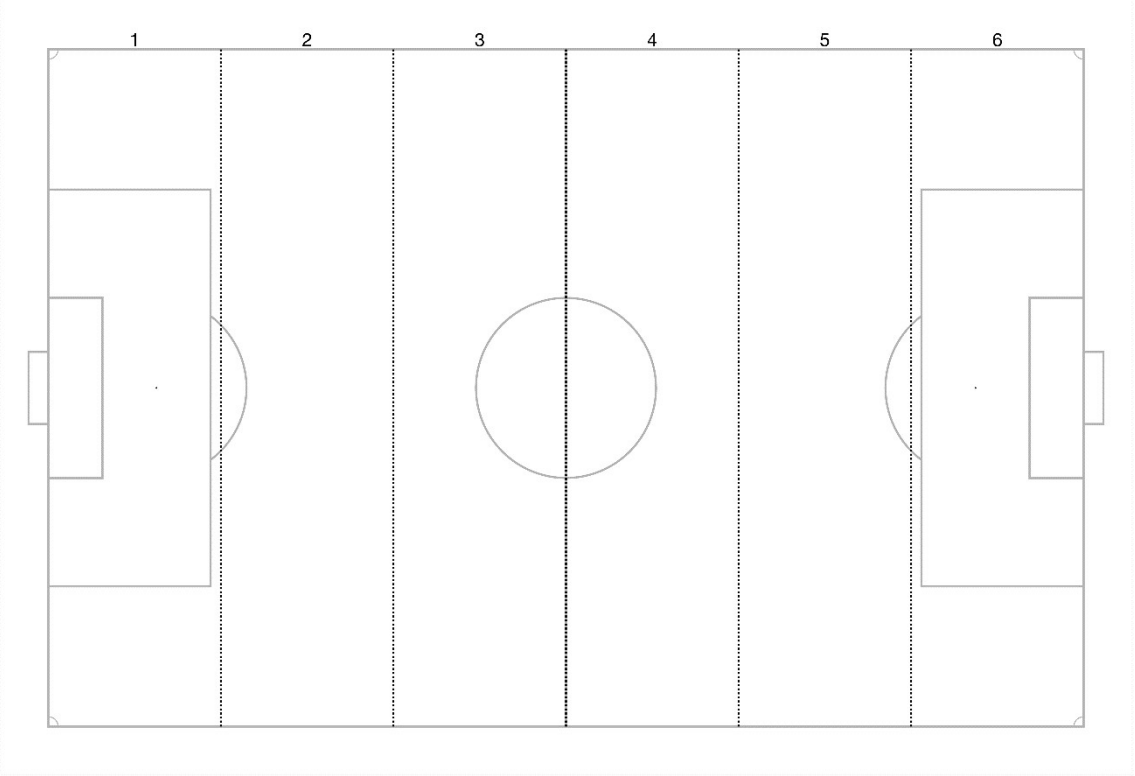


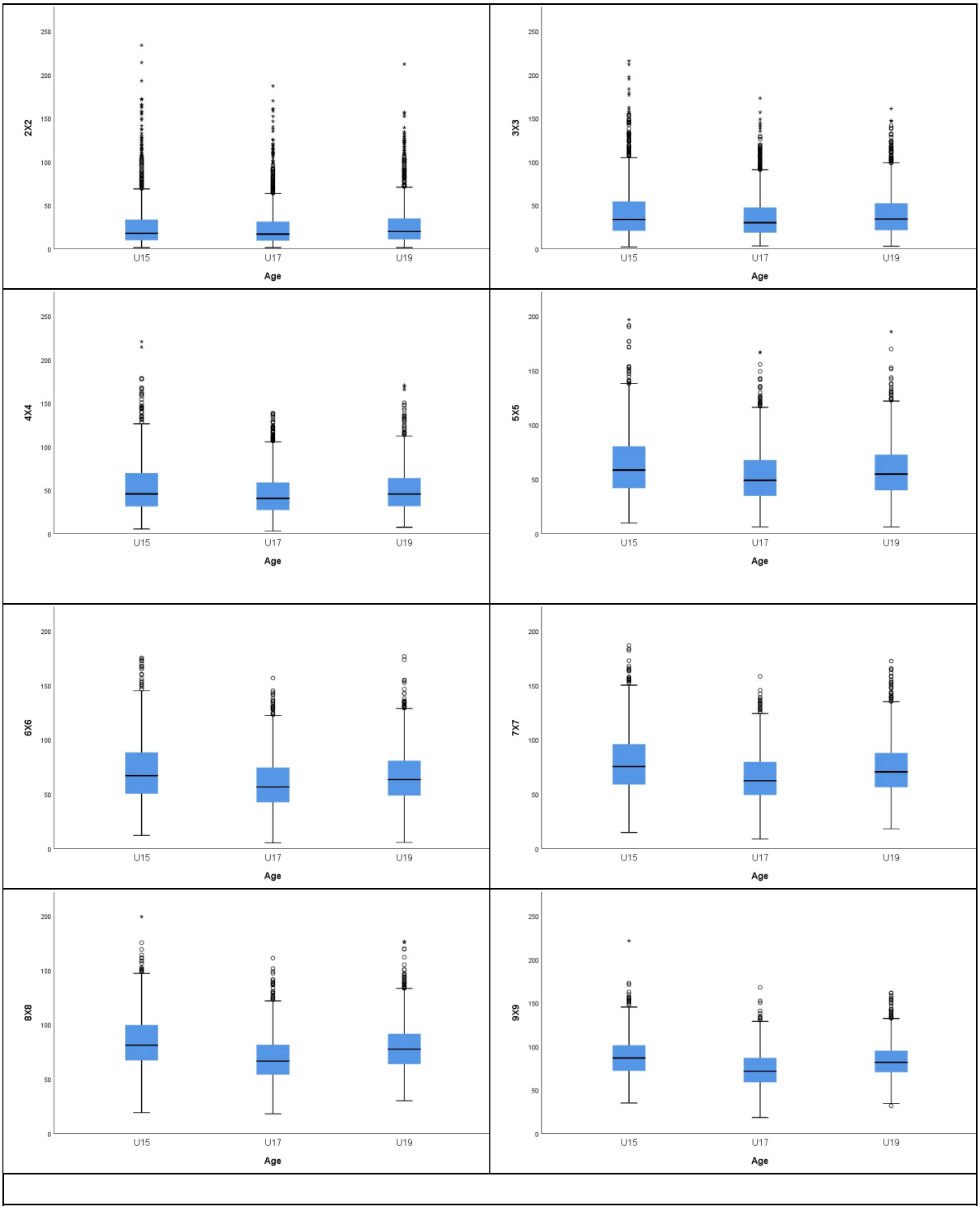
Figure 6. The pitch was divided into different six zones

Statistical Analysis

Initially, the IPA was calculated for each numerical relation and the results grouped by age. The normality of data was analysed through the Kolmogorov-Smirnov test, revealing a non-normal and strongly asymmetric distribution. Thus, a descriptive analysis was performed through the median, interquartile range. The lack of normality led to the adoption of the Jonckheere-Terpstra test when comparing age groups. Pairwise comparisons between each age group and numerical relations were performed by calculating the standardized effect sizes (ES) (Pallant, 2007). Therefore, the effects were described according to the following scale: null (0.00-0.10); weak (0.11-0.29); moderate (0.30-0.49) and strong (≥0.5) (Cohen, 1988). In the comparison between the different areas for each level, the Kruskal-Wallis H test was used. The identification of the differences detected by both non-parametric techniques was performed using Bonferroni Correction. The level of significance was set at $p < 0.05$ for multiple tests. For statistical analysis, the following software was used: IBM SPSS statistic-v.26.0.

Results

Figure 7 shows the median of the IPA (m^2) of each numerical relation in each age group. The results revealed higher values for U15 and lower values for U17, in all numerical relations.



