

Desenvolvimento, validação e aplicação da fórmula *Defensive Golden Index* para a análise de jogadores de Futebol em Fase Defensiva. Estudo da equipa sénior do *Futbol Club Barcelona*.

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Porto, 2020



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Palavras-chave: FUTEBOL; DEFESA; DEFENSIVE GOLDEN INDEX; *FUTBOL CLUB BARCELONA*; ANÁLISE DE JOGO

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Resumo

O objetivo deste estudo foi desenvolver, validar e aplicar uma nova fórmula chamada *Defensive Golden Index* (DGI) com os objetivos de i) identificar os jogadores mais valiosos (Defensive Golden Players (DGP) na fase defensiva; ii) investigar a influência da variável situacional (qualidade do adversário) no desempenho individual dos jogadores em fase defensiva; e iii) investigar a influência da variável situacional (local do Jogo) nas diferentes fases da competição. O primeiro artigo incluído na dissertação reflete os procedimentos metodológicos utilizados para validar a fórmula DGI. Para a sua construção selecionaram-se 12 variáveis referentes a ações tático-técnicas de jogadores em fase defensiva. Através de um questionário aplicado a 11 especialistas em futebol, obtiveram-se as respostas que permitiram construir e validar a fórmula. Aplicou-se a fórmula DGI a um total de 80 jogos da equipa sénior do *Futbol Club Barcelona* (FCB). Na liga espanhola 2018/19 analisaram-se 38 jogos; enquanto que na Liga dos Campeões UEFA 2015/16, 2016/17, 2017/18 e 2018/19 analisaram-se 42 jogos. Através da aplicação da DGI, objetivou-se identificar e classificar o desempenho defensivo dos jogadores do FCB em função das variáveis, qualidade do adversário, (artigo 1), local do jogo e fase da competição (artigo 2). Identificou-se que o jogador Gerard Piqué (defesa-central direito) foi considerado o DGP do FCB na liga espanhola 2018/19 em jogos contra adversários de nível médio e baixo. Por sua vez, Clement Lenglet (defesa-central esquerdo) foi o DGP contra adversários de nível alto. Independentemente do nível do adversário, os jogadores do corredor central apresentam melhores desempenhos defensivos (Gerard Piqué, Clement Lenglet e Sergio Busquets). Na Liga dos Campeões UEFA 2015/16, 2016/17, 2017/18 e 2018/19, nos jogos em casa, Gerard Piqué foi considerado o DGP no total de jogos e no *playoff*. Na fase de grupos, Javier Mascherano foi o DGP. Nos jogos fora de casa, no total de jogos e fase de grupos, Daniel Alves foi considerado o DGP, enquanto que no *playoff*, Arturo Vidal foi o DGP. Os jogadores mais valiosos (DGP), fora de casa, jogaram pelo corredor lateral. A DGI revela-se útil para identificar e classificar jogadores em fase defensiva, contribuindo assim para o melhor conhecimento da equipa e, contribuindo para um melhor planeamento do treino e da competição.

Palavras-chave: FUTEBOL; DEFESA; DEFENSIVE GOLDEN INDEX; *FUTBOL CLUB BARCELONA*; ANÁLISE DE JOGO

Abstract

The aim of this study was to develop, validate and apply a new formula called *Defensive Golden Index* (DGI). This work intended to i) identify the most valorous players (Defensive Golden Players (DGP)) in the defensive phase; ii) investigate the influence of the situational variable (quality of opponent) in individual performance of the players in defensive phase; and iii) to investigate the influence of match location in the different competition phases. The first article included reflects the methodological procedures used to validate the DGI formula. For its construction, 12 variables were selected regarding tactical-technical actions of players in defensive phase. Through a questionnaire applied to 11 experts, we obtained the answers that allowed to build and validate the formula. The DGI formula was applied to a total of 80 games of *Futbol Club Barcelona* (FCB) first team. In the Spanish league 2018/19, were analyzed 38 matches, and in UEFA Champions League 2015/16, 2016/17, 2017/18 and 2018/19 were analyzed 42 matches. During the DGI application, the objective was to identify and classify the defensive performance of FCB players according to the variables of the quality of opponents (article 1), match location and competition phase (article 2). It was found that Gerard Pique (right center back) was considered as DGP of FCB in Spanish League 2018/2019 season, in matches against medium and low-level opponents. In turn, Clement Lenglet (left center-back) was the DGP against high level opponents. Regardless of the level of the opponent, the players in the central path showed better defensive performances (Gerard Pique, Clement Lenglet and Sergio Busquets). In UEFA Champions League, 2015/16, 2016/17, 2017/18, 2018/19, in home matches, Gerard Piqué was considered the DGP in total matches and in the playoffs stage. In group stage, Javier Mascherano was the DGP. In away matches, in total matches and group stage, Daniel Alves was considered the DGP, while in playoffs Arturo Vidal was the DGP. The defensive golden players (DGP), in away matches, played mostly in the lateral paths. The DGI proves to be useful for identifying and classifying players in the defensive phase, thus contributing to a superior knowledge of the team and players also contributing to the superior planning of training and competition.