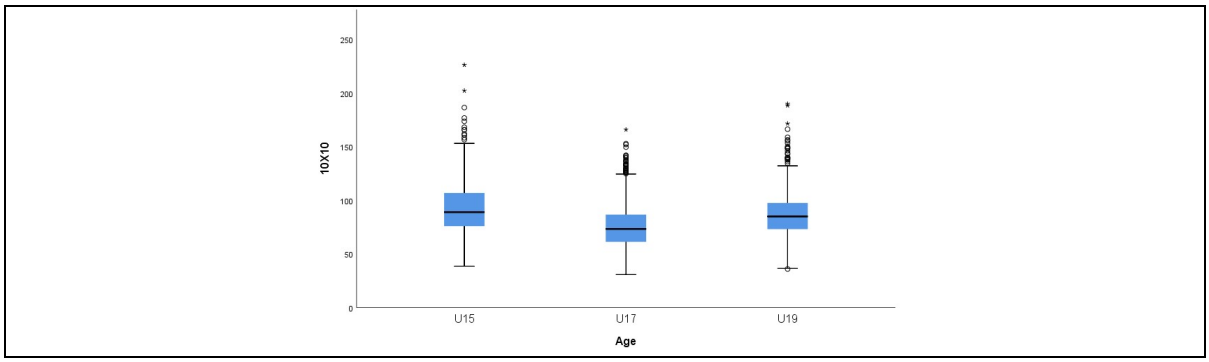


Figure 7. Values IPA (median) in U15, U17 e U19

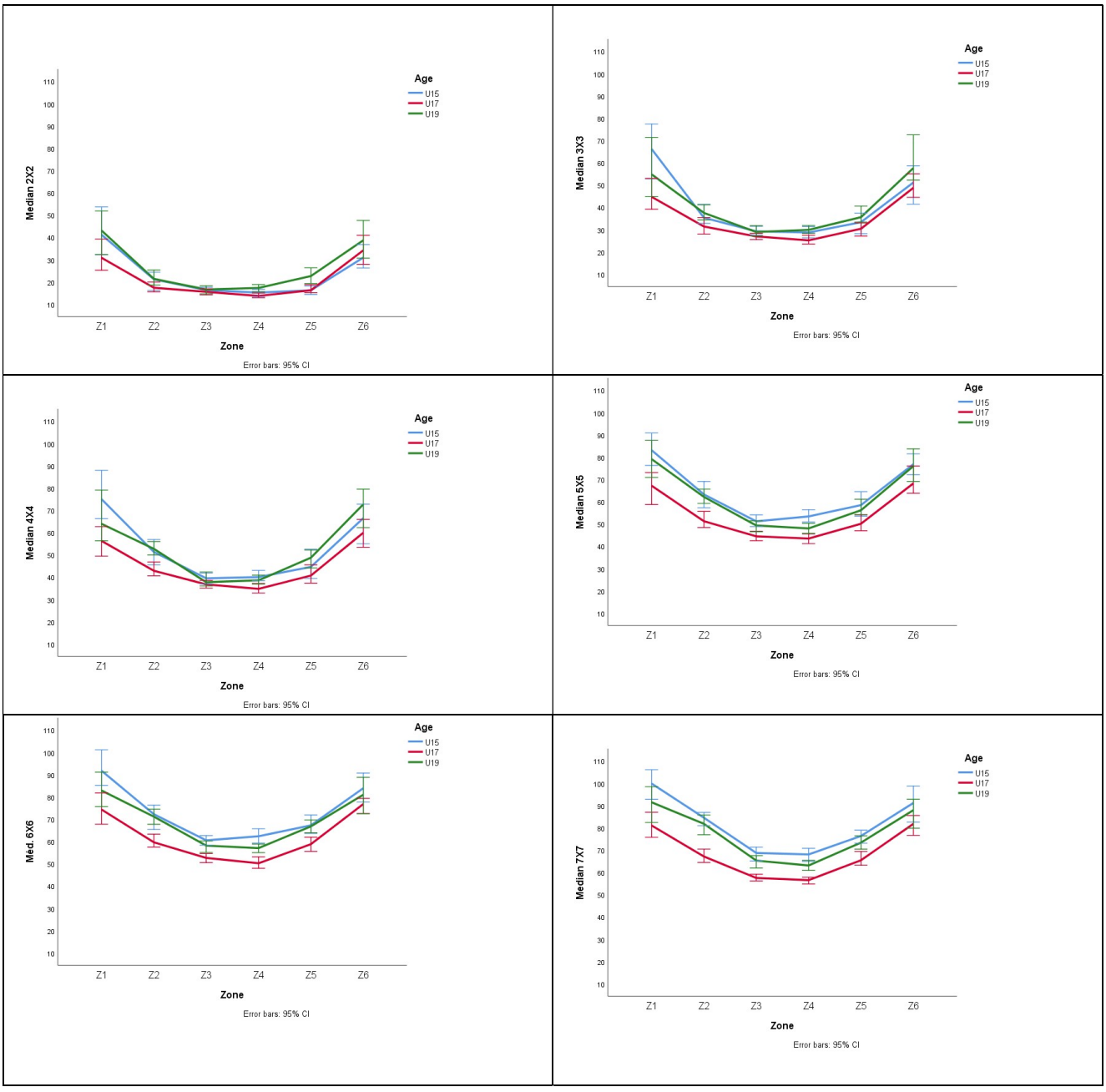
Table 7 presents the significant differences between numerical relations, namely 2x2 (p = 0.047), 5x5 (p = 0.001) and 6x6 to 10x10 (p = 0.000), between the different age groups. Moderate differences were observed in 8x8 to 10x10 and weak differences for other numerical relations between U15 and U17. Between U15 and U19 all the differences were null to weak and between U17 and U19 all the differences revealed a weak effect.

Table7. Comparison between ages in each numerical relationship

					Effect size		
Players	t_{jt}	Z	p-value	Post- hoc	U15 – U17	U15-19	U17-19
2x2	4313886	1.99	0.047	$U15^{b}>U17^{a}$ $U19^{b}>U17^{c}$	0.04		0.07
3x3	4206562	.082	.935				
4x4	4136618	-1.159	.246				
5x5	4018348	-3.258	.001		-0.17 (weak)	-0.07 (null)	0.11 (weak)
6x6	4012436	-3.36	.000		0.20 (weak)	0.08 (null)	0.13 (weak)
7x7	3978330	-3.97	.000		0.24 (weak)	0.09 (null)	0.17 (weak)
8x8	3960919	-4.28	.000	$U15^{bc}>U19^{ab}>U17^{ac}$	0.31 (moderate)	-0.11 (weak)	0.22 (weak)
9x9	3992537	-3.72	.000		-0.31 (moderate)	-0.10 (null)	0.24 (weak)
10x10	3959018	-4.31	.000		-0.36 (moderate)	-0.12 (weak)	0.28 (weak)

The results of IPA (m2) for each numerical relation revealed an effect of the pitch zone (Figure 4). Higher values were observed in the zones closer to the goals (Z1 and Z6) and lower values in the middle zone of the pitch (Z3 and Z4), with significant differences in all numerical relations and ages

(p = 0.000). An effect of age was also observed in the different areas analysed. While in U15 the highest values were always in zone 1, in U17 and U19 they were in zone 1 or zone 6 (Figure 8). It is also worth mentioning that despite variations in age levels or in numerical relations no significant differences were observed between zones 1 and 6, zones 2 and 5 and zones 3 and 4.



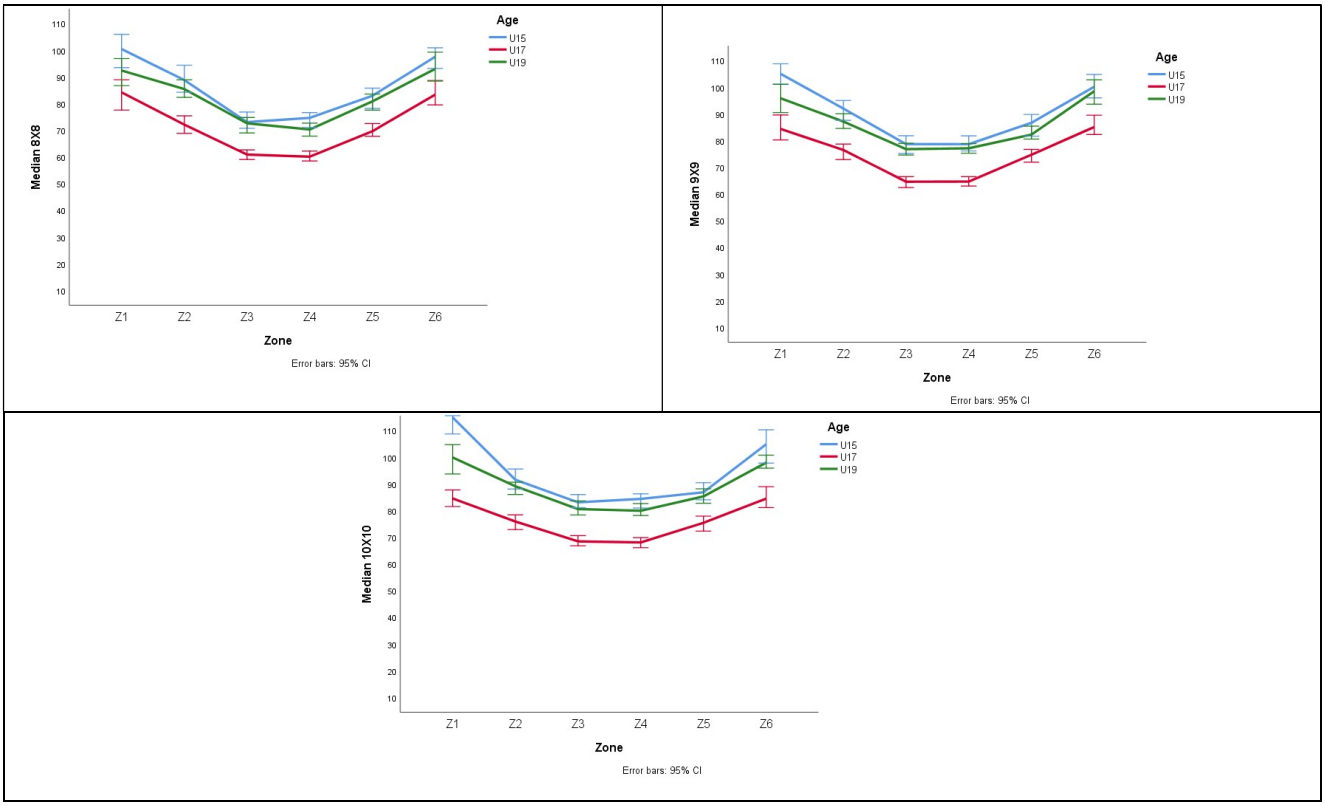


Figure 8. Median in six zones at each age (U15, U17 e U19)

Discussion

This study aimed to identify the differences between IPA according to age (U15, U17, U19), numerical relations and different pitch zones. In general, results revealed differences between age groups for different numerical relations and considering the pitch zones of play.

As expected, IPA values revealed general differences between players of different age groups (U15, U17, U19). However, there was no gradual increase in IPA concerning age. U15 values revealed the highest IPA values, U17 values corresponded to the lowest ones, and U19 values were associated to intermediate IPA values. According to previous studies, variations in age directly influence the way through which players explore the pitch and, consequently, how they explore own possibilities as well as their teammates', depending on the opponent's behaviour (Menuchi, Moro, Ambrósio, Pariente, & Araújo, 2018; Nunes, Gonçalves, Davids, et al., 2020). Probably, this variation in space is related to the ability of players to adjust their individual performance behaviours to the playing area, according to their teammates, opponents and ball placement (Travassos et al., 2018). In opposition to our expectations, similar IPA results were observed between U15 and U19 players, with the U17 revealing the lowest values. However, the similarities between the IPA U15 and U19 are sustained by different reasons. While the higher IPA of U15 could be related with the need for more time and space to decrease the ball pressure and to ensure additional time for decision and action (Nunes, Gonçalves, Davids, et al., 2020), the higher IPA for U19 could be related with the higher capability to manage the interacting space with teammates and opponents according to ball placement and game dynamics (Folgado et al., 2014; Travassos et al., 2018). The maturation stage

in the young U14 and U15, due to bodily changes that occur as a result of peak height speed, can influence technical actions and motor skills (Philippaerts et al., 2006), with implications in tactical behaviour and decision-making (Sevil-Serrano, Práxedes, García-González, Moreno, & Del Villar, 2017). Also, changing the game format from football 7 to football 11 can contribute to less game efficiency in the U14 and U15, creating the need to use more space and time to perform due to the increase in the number of players and the spatial-temporal relations that they need to manage (Lapresa, Arana Idiakez, & Garzón, 2006).

Regarding the more reduced space occupation by U17, a possible reason may be related to the time of knowledge acquisition by players of this age. In fact, they are at the beginning of the specialization stage and, therefore, their knowledge of space is still under development (Machado, 2015). In this way, players tend to reduce the distance between them in the attacking stage, resulting in lower IPA values compared to other age groups. Data suggest that, up to U17, players reveal difficulties in adapting to the constant changes occurring in the playing area and individually adjust their actions according to the ball placement. These differences in IPA according to players age suggest that the manipulations of playing areas in SSCG during training sessions should be adjusted according to the age level of players to promote most adjusted contexts of learning (Olthof et al., 2019; Travassos et al., 2018).

Interestingly, the IPA values tend to reveal higher differences between age groups for higher numerical relations of players. Several studies on SSCG suggest that the greater number of players involved the less the variability in players' positioning, making the game more positional (Silva et al., 2015). Thus, while with low number of players the IPA seems stable, increasing the number of players that participating on the game tend to highlight the adaptive behaviours of players to occupy space according to their own individual and relational tactical capabilities. Further research is required on this topic to understand the dynamic of such variations according to players' levels of expertise and individual tactical, technical, and physical capabilities.

At the end, the analysis of IPA according to the pitch zones of play revealed that, in general, the zones closest to the goals presented the higher values of IPA. While in the U15, in all numerical relations, the highest values occurred in the zones closest to the own goal, in the U17 and U19, the highest values were found in the zone closest to the opponent's goal. With the increase in the number of players, the highest values in both echelons tended to be associated to the U17 in zone 6and to the U19 in zone 1.

The study also revealed three similar IPA values for all numerical relations and ages: i) in the zones closest to the goals (Z1 and Z6), values were higher; ii) in Z2 and Z5, values were intermediate; iii) in the middle zone (Z3 and Z4) values were lower. These data revealed zones with similar IPA but with different objectives. Although players' functions depend on their position on the pitch, which leads to different dynamics within the game (Caro et al., 2019), there were similarities in the playing areas according to their relative position on the field in relation to own or opposite goal. For example, while zone 1 is characterized by the beginning of the attacking stage, zone 6 is the space

where the attack finishes. Zone 2 is characterized by the security actions of players to continue the attacking stage. Zone 5 is the space of the pitch that is suitable for the players to risk so as to initiate the imbalance in the opponent's defensive stage. Zones 3 and 4 reveal similar objectives, such as preparation of finishing situations. The difference in values in the IPA between the middle and the zones close to the goal posts may be due to the constraints of the offside rule, promoting a greater length distance between players, since the ones on the defensive line are close to the midfield line when the ball appears in more advanced areas of the pitch (Tenga et al., 2015). On the other hand, when teams have ball possession in zones close to the goal, they tend to place players further from the ball in terms of width and length, to continue the attack, promoting the distance of the team's players. When the ball is on the middle zone, the teams tend to place the players further from the goal, to be more compact, reducing the distances between players and making IPA smaller in the middle zone.

Current findings suggest differences in IPA in youth football compared to professional football. These results may help coaches to adjust the dimensions of the SSCG according to different age groups and to the objectives concerning different field zones. However, further research is required to link such spatial occupation with the team purposes and the types of actions that tend to occur in each zone. Thus, it will be possible to better design SSCG that combine the collective with the individual requirements according to what happens during the game.

One of the present study limitations was the use of recreated matches during training sessions instead of regular matches. Despite ensuring a controlled environment, it lacks the competitive demands present in a regular match. Future studies should be carried out in regular competitions.

Pratical Implications

This study suggests the need to vary the playing area according to age level, numerical relations and the collective goals of each task according to the field location. In other words, the sectorial training of defenders, midfielders or attackers associated with different objectives must be trained in different spaces. The design of SSCG should respect the proportionality of space occupied by players of each team according to their own individual and collective capabilities for action. Thus, the evaluation of teams' space of play should be done during the season in order to constantly promote new adaptations in players' behaviours according to coaches' purposes. The use of higher proportional IPA in comparison with the game should offer additional time of players to perceive and act during the training sessions, while the use of lower proportional IPA will require faster perception and more precision in actions. The presented values could be used as reference for the design of SSCG in the U15, U17 and U19 age levels if they don't have possibility to measure the IPA values of their own team. Further research should be developed to link the variation in space occupied and the game moment, helping coaches to design more representative tasks in relation to the competitive environment.

Capítulo 5 – How Football Players' Age Affect Passing Patterns of Play According to Field Location

Abstract

This study aimed to characterize the passing patterns that support collective tactical behaviour in football players of different ages (U15, U17, and U19) in different field zones. Two hundred and twenty-eight male players, divided into U15, U17, and U19, participated in the study. Cluster analysis was used to group the passes into three sizes (short, medium, and long). The chi-square test was used to analyse the effect of player age on game- passing patterns in each field zone. The results revealed that long and medium passes were used more in areas close to the goals and short passes in the middle area of the field, concerning all ages ($p<0.001$). Furthermore, the analysis of the relative distance between the ball carrier and the receiver indicated that older players (U17 and U19) used more distant players to pass the ball in medium and long passes. These results can help coaches design small-sided games according to the players' ages and adjust to the field's space and the numerical relationship, thus creating a greater transfer from training to competition.

Keywords: football, age, field zone, passing, receive

Introduction

Over the years, football has revealed a great evolution concerning its laws, tactical systems, styles of play used and particularly training methods. One of the reasons for this development concerns the increased use of technologies to understand the game (Link & Hoernig, 2017; Rein & Memmert, 2016) and to better explain the performance factors that characterize teams and players (Gollan, Bellenger, & Norton, 2020; Travassos et al., 2013). Likewise, scientific research in football has improved the capacity to describe the game (Sarmento et al., 2018) and understand the impact of contextual variables (e.g. venue, match status, quality of opposition and match period) in the style of play and the tactical behaviour of the teams (Fernandez-Navarro, Fradua, Zubillaga, & McRobert, 2019; Lago, 2009). Such knowledge allow coaches to identify the important aspects that support the design of training sessions and ensure a better transfer of practices to competition, i.e., improve the performance of their teams and players (Gonçalves et al., 2019).

For example, the analysis of positional data and passing patterns of play, or network analysis allow some improvements in the tactical exploration of space-time relations in different game moments by different teams (Aquino et al., 2019; Gama, Dias, Couceiro, Sousa, & Vaz, 2016). The tactical behaviours of players and teams seems to be identifiable and reveal a signature that is dependent of the relationship they establish between teammates, opponents and the position of the ball in relation to the goal (Headrick et al., 2012; Laakso et al., 2017).

Moreover, previous studies have shown that, depending on the zone of the field where the ball is located, the players' tactical behaviours vary, causing changes in the collective dynamics between teams (Fradua et al., 2013; Tenga et al., 2015). Likewise, in the defensive sector, defenders tend to show less variability in displacements and in individual tactical actions (number and type of passes). On the other hand, in the attacking sector, attackers tend to reveal variability in space-time relations to create imbalances in the opponent (Gonçalves, Figueira, Maçãs, & Sampaio, 2014; Laakso, Davids, Liukkonen, & Travassos, 2019). Moreover, midfielders tend to reveal a greater number of actions in different game contexts due to occupying a more central position on the field, with higher variability in players' relations (McGuckian, Cole, Chalkley, Jordet, & Pepping, 2020) from which a large part of attacks are built. Thus, in analysis of players, the tactical action must be contextualized based on the variables that constrain their possibilities of action, such as the area of the field, the number of players closest to the ball (Caro et al., 2019; Passos, Amaro e Silva, Gomez-Jordana, & Davids, 2020), or the location of the teammate who can receive the ball (Travassos, Duarte, et al., 2012).

The way players explore the game's action possibilities, and the how the ball moves around the pitch is, however, not only based on the context of play but also on the players' action capabilities (Folgado et al., 2014; Olthof et al., 2015). For example, older players with more technical-tactical skills tend to play more in width than in depth, enhancing a more elaborate game, while younger players with less skill tend to use the more direct game (Almeida et al., 2017) but with less effectiveness for progression or to create finishing situations (Varley et al., 2012). Thus, older and

more skilled players generally shown greater capacity to adapt to the existing playing space, allowing the emergence of more functional collective behaviours (Silva, Aguiar, et al., 2014). On the other hand, at the level of the ball patterns of play, younger players tend present a random exploration of possibilities for action, with a dependency on passes around specific players and less efficiency in the passes of older players (Grund, 2012). That is, younger players tend to be less intentional in exploring the free spaces and, at the same time, present less motor efficiency to perform with precision in the available space and time. Therefore, players' age, or even the players' maturation stage, can influence technical actions and motor skills (Philippaerts et al., 2006), with implications in tactical behaviour and decision-making (Sevil-Serrano, Práxedes, García-González, Moreno, & Del Villar, 2017)

Summarizing, it may be considered that the patterns of passes allow the assessment of the offensive style of the teams as well as the teams' qualitative level to adapt to the variation of the existing playing space. Thus, there is a need to compare different age groups to understand the variation of tactical behaviours through the passing pattern (Gonçalves et al., 2017). Therefore, this study aimed to characterize the passing patterns that support collective tactical behaviour of football players of different ages (U15, U17 and U19) by identifying their length, field zone, and relative distance between the passer and the receiver. Variations inthe passing patterns of play depending on the field zones where the ball was were expected. Moreover, identifiably different lengths of passing and the relative distance of the playersthat receive the ball, according to variations in players' age, were expected.

Material and Methods

Participants

A total of two hundred and twenty-eight male players who competed in the Portuguese national first division for each age group was represented by under 15 (n = 76, age 14.4 ± 0.4 years, height 1.61 ± 0.07 weight 52.2 ± 9.0, biological maturation 84% middle and 16% early); under 17 (n = 76, age 15.6 ± 0.5 years, height 1.74 ± 0.05, weight 63.1 ± 7.5 biological maturation 94% early and 6% middle) and under 19 (n = 76, age 17.7 ± 0.5 years, height 1.78 ± 0.09, weight 75.3 ± 9.3, biological maturation 100% early). Three different clubs participated in each age group.

Procedure

A total of nine games were played using the official rules (three by age). Moreover, biological maturation was calculated for boys using the maturity offset formula (MO)=7.999994 + (0,0036124 x (age x height)); R^2=0.896; SEE = 0.542 (Moore et al., 2015).

The coaches defined the team composition in each simulated game to ensure balanced and competitive matches. Positional data of all the players were collected using individual global positioning systems (GPS) units at 10 Hz (S5, Catapult Innovations, Melbourne, Australia). Goalkeepers were not included in the study. GPS were turned on 15 minutes before each game. The games were recorded using the camera (Panasonic HC-V160).

Notational analysis was performed by recording the following player actions: passing the ball, receiving the ball, shooting recovering the ball and fouls. For this analysis, the software LongoMatch (version 1.3.7., Barcelona, Spain) was used, considering the time of each action for synchronizing the ball events with the GPS positional data. In addition, a visual representation of each simulated match was processed, presenting the ball position and displacement. Finally, this representation was used for possible notational errors correction, by comparing it with the original video (Folgado et al., 2019).

The field was identified into different six zones according to previous studies (Fradua et al., 2013) (Figure 9). The position of the ball passer and ball receiver was classified according to those different zones of the field for the analysis of the passes pattern. Zone 1 (Z1) is located near the team's own goal and zone 6 (Z6) is located near to the opponent's goal.

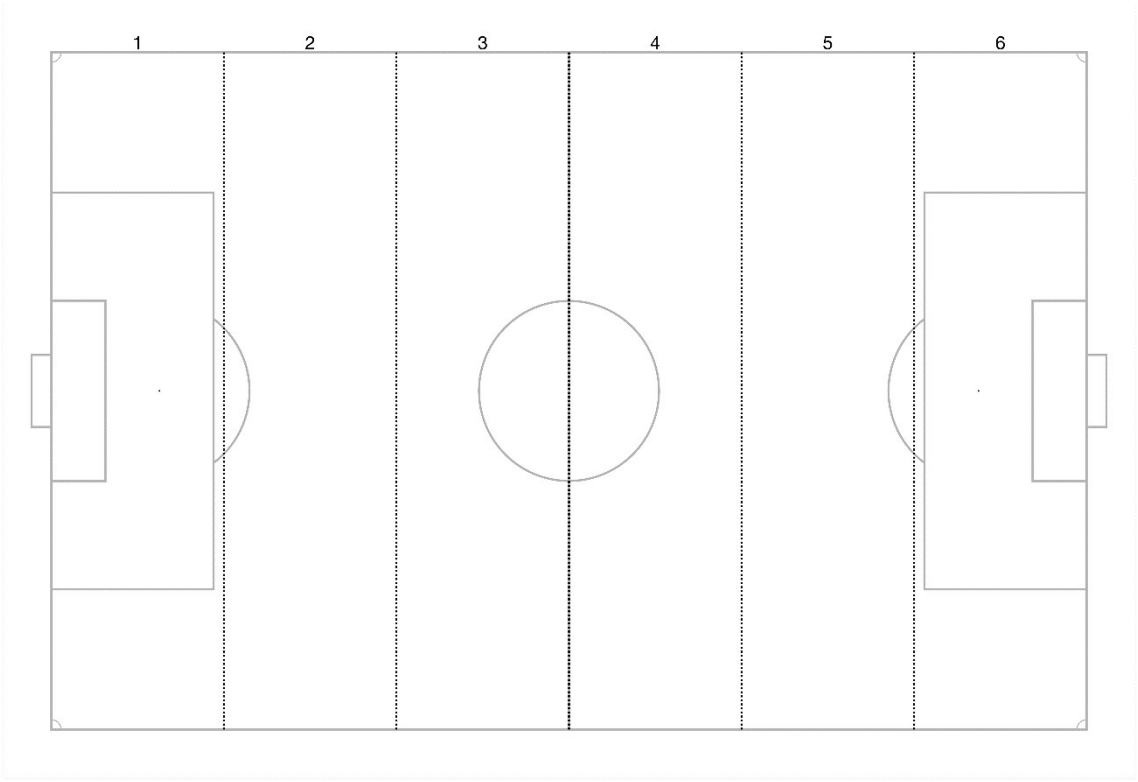


Figure 9. The field was divided into different six zones.