Keywords: SOCCER, DEFENSE, DEFENSIVE GOLDEN INDEX FORMULA, *FUTBOL CLUB BARCELONA*; MATCH ANALYSIS

Lista de Abreviaturas

Quadro 1. Lista de Abreviaturas

Abreviaturas	Nome
A	Anticipation
BR	Ball Recovery
CB	Center-back
CM	Center midfielder
DAFBF	Defensive action resulting in ball out of the field
DAFBPEH	Defensive action followed by body pass, except the head;
DAFHP	Defensive action followed by
DM	<i>Duel-mean</i>
DGI	Defensive Golden Index
DGP	Defensive Golden Player
FCB	Futbol Club Barcelona
FW	Forward
NFPDOGS	Number of conceived fouls that originated non-dangerous situations
NSB	Number of shots blocked
NYCR	Number of yellow cards received
OM	Offensive Midfielder
S1x1D	Successful 1x1 defensive
SI	Successful interceptions
SCP	Secondary position
SP	Specific position
SS	Second striker
T	Tackle
TP	Time played
TPvsT-A	Time played in away matches (Total)
TPvsT-H	Time played in home matches (Total)
TPvsPG-A	Time played in away (Group stage)
TPvsPG-H	Time played in home (Group stage)
TPvsPOFF-A	Time played in away (playoffs)
TPvsPOFF-H	Time played in home (playoffs)
WM	Wide midfielder

Capítulo 1

Introdução Geral

Introdução Geral

Conforme refere Castelo (1994, 1996) o futebol apresenta seis vertentes essenciais: o regulamento, que é o código que permite a igualdade de oportunidades; o espaço de jogo; as ações técnicas, que são comportamentos visíveis na resolução de problemas no jogo; a comunicação motora, que se refere a sinais e gestos que substituem a palavra para a execução de determinadas situações; o tempo; e a tática/estratégia, que nos remete para a representação simplificada das relações de cooperação e oposição dos jogadores.

Observação e Análise de jogo

A investigação na análise de jogo tem ajudado na performance desportiva (Kuhn, 2005), em grande parte porque permite retirar informação importante para entender as situações que ocorrem no jogo de Futebol (Barreira, Garganta & Anguera, 2013). No entanto, a observação tem-se focado essencialmente na análise das interações dos jogadores através da troca de passes (Lusher, Robins, & Kremer, 2010), complementando os métodos tradicionais utilizados na análise individual do futebol (Bartlett, Button, Robins, Dutt-Mazumder, & Kennedy, 2012).

O jogo de futebol pode ser visto de várias formas e perspetivas, em que os treinadores têm que saber fazer a leitura de jogo corretamente conseguindo ler o que está a acontecer e retirar conclusões para transmiti-las aos jogadores (Kormelink & Seeverens, 1999). Para isso, alguns autores sugerem diferentes formas de mapear o jogo. Por exemplo, Castelo (2019) organiza o processo ofensivo em quatro etapas: construção; preparação para a criação; criação; e finalização. Relativamente ao processo defensivo, o autor (2019) refere que o processo defensivo se inicia na etapa de equilíbrio defensivo, passando pela recuperação defensiva até à “defesa propriamente dita”. Segundo Bangsbo e Peitersen (2002), no processo defensivo podem encontrar-se as seguintes etapas: distrair/ganhar posse de bola; recuperar a posse de bola ou construção direta do jogo; e prevenir a finalização.