Attacking field players' distance to the ball carrier were also calculated, as well as their and their relative distance, ranked for every moment of the match, from the closest player (P1) to the furthest player (P9) (Vilar, Duarte, et al., 2014).

Data Analysis

Through a cluster analysis, the passes (total = 4537; U15 = 1184, U17= 1184; U19 = 1460) were grouped into long, medium, and short, using the *k*-means method, computed per age group. Calculations were made to obtain the averages of the long passes (31.67 m ±6.72), medium passes (16.69 m ±2.93) and short passes (8.29 m ±5.62). In order to compare the pass distribution, considering the pitch zones, the pass range and the ages, the simple chi-square test was used (contingency table) with a defined significance level of $p < 0.05$. The adjusted residues were computed for pairwise comparison to reveal the differences within each group (Campbell, 2007). The pairwise *p*-value was calculated using the Bonferroni correction method. For statistical analysis the jamovi project software was used (version 1.6.).

Results

Table 8 reveals the mean value of long, medium, and short passes (mean ± standard deviation) in relation to players' age and considering the six zones of the field. In general, in all the players' age groups, the short passes turned out to be the mostly used (U15 – 44.7%; U17 – 49%; U19 – 45.3%), followed by medium (U15 – 39.3%; U17 – 37.9%; U19 – 40%) and in a much less quantity long passes (U15 – 16%; U17 – 13%; U19 – 14.7%) (Table 8). Pairwise comparison revealed that U15 used more long passes than U17 and U19.

Table 8. Descriptive analysis of passes length by age

Age	Zone	Passes length					
		Short		Medium		Long	
		N (%)	M ±SD	N (%)	M ±SD	N (%)	M ±SD
U15	1	2.8	8.39±2.63	3.9	18.49±2.53	2.4	29.69±5.00
	2	6.8	8.23±2.54	6.1	16.93±3.06	2.2	29.75±8.44
	3	10.9	8.54±2.44	9.8	16.37±2.94	3.2	33.99±8.67
	4	13.4	8.26±2.61	8.3	16.55±3.01	3.9	30.40±6.76
	5	7.9	8.23±2.55	6.7	16.68±2.98	1.6	32.35±10.14
	6	3.0	8.74±3.00	4.6	16.96±3.11	2.8	32.23±7.62
	Total	44.7	8.36±2.57	39.3	16.82±3.00	16.0	31.56±7.91
U17	1	2.4	8.14±2.73	2.9	16.50±2.85	2.1	39.12±20.35
	2	8.6	8.19±2.68	6.9	16.71±2.80	2.0	30.32±9.46
	3	12.6	7.96±2.66	9.1	16.48±2.90	2.2	32.40±7.96
	4	11.8	8.31±2.50	7.8	16.47±2.86	2.9	31.21±7.26
	5	9.2	8.19±2.62	6.8	16.19±2.88	2.2	29.86±5.81
	6	4.5	8.12±2.94	4.4	16.79±3.13	1.5	38.85±21.25
	Total	49.0	8.15±2.65	37.9	16.50±2.89	13.0	33.04±12.92
U19	1	1.6	8.37±2.75	3.3	17.32±2.48	2.2	31.58±7.69
	2	8.3	8.36±2.66	7.3	16.80±2.82	2.3	29.39±6.78
	3	11.6	8.30±2.56	9.4	16.49±2.78	2.6	30.80±5.76
	4	13.7	8.24±2.60	10.6	16.38±2.87	3.9	29.99±6.31
	5	7.6	8.40±2.68	6.0	16.75±3.19	2.0	28.90±5.37
	6	2.5	9.18±2.33	3.4	17.53±2.95	1.7	32.60±7.47
	Total	45.3	8.37±2.60	40.0	16.76±2.87	14.7	30.42±6.57

n: relative frequency; m ± sd: Mean ± standard deviation.

However, statistically significant differences were noticeable (χ^2 = 113.0, p>0.001) in the occurrence of different types of passes according to the pitch zones. The significant variations were recorded in the long passes in zone 1 (p<0,00001), zone 3 (p=0.00016) and zone 6 (p=0.00003) and in the short passes in zone 1 (p=0.00000), zone 4 (p=0.00136) and zone 6 (p=0.00002). In the zones nearest to the goal (zones 1 and 6), medium passes were the mostly used, while short passes were predominantly used in the medium zone of the pitch (zones 2 to 5). At the end, short passes occurred less in zone 1 and long passes in the other zones (Figure 10). Overall, teams revealed a relative higher frequency of medium and long passes than short passes closer to the goal.

Considering the variation in the type of passes according to the pitch zones by age group, the results revealed significant differences for all the age groups analysed (U15, χ^2 = 41.6, p<0.001; U17, χ^2 = 39.9, p<0.001; U19, χ^2 = 53.5, p<0.001), and the types passes analysed (long, χ^2 = 18.7, p < 0.044; short, χ^2 = 20.1, p < 0.029), except for medium passes (χ^2 = 15.0, p=0.132).

Moreover, in the distribution of passes by each zone, the results revealed significant differences regarding long and short passes in zone 6 (p=0.000), with a value above the expected in the U15.

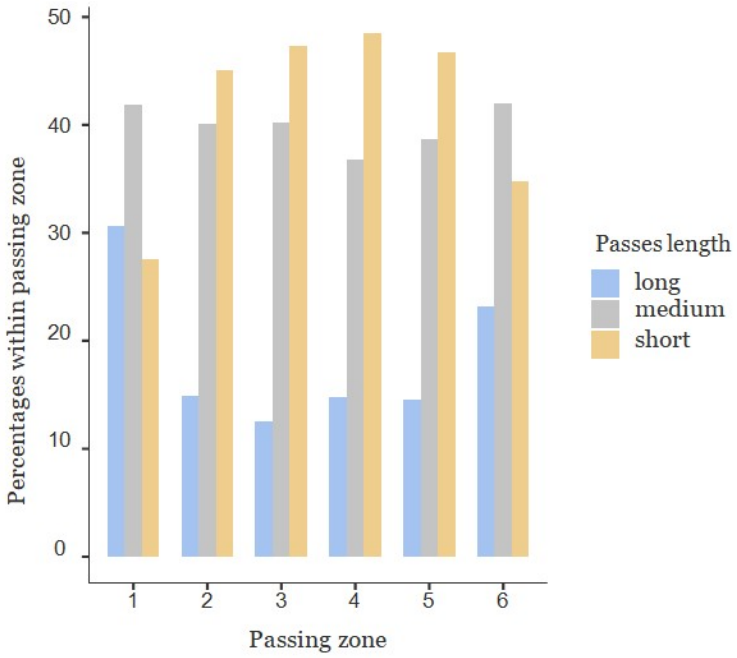


Figure 10. Distribution of the total number passes by field zone.

Significant differences appeared in long and short passes in zone 1 and 3 (p=0.000), with a value above the expected for long and below for short passes in the U17. Significant differences were reported in long and short passes in zone 1 (p=0.000) with values above to the expected for long and below for short passes in the U19. In general, long passes were above expectations in the areas

close to the goals and below expectations in the middle areas of the field. In opposition, short passes were below the expected in the areas close to the goals and above the expected in the middle areas of the field.

Moreover, we observed significant differences in the players who received the ball considering age in long passes ($\chi^2 = 32.2$, $p = 0.010$) and medium passes ($\chi^2 = 31.8$, $p = 0.011$).

Concerning short passes, in all ages, the player who received the most passes was P1. In this type of pass, there were only differences in the distribution for the fifth player, with the U17 considering this player at this distance (Figure 11). Regarding medium passes, the player who received more passes in the U15 was P2 ($p>0.05$); in the U17 ($p=0.000$) and U19 ($p=0.000$), it was P3. As for long passes, the player who received more passes, in the U15, was P5 ($p=0.000$); in the U17 ($p=0.000$) and U 19 ($p=0.000$), the player who received more passes was P6. The results show a trend for the younger players to use relatively closer players for long and medium passes, compared to older players.

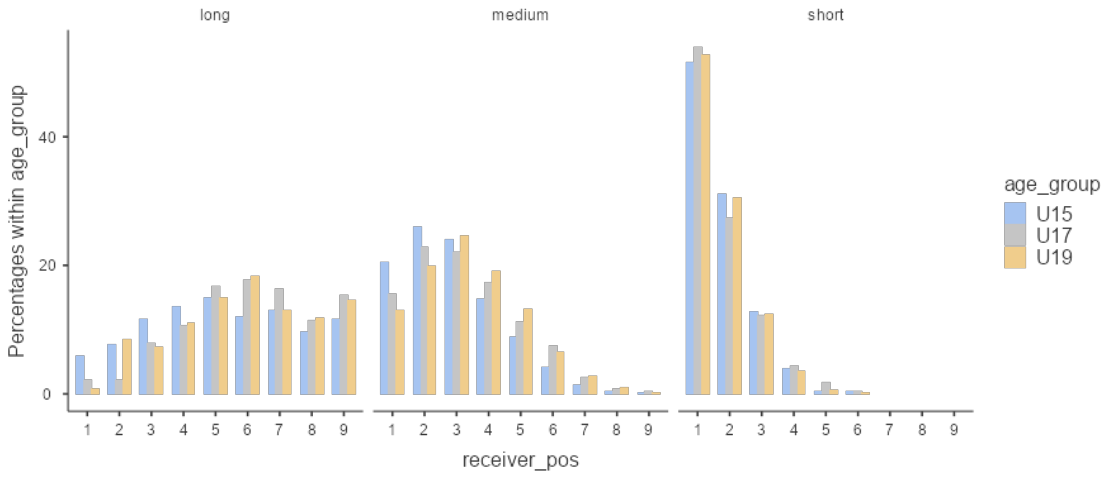


Figure 11. Passing distribution relative frequency of completed passes considering the relative distance between the ball receiver and the ball carrier, per age group and pass length.

Discussion

This study aimed to characterize the passing patterns that support collective tactical behaviour of football players of different ages (U 15, U 17 and U 19). According to our expectations, some variations in the passing patterns of play were observed according to the field zones of the ball where the pass was performed. For example, in all ages, the most used passes in the areas close to the goals was the medium pass, and in the medium zone it was the short pass. Moreover, according to our expectations, variations in age category promoted variations in the type of most frequent passes and in the player that receives the ball.

Effect of field zones

In the analysis of the effect of the variation of the zones in which the ball was, we verified that in zone 1 medium passes were the most used. In line with previous studies, in zone 1, teams in possession of the ball tend to have numerical superiority with great values of individual areas per player, regardless of age (Coito, Folgado, Romero, Loureiro, & Travassos, 2022; McGuckian et al., 2020). In this play area, near the team own goal zone, the players needed to use medium and long passes that allowing the creation of space to start the offensive game safely and consequently advancing on the field and passing the opponent's 1st defensive line.

In the middle area of the field (Z2 to Z5), there was an increase in short passes and a decrease in long passes. In these areas, the short pass was the most used, suggesting that teams, regardless of age, seek to establish functional relationships between the closest players to create a numerical advantage in the group relationships between the players closest to the ball (Travassos, Araújo, Davids, Esteves, & Fernandes, 2012) and in this way try to overcome direct opponents and create defensive imbalances for the opponent (Aquino et al., 2019).

While zone 2 is characterized by the space where the organized attack begins, normally with little pressure on the ball and maintaining the numerical superiority of the attack, in zones 3 and 4 the individual playing area per player is smaller compared to the zones close to the goals (Coito et al., 2022; Fradua et al., 2013), promoting more ball possession for the exploration and creation of progression possibilities (Caro et al., 2019) and more possibilities for shorter passes As verified in previous studies, zones 2 to 5 correspond to the areas of the field with high values of pass variability in view of the space constraint to play and the plasticity in the offensive tactical behaviour necessary to promote progression in the game area (Clemente, Couceiro, Martins, Mendes, & Figueiredo, 2015).

In zone 6, with the decrease in distance to the opponent's goal, the most used type of pass was the medium pass due to the change concerning the objectives of ball circulation (creating imbalances to finish) and the emergence of possibilities to shoot on goal (Headrick et al., 2012). In this area, in fact, there tends to be a lower number of passes compared to the middle area of the field due to the proximity of the opposing goal that motivates the dribble and the shot. In this area, the team in possession of the ball tends to be outnumbered, and the short distance to the defending goal enhances the emergence of individual actions on the ball at greater risk (Vilar, Esteves, et al., 2014). The location of the goal proved to be an informational invariant that conditioned the interpersonal relationships and the individual and collective behaviours of the players (Headrick et al., 2012; Laakso et al., 2017). The field areas motivate the players' need to explore different possibilities of action, so as to discover the best solution according to the game requirements (Travassos, Araújo, et al., 2012).

Effect of players age on field zone dynamics

The effect of age on the different types of passes showed significant differences in long and short passes. The results revealed that younger players (U15) tend to use long (Z6) and medium (Z5 and Z6) passes more than older players (U17 and U19). This evidence is in line with previous studies, which revealed that younger players tend to adopt behaviours that allow them to approach the opponent's goal faster, compared to older players (Olthof et al., 2019).

On the contrary, U19 and U17 tended to use more long, medium and short passes in zone 4 and zone 5 compared to U15. Previous studies suggest shorter distances between strikers and defenders in the middle zone of the field (Coito et al., 2022). This spatio-temporal decrease potentiates variability in the possibilities for action depending on the variability of spatial occupation of teammates and opponents (Menuchi et al., 2018), leading to the emergence of greater variability in the types of passes in order to obtain more functional actions and adjusted to the conditions encountered (Silva, Duarte, et al., 2014).

The data suggest that older players showed greater variability in passes as showed greater adaptability in smaller playing areas (Olthof et al., 2019). In line with other studies, older players revealed a greater adaptability to the effects of manipulating the playing areas compared to younger players (Canton et al., 2019; Folgado et al., 2014). Thus, the greater game experience and consequent ability to functionally explore possibilities for action (Hewitt, Greenham, & Norton, 2016) of older players makes them more efficient in passing and gives them a better occupation of field spaces to receive the ball (Menuchi et al., 2018). Our data also suggest that the players who most often received the ball were the closest to the ball carrier in the U15, regardless of the type of pass. On the other hand, older players passed the ball more often to teammates, with more distant relative positions according to the length of the pass. For example, in the long pass, the player who received the ball most times was P6 in U17 and U19. In the medium pass, it was P3 in the U19, and with similar values it was P2 and P3 in the U17, while, in short passes, the players closest to the ball (P1 and P2) revealed a greater tendency to receive the ball, regardless of age. Older players' ability to passes to more distant players may be due to their apparent advantages in body mass and level of maturity compared (Hunter et al., 2021; Silva, Travassos et al., 2014) to younger players. The data suggest that the U15 made more long passes to the same relative position of the receiver compared to the U17 and U19, which is in line with another study that showed higher values of individual areas per player in the U15 level (Coito, et al., 2022).

Moreover, older players with more playing experience are more flexible to the game dynamics (Silva, Aguiar, et al., 2014; Silva, Duarte, et al., 2014), while younger players tend to play with more rigid behaviours (Grund, 2012). However, greater knowledge of the game allows players to gather more and better information from the environment, perceiving more possibilities for action (Silva, Travassos, et al., 2014). The study suggests that the sizes of passes performed in the soccer game were influenced according to the field area and players's age. In practical terms, these results reinforce that the creation of exercises should consider the variation of the field location and the

use of different numerical relationships in order to achieve a greater adjustment to the game conditions and ensure greater transfer between training and competition (Laakso et al., 2019).

Due to the obtained results, and in order to better prepare the players to explore the best passing actions in zone 1, we suggest that the design of the SSCGs should include a numerical superiority of attacking team (McGuckian et al., 2020) with more than 4 players in the defence in order to clearly define the first defensive line and space to explore in-between lines (Travassos, Monteiro, Coutinho, Yousefian, & Gonçalves, 2022). The space used should be manipulated to allow players freedom of action in carrying medium passes, but also long and short ones according to the spatial-temporal relations with opponents. The manipulation of spaces should be considered according to the age of the players, with wide spaces for U15 than for U19 (Coito et al., 2022). We also suggest that coaches could introduce two goals that the defensive team can use to score when recovering the ball to increase the feeling of danger in the case of losing ball possession (Travassos, Gonçalves, et al., 2014).

Regarding zones 2 to 5, we suggest that the design of the SSCGs should include a numerical equality of teams from 5x5 to 8x8 (Coito et al., 2022; McGuckian et al., 2020), and promote variability on the exploration of short to medium passes both in lateral and longitudinal directions. For that, the manipulation of spaces should be considered according to the age of the players and number of players involved, with wide spaces for U15 and U17 than for U19 (Coito et al., 2022). The use of higher spaces high fewer number of players, particularly to youth players, tend to increase the number of individual actions in the exploration of possibilities for play due to the low restrictions in the spatial-temporal conditions (Nunes, Gonçalves, Coutinho, Nakamura, & Travassos, 2021). We also suggest that coaches could manipulate the field such as the orientation (regular, square, triangle) (Coutinho et al., 2018) , or even restrict the spaces that players could use in the field or even restrict the spaces that players could use in the field (Gonçalves et al., 2017), to promote adaptive capacity to explore the environment and explore the possibilities for short lo long passes according to the conditions of the environment. Moreover, by considering the restriction of space and time to play and also the great number of players involved in the zones 2 to 5, we suggest the manipulation of the number of touches as a constraint to improve players capacity to adjust body position according to the game flow, constantly pick up the information from the environment before to have the ball possession (Oppici, Panchuk, Serpiello, & Farrow, 2018) and promote the passing skill and promote the passing skill (Coutinho et al., 2021).

In zone 6, we suggest that the design of the SSCGs should include numerical relations up to 10 players (5x5) with a playing area that will enable possibilities of action in the variety of medium and long passes. In this area, we suggest that the design of the SSCGs should include numerical equality to promote the variability of short and medium passes and numerical superiority in the attacking team of two or more players in relation to the opponent to allow more shooting opportunities (Vilar, Duarte, et al., 2014). Moreover, zone of field, the manipulation of spaces should be considered according to the age of the players and number of players involved, with wide spaces for

U15 than U17 and U19 (Coito et al., 2022). We also suggest the use of several goals (three to six) to promote greater distances between the players of one's own team and those of the opponent team, in order to increase the variability of the individual and collective behaviours of the teams (Travassos, Gonçalves, et al., 2014).

Conclusions

This study suggests, with the extrapolated data from the game, the need provide players with environmental conditions during training, which are appropriate for the type of passes intended for the game. The ratio number of players and space motivates different ways of exploring the game depending on the players' own abilities (Laakso, Davids, Luhtanen, Liukkonen, & Travassos, 2021). For this, in the design of small games, the coach must consider the game area and its proximity to the goal, the ratio number of players / game space and the players' age.

Besides the study's contribution for practical purposes, some limitations should be acknowledged. Firstly, the games were not official. Thus, it reduces the competitive levels of an official game, despite ensuring a controlled environment. In addition, the teams played according to their own game model without any control of playing formations used over the matches (e.g., Gk+4+4+2 or Gr + 4+3+3).

Future studies may consider the directionality of passes to help understand the playing style of teams and relate it to the types of passes in the different offensive phases of the game. The distance between strikers and defenders should also be considered in future studies to understand the type of pass with the proximity of the defender in relation to the ball receiver. Moreover, further research should consider not only the age/category of players but also their maturation stage and the relationship with the type of passes performed. The maturation stage should be considered in all studies with youth players due to its implications in their characterization of capabilities for action.

Capítulo 6 - Discussão Geral

A presente tese teve como objetivo melhorar a compreensão sobre o comportamento tático de equipas de futebol de formação (sub 15, sub 17 e sub 19) de acordo com as zonas do campo e as idades dos jogadores e consequentes implicações para o desenho e manipulação de JRC. Para o efeito, foram desenvolvidos três estudos, nomeadamente uma revisão sistemática que procurou descrever e analisar sistematicamente os sistemas de rastreamento, as variáveis e os métodos estatísticos usados para avaliar o comportamento tático de jogadores e equipas nos JRC. De um modo geral, os resultados mostraram que os GPS foram os sistemas de rastreamento mais utilizados, para avaliação do comportamento tático, através de diferentes métricas espaciais que derivam do posicionamento dos jogadores.

A partir das incongruências na literatura, o segundo estudo procurou avaliar a área individual por jogador de acordo com a idade, relações numéricas e as zonas do campo em três escalões de formação (sub 15, sub 17 e sub 19). Os resultados revelaram que o espaço ocupado pelas equipas é dependente da zona do campo e que os valores de área individual por jogador foram mais altos com o acréscimo das relações numéricas e no escalão sub 15. De um modo interessante, as diferenças são mais vincadas entre escalões para relações numéricas superiores.