Os indicadores observados nos vários conceitos defensivos (observação e análise dos jogos de futebol) são aspetos decisivos a ter em conta na fase defensiva_(Bangsbo & Peitersen, 2002, 2002; Castelo, 1994, 1996; Kormelink & Severens, 1999). Estes autores remetem-nos para os seguintes conceitos:

1) Processo Defensivo: a colocação da bola e baliza, velocidade e ângulo de aproximação;

2) Métodos e organização defensiva: identificação e classificação do método mais utilizado, tipo de pressão (agressiva, contínua), velocidade de reação, tipo de transição, utilização da lei do fora de jogo, tipo de marcação (apertada, solta), adaptações do método defensivo, tipo de recuo das linhas, avanço no terreno de jogo, dispositivo tático, posição, zonas e funções dos jogadores, atitude após perda da bola, descrição das funções e posições nas bolas paradas;

3) Linhas setoriais (defensiva/ média/ atacante):

- Fase Defensiva: tipo de formação, tipo de marcação, desempenho da execução técnica e ligações com a última linha (presença de líbero ou trinco), os defesas tentam o desarme, qual é a cooperação entre guarda-redes e defesas, cooperação entre defesas e atacantes, cooperação das linhas, impedimento por parte dos atacantes da construção de jogo, zona de oposição, como é feita a ligação com a restante equipa;
- Transição Defensiva: velocidade da mudança de atitude, cooperação entre jogadores, zonas onde as ações ocorrem, execução técnica das ações;

4) Estilos de jogo: marcação a zona, marcação individual, técnica ou faltosa, mudanças de tempo, normal ou agressivo, marcação mista, zona pressionante lateral, zona pressionante central, pressing alto, pressing baixo, bloco baixo, bloco alto, utilização fora-de-jogo;

5) Desarme: frontal, lateral e queda;

6) Deslocamentos defensivos: coordenação de movimentos homogeneidade, ligações associativas, velocidade deslocamentos, proteção e impedimento da progressão da bola;

7) Desdobramentos: responsabilidade coletivas;

8) Ações de dobra – velocidade, ângulo, condução para espaços perigosos, velocidade de reação ao desequilíbrio;

9) Temporização - utilização da infração, sucesso da marcação do portador e dos restantes possíveis atacantes, ocupação de espaços;

10) Cortinas: tipo de interposição correta, tipo de deslocamentos para o centro de jogo, qualidade da formação correta da barreira.

Ações Defensivas Individuais em Futebol

No que diz respeito às ações defensivas individuais em Futebol, diferentes autores (e.g. Amieiro, 2005; Castelo, 1994, 1996; Garganta, 1997, 2006) aportam algumas definições:

1) Desarme: ação técnica e tática realizada pela defesa com o objetivo de intervir sobre a bola em luta direta com o oponente com bola;

2) Desarme Frontal: gesto técnico-tático de desarme, efetuado à frente ao adversário.

3) Desarme Lateral: gesto técnico-tático de desarme efetuado de lado do adversário.

4) Desarme com Deslizamento: Gesto técnico-tático de intervir sobre a bola em queda.

5) Marcação: ação técnico-tática de posicionar-se junto ao adversário (ainda sem bola) ou de forma a ocupar espaços livres, tendo em conta a relação com a bola e com os colegas, para ganhar ou evitar que o adversário controle a bola (Amieiro, 2005);

6) Interceção: ação técnica-tática que consiste no jogador apoderar-se da bola entre uma linha de passe do adversário.

7) Carga: ação exercida efetuada na luta direta por dois jogadores que procuram o contato físico.

Estas ações relacionam-se com o desempenho de jogadores e equipas, e podemos escolher as variáveis nas análises (Liu et al., 2013; Liu, Gomez, Lago-Peñas, & Sampaio, 2015a; Liu, Hopkins & Gomez, 2015b; Garganta, 1997), estas ações e eventos são defensivos e estes autores referem algumas definições como:

1) duelo aéreo com sucesso: uma ação técnica e tática com luta direta pela bola em uma trajetória aérea descontrolada, ganha ao adversário.

2) Desarme: situação de luta direta com um jogador adversário, que tenta manter a bola;

3) Intercepção: um jogador interceta um passe com algum movimento ou leitura da jogada;

4) Clearance: tentativa feita por um jogador de tirar a bola da zona de perigo, quando há pressão (dos adversários);

5) Remate bloqueado: um jogador bloqueia uma tentativa de golo na direção a baliza;

6) Falta cometida: qualquer infração cometida por um jogador que é penalizada como falta pelo árbitro

As informações fornecidas pela avaliação de desempenho são de extrema importância para as equipas técnicas. A análise influencia o processo de treino e a preparação da competição. A interpretação dos dados dará origem ao planeamento dos comportamentos tático-técnicos a serem executados no treino (Pedreño et al., 2018).