Por fim, o terceiro estudo procurou caracterizar os padrões de passe que sustentam o comportamento tático coletivo de jogadores de futebol, de diferentes idades, nas diferentes zonas do campo. Os resultados revelaram que, em geral, os passes médios e longos foram utilizados nas zonas mais próximas das balizas e os passes curtos nas zonas médias do campo. Outro dado interessante, os jogadores mais novos realizam passes mais longos para mesma posição relativa do recetor comparados com os sub 17 e sub 19. Estes resultados são de maior importância para a compreensão do jogo em função das idades dos jogadores, permitindo que os treinadores desenvolvam JRC de acordo com as capacidades dos jogadores em cada idade e em função dos objetivos dos exercícios ajustados ao espaço do campo e relação numérica, permitindo maior representatividade dos exercícios realizados e consequentemente maior transfer para o contexto competitivo (Pinder, Davids, Renshaw, & Araujo, 2011).

6.1. Avaliação do comportamento tático nos jogos reduzidos no futebol

Os resultados da revisão sistemática sugerem que os estudos focados na avaliação do comportamento tático individual e coletivo das equipas nos JRC no futebol aumentaram nos últimos anos. Uma das razões para o crescimento destes estudos tem por base a utilização massiva dos métodos de rastreamento em treino e jogo, criando a necessidade de produção de conhecimento associado (Linke et al., 2018). O sistema de rastreamento mais utilizado nos 31 estudos incluídos na revisão sistemática foram os GPS devido a serem portáteis e simples na sua utilização, embora, a sua precisão e a fiabilidade dependam do número de satélites detetados em cada momento (Colino et al., 2019). A revisão sistemática revelou que a partir dos dados

posicionais (x,y) foram derivadas 21 variáveis posicionais / espaciais, embora algumas foram utilizadas com nomenclaturas diferentes mas com objetivos similares (Sarmento et al., 2018). Desta forma, para clarificar a sua utilização, estas foram agrupadas em quatro categorias: equilíbrio das equipas, espaço ocupado, largura e profundidade das equipas, distância interpessoal.

6.1.1. Equilíbrio das equipas

Os resultados revelaram para análise do equilíbrio das equipas foram identificadas cinco variáveis posicionais: centro geométrico, team separateness (TS), stretch index (SI), relative stretch index (RSI) and spread rate (SR). No entanto, o centro geométrico (CG) e o stretchindex (SI) foram as variáveis mais utilizadas e mais robustas devido a serem sensíveis à manipulação dos constrangimentos de tarefa (número de jogadores, relação numérica entre as equipas, número e localização das balizas e da idade dos jogadores) (Barnabé et al., 2016; Frencken et al., 2011; Olthof et al., 2015). O CG permite analisar a distância de cada equipa para a própria baliza e do adversário (Frencken et al., 2011), a distância entre as equipas (Duarte et al., 2012; Frencken et al., 2011) e a dispersão do jogador no campo calculando a distância entre os jogadores e o CG (Sampaio & Maçãs, 2012). O SI foi utilizada em estudos para, também, avaliar a expansão e a contração do espaço ocupado pelos jogadores nos dois eixos (longitudinal e lateral) (Bartlett, Button, Robins, Dutt-Mazumder, & Kennedy, 2012) e aumentar a compreensão da direccionalidade do jogo (Olthof et al., 2015) e revelou ser mais sensível aos efeitos da idade (Canton et al., 2019). Assim, o centro geométrico pode ser utilizado nos JRC na análise das interações dinâmicas entre as equipas durante as fases ofensivas e defensivas (Frencken et al., 2011; Vilar, Araújo, Davids, & Bar-Yam, 2013), enquanto, o SI pode ser utilizado para caraterizar o estilo de jogo das equipas.

6.1.2. Espaço ocupado

Nesta categoria foram agrupadas quatro variáveis posicionais, área coberta, área efetiva de jogo, distância à baliza da equipa, e do adversário. As variáveis mais utilizadas foram a área coberta, que pode ser utilizada para medir a área de jogo na fase ofensiva e defensiva de cada equipa ou entre as duas equipas (Frencken et al., 2011) e a área efetiva de jogo, que pode ser utilizada para medir o menor espaço que contem todos os jogadores de uma equipa (Gonçalves, Marcelino, et al., 2016). Para Duarte et al (2012) podemos identificar três momentos de jogo para caracterizar a área coberta: quando a bola está controlada, quando ocorre o último passe e quando existe o cruzamento da linha atacante com a linha defensiva. Os resultados dos estudos que analisaram o espaço ocupado sugerem a necessidade do aumento da área coberta na fase ofensiva, em zonas próximas

da baliza do adversário, para potenciar o desequilíbrio defensivo do oponente (Duarte et al., 2012; Frencken et al., 2011; Frencken et al., 2013). No entanto, é necessário algum cuidado com a utilização destas variáveis, uma vez que em jogos com reduzido número de jogadores a área coberta e a área efetiva de jogo revelam limitações devido às constantes mudanças de posse de bola (Frencken et al., 2011). Já o aumento das relações numéricas permite maior variação nos espaços ocupados potenciando uma tendência mais clara nas variáveis descritas (Gonçalves, Marcelino, et al., 2016) permitindo avaliar diferentes "estilos" de jogo (Silva, Aguiar, et al., 2014). Assim, a utilização destas variáveis está dependente do número de jogadores nos JRC. Estudos futuros deverão considerar esta limitação nas variáveis, de modo a haver uma melhor compreensão dos resultados observados face ao evidenciado em campo.

6.1.3. Largura e profundidade das equipas

Na análise da largura e da profundidade do espaço de jogo foi adicionado o rácio entre estas duas medidas, designada por lpwratio. Esta variável foi utilizada, por exemplo, para analisar o efeito da manipulação da idade nos estilos de jogo e mostra a dispersão das equipas em campo (Folgado et al., 2014; Praça et al., 2016). Diversos estudos sugerem que as equipas mais novas tendem a jogar mais na profundidade que na largura na fase ofensiva devido a revelarem maiores variações do lpwratio (Folgado et al., 2014). No entanto, Folgado et al (2014) sugere a necessidade de adicionar outras variáveis posicionais ao lpwratio, para compreender as implicações táticas nos JRC. Neste sentido, alguns estudos utilizaram como complemento ao lpwratio, variáveis como o SI (Olthof et al., 2018; Silva, Duarte, et al., 2014) ou o CP (Folgado et al., 2014; Praça et al., 2016), de modo a uma compreensão mais global das interações espaciais existentes.

6.1.4. Distância interpessoal

Esta categoria inclui nove variáveis que representam as relações espácio-temporais entre os jogadores (atacante-atacante, defesa-defesa ou atacante-defesa). No entanto, com algumas diferenças nos métodos de cálculo, algumas variáveis foram utilizadas com objetivos semelhantes. A utilização das variáveis distância para intercetar o passe, e distância para intercetar o remate, permitem compreender como as manipulações dos JRC podem condicionar as possibilidades de ação dos jogadores para a interceção da bola, as linhas de passes ou o remate à baliza (Vilar, Esteves, et al., 2014). A distância entre atacante-defesa, representa a distância entre o atacante e cada defesa, permitindo compreender como os jogadores podem explorar ou ocupar o espaço de jogo. Já a distância do guarda-redes com a linha defensiva permite perceber o espaço que pode ser explorado pelos atacantes nas zonas próximas da baliza do adversário (Vilar, Duarte, et al., 2014). Para alguns autores, a variável distância entre os companheiros é considerada uma das principais

variáveis de informação que revelam as diferenças entre as fases do ataque e da defesa (Coutinho, Gonçalves, Travassos, Folgado, et al., 2019; Gonçalves et al., 2017; Santos et al., 2018). Outras variáveis (espaço efetivo por jogador e raio do movimento livre) revelam a quantidade do espaço livre de cada jogador a cada momento ao longo do jogo. Para compreender as distâncias percorridas em relação à posição inicial e o espaço ocupado pelos jogadores foram utilizadas as variáveis distância do jogador ao local e índice de exploração espacial (Gonçalves et al., 2017). Em futuros estudos, nas relações espácio-temporais entre os jogadores poderão ser utilizadas as variáveis posicionais (atacante-atacante, defesa-defesa ou atacante-defesa) para compreender o efeito da manipulação numérica na fase ofensiva e defensiva nos JRC. A variável que avalia a distância entre o guarda-redes e a linha defensiva pode ser mais explorada nos estudos sobre os JRC devido às informações que podem emergir nas zonas próximas da baliza do adversário.

6.1.5. Métodos de análise

A revisão sistemática identificou diferentes métodos não-lineares para medir a evolução da variabilidade da relação espácio-temporal dos jogadores e equipas nos JRC. Neste sentido, as variáveis mais consistentes e mais utilizados nos estudos incluídos na revisão sistemática foram a*pproximate entropy* (ApEn) e *sample entropy* (SampEn). Estes métodos foram indicados para avaliar a dinâmica das distâncias entre cada jogador para o adversário mais próximo, através das variáveis posicionais: área coberta, centro geométrico, largura e comprimento da equipa (Duarte, Araújo, et al., 2013) ou a variabilidade da distância entre os jogadores (Coutinho, Gonçalves, Travassos, Abade, et al., 2019; Gonçalves, Esteves, et al., 2016; Santos et al., 2018). O método *shannon entropy* foi utilizado para analisar a variabilidade do comportamento dos jogadores na manipulação do espaço de jogo e do número de jogadores (Silva, Aguiar, et al., 2014) e mostraram que o deslocamento dos jogadores no campo tende a ser mais regular com o aumento do número de jogadores e da área de jogo nos JRC.

Outros métodos estatísticos não lineares, *relative phase* e o *running correlations* permitem a descrição dos padrões de coordenação entre jogadores e equipas através da análise da sincronização entre os deslocamentos dos jogadores e das relações-temporais dos jogadores e equipas (Travassos, Vilar, et al., 2014). Na *relative phase* os modos de coordenação são expressos em ângulos 0º e 360º, representando uma relação simétrica e 180º e seus múltiplos representando uma relação assimétrica. Através do método *running correlations* é possível identificar três tipos de tendências de coordenação: uma forte correlação positiva entre as variáveis quando os resultados são positivos e próximos de 1, revelando sincronização; uma forte correlação negativa entre as variáveis quando os resultados são negativos ou próximo de -1, revelando anti-sincronização e, por fim, um padrão irregular de falta de coordenação quando os resultados tendem para zero.

Em futuros estudos, poderemos considerar os métodos não lineares, ApEn e SampEn, como os mais robustos a ser utilizados nos JRC para avaliar a variabilidade e os padrões de coordenação das relações espácio-temporais entre os jogadores e as equipas.

Face aos resultados apresentados nesta revisão, urge a realização de mais investigação que permita comparar a dinâmica de cada variável posicional em jogos reduzidos e para aumentar a compreensão das mudanças nos padrões de comportamentos táticos e padrões de coordenação entre jogadores no desempenho individual e coletivo. Do mesmo modo, é necessária uma maior compreensão entre os resultados obtidos por estas variáveis nos jogos reduzidos e a sua transferência para o contexto competitivo, tendo por base as caraterísticas do jogo de futebol.

6.2. Área individual por jogador de acordo com a idade, relações numéricas e as zonas no futebol

Tendo por base as limitações identificadas na literatura relacionadas com a falta de conhecimento sobre o efeito da idade no espaço ocupado por jogadores de diferentes idades, o segundo estudo procurou quantificar a área de jogo individual por jogador (IPA) através do jogo formal nas diferentes relações numéricas e zonas do campo no futebol jovem.

6.2.1. Efeito da área individual por jogador

Os resultados revelaram valores mais elevados para a área individual por jogador (IPA) para os sub 15 e mais baixos para os sub 17, enquanto os sub 19 revelaram valores intermédios em todas as zonas do campo e relações numéricas.

Em linha com estudos anteriores, as variações de idade influenciam diretamente na forma como os jogadores exploram o campo e, consequentemente, como exploram as possibilidades próprias e dos companheiros da equipa, dependendo do comportamento do adversário (Menuchi et al., 2018; Nunes, Gonçalves, Davids, et al., 2020). Os resultados dos estudos que analisaram o efeito da manipulação do espaço de jogo comparando áreas de jogo pequenas, intermédias e grandes revelaram que o aumento do espaço de jogo potencia maiores distâncias entre os jogadores na fase ofensiva e defensiva, promovendo uma circulação de bola com mais segurança e com mais sucesso nas ações desenvolvidas pelos jogadores (Castellano et al., 2017; Silva, Duarte, et al., 2014; Silva, Vilar, et al., 2016). Em sentido contrário, valores reduzidos da IPA tendem a originar menos tempo para decidir e, consequentemente, mais insucesso nas ações técnico-táticas desenvolvidas pelos jogadores (Silva, Aguiar, et al., 2014; Silva, Duarte, et al., 2014). Assim, os valores mais altos da IPA podem sugerir que os jogadores mais novos necessitem de mais tempo e espaço, diminuindo dessa forma a pressão sobre a bola e garantindo tempo adicional para a decisão e ação (Nunes, Gonçalves, Roca, & Travassos, 2021; Vilar et al., 2013). Para além do referido, valores de IPA

superiores associados a jogadores mais jovens podem estar associados à transição do formato do futebol 7 e 9 para o 11,contribuindo para uma menor capacidade de gestão das relações espácio-temporais dos jogadores (Lapresa et al., 2006). Por sua vez, o valor superior da IPA dos sub 19 em comparação com os sub 17 pode estar relacionado com uma maior capacidade de explorar o espaço de jogo e de maior eficiência na interação entre os companheiros da equipa e do adversário, devido a revelarem maior conhecimento do jogo (Folgado et al., 2014; Olthof et al., 2018). Desta forma, as manipulações do espaço de jogo devem ser ajustadas com a idade (Olthof et al., 2019). Os treinadores devem desenhar JRC similares aos ambientes competitivos, para surgirem possibilidades de ação de acordo com a competição (Chow et al., 2007). As possibilidades de ação (i.e. affordances) surgem à medida que os jogadores exploram o ambiente competitivo (Davids et al., 2013)e emergem com o aumento da realização de tarefas práticas representativas em ambientes de aprendizagem (Ramos, Davids, Coutinho, & Isabel, 2022). Assim, os valores da IPA devem ser representativos de acordo com a idade dos jogadores e os dados sugerem que os treinadores devem desenhar os JRC com valores superiores da IPA nos escalões mais jovens em comparação com os jogadores mais velhos, para emergir maior eficácia na tomada de decisão dos jogadores.

6.2.2. Zona do campo

Os dados do estudo revelaram valores semelhantes da IPA para todas as relações numéricas e idades, mas distintos entre si, em função da zona do campo em análise: os valores mais altos nas zonas próximas das balizas (Z1 e Z6), valores intermédios na zona 2 e zona 5 e valores mais pequenos na zona média do campo (Z3 e Z4).

Em estudos anteriores, com jogadores de elite, os resultados foram semelhantes aos apresentados para as três zonas do campo mencionadas (Caro et al., 2019; Fradua et al., 2013). Os valores mais elevados nas zonas próximas das balizas podem ser justificados pela regra do fora de jogo que tende a promover uma distância de maior comprimento entre os jogadores do setor defensivo que estão próximos da linha do meio-campo quando a bola surge em áreas mais avançadas do campo (Tenga et al., 2015).

No entanto, os objetivos nas zonas próximas das balizas são diferentes nas zonas 1 e 6. Na zona próxima da própria baliza as ações técnico-táticas dos jogadores são de maior segurança devido a existirem maiores distâncias espácio-temporais entre os jogadores. No entanto, na zona próxima da baliza do adversário, as ações técnico-táticas dos jogadores devem ser de maior risco para promover o desequilíbrio defensivo no adversário, para finalizar o ataque. Com a bola na zona média do campo, as áreas de jogo tendem a ficar mais pequenas devido às equipas, normalmente, colocarem os jogadores mais longe das balizas para ficarem mais compactas. A diminuição dos valores da IPA ocorre pela diminuição das distâncias entre os jogadores da própria equipa e do adversário (Castellano et al., 2017; Coutinho, Gonçalves, Travassos, Abade, et al., 2019). Estes

dados sugerem que os treinadores, na construção dos JRC, devem considerar a zona do campo e a idade dos jogadores, em função dos objetivos a alcançar e as manipulações realizadas. Tendo como ponto de partida a competição em cada um dos escalões, as manipulações das relações numéricas nos JRC devem ser representativas de cada uma das zonas do campo, de modo a realçar as informações funcionais que regulam os seus comportamentos individuais e coletivos e que podem ser projetados para a competição (Silva, Travassos, et al., 2014). A criação de contextos permite a exploração visual de acordo com as pistas informacionais da competição e tem por base as restrições espaciais e temporais da competição tendendo a mostrar mais probabilidade de sucesso na tomada de decisão e ação, em contextos competitivos de pressão adicional (Davids et al., 2013; Santos, Gonçalves, Coutinho, Vilas Boas, & Sampaio, 2022).

Assim, os JRC que devemos desenhar para estarem de acordo com as características da zona 1 devem incluir desigualdade numérica com a equipa que inicia a fase atacante em superioridade numérica com dois ou mais jogadores. No entanto, na zona 6 para emergir ações de risco como o drible, remate e o aumento da velocidade na circulação da bola, os JRC devem ser desenvolvidos em igualdade numérica envolvendo 2 a 10 jogadores com a inclusão de uma a três balizas por equipa. Outra hipótese no desenho dos jogos reduzidos para que aumentem a representatividade face ao contexto competitivo da zona 6 será as equipas em posse de bola poderem jogar em inferioridade numérica para potenciar nos jogadores o aumento do número das ações técnicas individuais ofensivas e a velocidade na circulação da bola de forma a superar o adversário (Sampaio et al., 2013). A utilização de balizas nestas zonas pode também ser útil, uma vez que estudos anteriores revelaram que estas aumentam a direccionalidade do jogo em função da sua colocação em diferentes espaços (Travassos, Gonçalves, et al., 2014; Vilar, Esteves, et al., 2014).

6.2.3. Efeito das relações numéricas na idade dos jogadores

Neste estudo, em todas as relações numéricas os valores da IPA variaram de acordo com a idade dos jogadores e revelaram maiores diferenças significativas entre os escalões etários, quando as relações numéricas foram iguais ou superiores a dez jogadores.

No entanto, a diferença de comportamentos táticos, face a diferentes idades dos jogadores, tende a promover diferentes estilos de jogo com os jogadores mais novos a explorar mais a profundidade do campo, utilizando um jogo mais direto para a baliza adversária, enquanto, os jogadores mais velhos tendem a evidenciar um jogo mais apoiado com mais posse de bola utilizando mais a largura do campo (Barnabé et al., 2016; Folgado et al., 2014). Esta diferença dos estilos de jogos nos escalões etários pode ser devida à maior capacidade dos jogadores mais velhos de interagir com o ambiente competitivo, emergindo mais eficiência nos comportamentos técnico-táticos de acordo com as várias fases do jogo. Desta forma, no desenho dos jogos reduzidos as áreas de jogo devem ser maiores nos escalões mais jovens e o aumento deve ser ainda mais significativo quando as relações numéricas incluem mais de dez jogadores.

6.3. Padrões de passe em jogadores de futebol de diferentes idades nas diferentes zonas do campo

Tendo como objetivo uma melhor compreensão de como os jogadores de futebol de diferentes idades exploram, não apenas o espaço de jogo, mas também os passes que sustentam a dinâmica de jogo, neste estudo procurámos caracterizar os padrões de passe no futebol de formação, nas diferentes zonas do campo. De acordo com o esperado, os resultados evidenciaram diferenças no tipo de passe em função da idade dos jogadores e do local do campo. Mais especificamente, o passe médio foi o mais utilizado nas zonas próximas das balizas e o passe curto foi o mais utilizado na zona média do campo nos sub 15, sub 17 e sub 19.

6.3.1. Efeito da localização da baliza no tamanho dos passes

O efeito da idade não revelou diferenças significativas na distribuição dos passes pelas zonas do campo. Em todos os escalões etários, sabendo que a baliza ofensiva e defensiva de cada equipa se constitui como um atractor na determinação do comportamento a explorar para finalização / evitar finalização, verificou-se que os jogadores que estão em posse de bola, nas zonas próximas das balizas, realizaram menos passes em comparação com as outras zonas do campo. Os dados sugerem a proximidade da própria baliza como um constrangimento que promove a tendência de utilizar passes médios e longos, para iniciar a construção das ações ofensivas em segurança e progredir no terreno de jogo em direção à baliza do adversário. De forma oposta, na zona próxima da baliza do adversário, os comportamentos individuais e coletivos da equipa em posse de bola têm como objetivo promover situações de finalização, através da variabilidade de passes, do drible e do remate (Headrick et al., 2012).

A diminuição espácio-temporal promove diferentes comportamentos individuais nos jogadores de acordo com a faixa etária (Olthof et al., 2015; Silva, Aguiar, et al., 2014; Silva, Duarte, et al., 2014). Os jogadores mais velhos revelaram maior capacidade de adaptação aos efeitos da manipulação das áreas de jogo (Canton et al., 2019; Olthof et al., 2019) conseguindo captar mais e melhor informação do meio envolvente devido ao maior conhecimento do jogo. Desta forma, revelaram maior variabilidade dos passes em espaços reduzidos, em comparação com os jogadores mais novos (Silva, Aguiar, et al., 2014).

Estes dados sugerem que para treinar o passe longo e médio, os JRC devem incluir áreas de jogo e relações numéricas grandes, para permitir possibilidades de ação representativas com as zonas próximas das balizas.

6.3.2. Distância Relativa dos Jogadores

Na análise da distância relativa entre o portador da bola e o recetor da bola verificou-se nos passes curtos que os jogadores que mais vezes receberam a bola foram os quatro jogadores mais próximos desta, embora, os dois jogadores mais perto do portador da bola fossem os mais solicitados nos três escalões etários. Nos passes médios e longos, os jogadores mais velhos revelaram capacidade de realizar os passes para companheiros com distâncias relativas maiores.

Esta capacidade de os jogadores mais velhos conseguirem passar a bola para jogadores mais distantes, pode ser justificada por terem maior experiência de jogo, permitindo percecionar e explorar mais possibilidade de ação (Araújo et al., 2006; Silva, Travassos, et al., 2014). Devido aos jogadores mais novos não conseguirem uma leitura do contexto tão rápida e precisa, necessitam mais espaço e tempo para detetarem e identificarem possibilidades para a ação. Para isso, sugerimos o aumento significativo da área de jogo nos JRC que permita aumentar a relação espácio-temporal entre os atacantes e os defesas e os companheiros da própria equipa (Nunes, Gonçalves, Davids, et al., 2020; Vilar, Duarte, et al., 2014). Com o aumento da distância entre o portador da bola e o oponente direto e com mais espaço a poder ser explorado pelos jogadores, tendem a emergir maiores distâncias entre os atacantes e os seus adversários diretos (Vilar et al., 2012). Este facto permite a exploração de mais possibilidades de ação, com mais eficácia, tornando os comportamentos individuais e coletivos dos jogadores mais ajustados funcionalmente ao contexto de jogo. Desta forma, o aumento da área de jogo e da relação numérica nos JRC promove maiores distâncias entre os companheiros da própria equipa, permitindo diferentes tipos de passes e o acréscimo da organização tática das equipas (Folgado et al., 2014; Olthof et al., 2019). Assim, o jogo mais organizado permite aos jogadores estarem mais regulares nas suas posições específicas, proporcionando maior variabilidade do jogo (Aguiar et al., 2015; Silva et al., 2015).

Desta forma, para aumentar a variabilidade na circulação de bola com os jogadores a poderem visualizar várias linhas de passe e com uma distância espácio-temporal significativa entre os jogadores para dificultar a interceção da bola dos defesas, sugerimos a inclusão no desenho dos JRC de mais de cinco jogadores e áreas de jogo grandes (Silva, Duarte, et al., 2014; Silva et al., 2015).

Capítulo 7 - Conclusões

Os resultados dos estudos realizados permitem, para além de uma melhor compreensão sobre o jogo, melhorar a manipulação dos JRC de acordo com as condições existentes nos contextos competitivos e, como tal, aumentar a representatividade dos mesmos tendo por base a idade dos jogadores, os objetivos associados a cada zona do campo, bem como as relações numéricas envolvidas.

Os dados indicam que, nos JRC em igualdade numérica, a área de jogo deve ser aumentada nos jogadores de idades mais baixas. De forma semelhante, jogadores mais jovens deverão jogar com números de jogadores mais baixos, face à complexidade do jogo face às suas capacidades. Deste modo, a área de jogo deve ser aumentada e o número de jogadores envolvidos menor nos jogadores mais novos em comparação com jogadores mais velhos devido a possuírem menores recursos para a ação e necessitarem de mais tempo para ajustarem as suas ações ao meio envolvente.

A tomada de decisão dos jogadores é influenciada pela distância da baliza e a zona da bola. Desta forma, nas zonas próximas da própria baliza as ações de segurança devem ser prioritárias. Para isso, estes devem incluir situações em desigualdade numérica de dois ou mais jogadores, tal como ocorre em jogo e possibilitando a existência de linhas de passe disponíveis. Na zona próxima da baliza do adversário, as ações são de maior risco e a construção dos JRC, para serem representativos na zona 6, devem ser em igualdade numérica podendo incluir quatro a doze jogadores e o acréscimo de balizas para emergir ações de remate. Na zona média do campo, com a densidade de jogo a ser a mais elevada, os IPA dos JRC devem ser pequenos e os jogadores devem jogar em igualdade numérica, para aumentar a velocidade da tomada de decisão (figura 12).

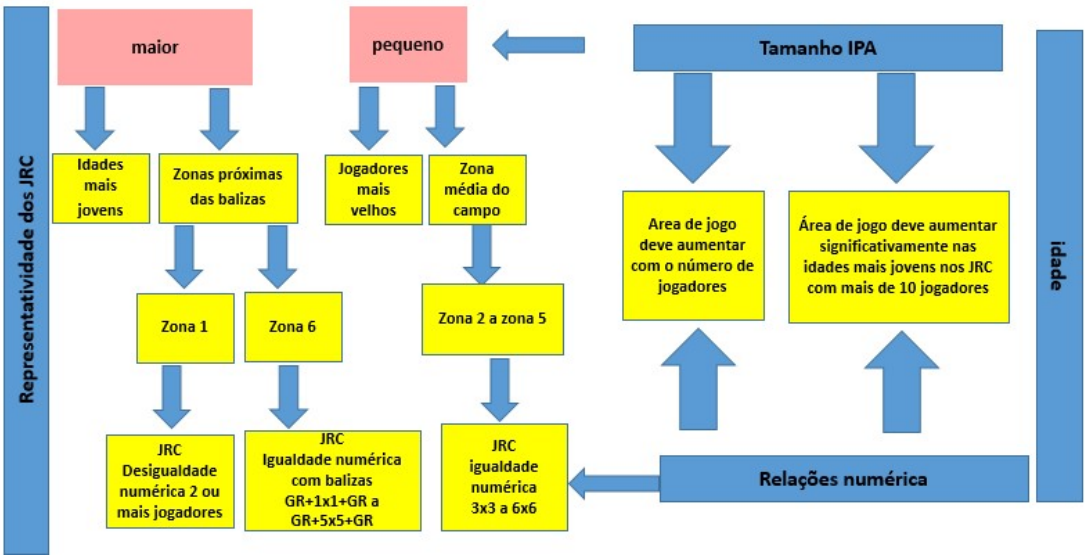


Figura 12. Aplicações práticas do estudo área individual por jogador de acordo com a idade, relações numéricas e as zonas no futebol

O terceiro estudo revelou que os padrões dos passes são influenciados pela zona da origem do portador da bola que realiza o passe e pela idade dos jogadores.

Em todas as idades foram mais utilizados os passes médios e longos, nas zonas próximas das balizas e os passes curtos, na zona média do campo. O desenho dos JRC, para emergir maior ou menor variabilidade dos passes, deve ter em consideração o efeito da manipulação do espaço de jogo e da relação numérica. Para potenciar os passes médios e longos, nos JRC as áreas de jogo devem ser grandes e incluir dez ou mais jogadores para garantir a variabilidade dos passes. A zona média do campo foi caracterizada pela maior variabilidade do jogo com os passes curtos a serem os mais utilizados, no entanto, a área de jogo por jogador foi mais pequena que nas outras zonas do campo. Para potenciar o passe curto nos JRC, as áreas de jogo devem ser pequenas e incluir até oito jogadores.

Outro dado interessante no estudo foi o efeito da manipulação da idade nas distâncias relativas entre o portador da bola e o recetor. Nos passes médios e longos, o portador da bola nos sub 17 e sub 19 utilizou jogadores mais distantes, para passar a bola em relação aos sub 15, enquanto, nos passes curtos foram os dois jogadores mais próximos da bola a receber a bola nos três escalões etários. Estes dados sugerem que para potenciar o passe médio e longo, a relação numérica nos JRC deve ser superior nos jogadores mais velhos, em comparação com os mais jovens. Isto deve-se a um maior conhecimento do jogo que permite recolher mais e melhores informações do meio envolvente (figura 13).

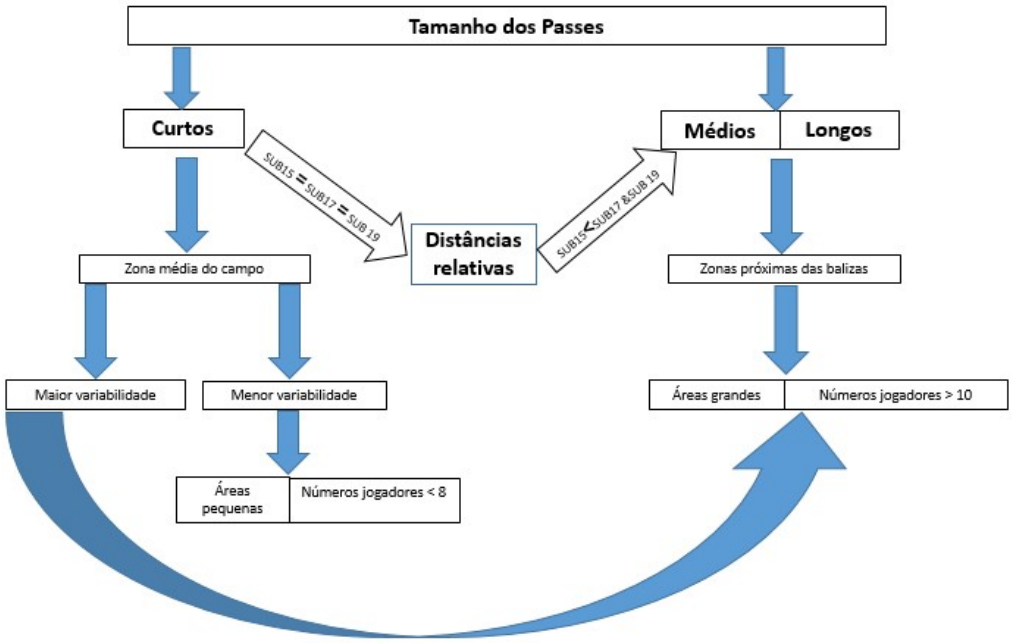


Figura 13. Aplicações práticas do estudo padrões de passe em jogadores de futebol de diferentes idades nas diferentes zonas do campo

Capítulo 8- Estudos futuros

A realização da presente tese possibilitou o aumento do conhecimento sobre o jogo no futebol jovem. Os resultados revelaram que os dados extrapolados do jogo formal devem servir de critério para a construção do desenho dos JRC, tendo como objetivo o desenvolvimento do comportamento tático individual e coletivo no futebol de formação.

Através da revisão sistemática foi possível identificar nos últimos anos muitos estudos sobre os JRC, no entanto, ainda existe a necessidade de aumentar a representatividade dos JRC nos escalões de formação. Desta forma, sugerimos estudos que contribuam para o conhecimento da ocupação espacial dos jogadores no futebol de formação potenciando o transfer do treino para a competição. Assim, futuras linhas de investigação podem ser desenvolvidas, tais como:

- Compreender o efeito do resultado do jogo na área individual, por jogador

- Avaliar o efeito dos diferentes sistemas de jogo com a área individual por jogador

- Perceber o efeito dos diferentes sistemas de jogo, nos padrões de passe em cada grupo etário

- Conhecer a medida da distância entre o portador da bola e o recetor, em cada grupo etário

- Avaliar a direccionalidade dos passes para ajudar a entender o estilo de jogo das equipas e relacionar com os tipos de passes nas diferentes fases ofensivas do jogo

- Medir a distância entre atacantes e defesas para compreender o tipo de passe com a proximidade dos defesas ao portador da bola e ao jogador que recebe a bola

- Relacionar a variação do espaço ocupado com o momento do jogo

- Estudar a priorização das áreas de jogo dos JRC, nas ações individuais ofensivas no jovem jogador

- Desenvolver um estudo longitudinal no ensino do jogo, baseado nos JRC, para avaliar o comportamento tático individual e coletivo

- Investigar os jogos reduzidos propostos na tese, para avaliar o comportamento tático coletivo

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