Os indicadores técnicos referem-se ao jogador de Futebol que executa as ações individuais em função da decisão e da ação do companheiro e do adversário, bem como fatores que também condicionam como o status da partida, a qualidade do adversário e o local da partida (Lago, 2010). Uma boa execução técnica depende sempre de uma boa decisão e isso depende do modelo de jogo que o treinador deseja para a equipa, portanto, as execuções técnicas são adaptadas ao contexto e são consideradas boas quando realizadas em condições ótimas de eficácia e eficiência (Oliveira, 2013). Assim, os indicadores técnicos podem ser ações de sucesso da fase defensiva (Barreira, 2013; Garganta, 1997, Fernandes, 2017) e ações de sucesso da fase ofensiva (Pereira, 2018; Hughes et al., 1998).

Os indicadores táticos fornecem informações sobre o jogo de futebol, são eles: posse de bola e sua influência no desempenho (Carmichael, Thomas & Ward, 2001; Gómez & Álvaro, 2002; Lago, Martin Acero, Seirul-lo & Alvaro, 2006; Castellano, 2006), posse de bola e sua relação com o local da partida, qualidade do adversário e status da partida (Lago, Seirul-lo, Casaís, Dominguez, & Martin

Acero, 2010), análise do jogo ofensivo (Hughes, Robertson, & Nicholson, 1998; Taipa et al., 2005; Castellano, Perea, & Hernández Mendo, 2008; Taipa, 2010; Molina, 2006; Lopez, Vegas, Martin, & Casimiro, 1998; Lago, 2010); análise de jogo defensivo (Barreira, 2013; Fernandes, 2017); relação entre os jogadores de uma mesma equipa e a circulação dos jogadores nas ações do jogo (Castellano, Hernandez Mendo & Haro, 2002; Grehaigine, Boutheir, & David, 1997); Análise de ações de jogo definidas (Sousa & Garganta, 2001; Boas Martinez, 2007; Açar et al., 2009; Reina, 2012); Análise de ações 1x1 e sua influência no resultado final (Gerisch & Reichett, 1993); Mapa de ações ofensivas e defensivas (Hughes et al., 1998).

Variáveis Situacionais

As variáveis localização do jogo (ou seja, jogar em casa ou fora), resultado momentâneo do jogo (ou seja, estando a equipa a ganhar, a perder ou a empatar) e a qualidade do adversário (forte ou fraco) são as variáveis que revelam maior influência no desempenho de equipas e jogadores de futebol (Carling et al., 2005; Taylor et al., 2008; Tucker, Mellalieu, James, & Taylor, 2005).

1.1. Problema

Relativamente à fase defensiva em Futebol, torna-se importante, que se tenha acesso a um conjunto de informações, no que diz respeito aos comportamentos defensivos individuais (Fernandes, 2017) que compõem a fórmula Defensive Golden Index, para determinar e identificar os jogadores mais valiosos. Para a análise de produtividade do jogador, de uma forma mais ampla, é importante recolher e processar dados relativos as variáveis defensivas (e.g. desarmes (Garganta, 1997), recuperações de bola, ação defensiva seguida de passe, interceções (Barreira, 2013).

Com a criação deste instrumento objetivo e válido para a análise do desempenho individual do jogador influenciado pelas variáveis situacionais (qualidade do adversário e local do jogo), conseguiremos recolher e processar dados relativos a performance individual do jogador, na fase defensiva.

1.2. Objetivos

Pretendeu-se, com este trabalho, desenvolver procedimentos com vista ao cumprimento dos seguintes objetivos:

- identificar e classificar o desempenho dos jogadores na fase defensiva do jogo de futebol.
- aplicar a fórmula Defensive Golden Index para identificar os *defensive golden players* de uma equipa de elite (*Futbol Club Barcelona* 2018/19), considerando o nível do adversário.
- aplicar a fórmula Defensive Golden Index para identificar os Defensive Golden Players de uma equipa de elite (*Futbol Club Barcelona* 2015/16, 2016/17, 2017/18, 2018/2019 na Liga dos Campeões), considerando o local do jogo.

1.3. Estrutura da Tese

A tese foi dividida em 6 capítulos:

Quadro 2. Capítulos da dissertação

1	Introdução, Problema, Objetivos e estrutura da tese
2	Estudo 1: The Defensive Golden Index: a novel method that classifies Football players' performance in the defending plays Estudo 2: Is <i>Futbol Club Barcelona</i> defensive performance influenced by match location and phase of the competition? Application of the Defensive Golden Index
3	Discussão Geral
4	Conclusões, Aplicações práticas, Limitações e futuros estudos
5	Referências

	Anexos
	I. Defensive Golden Index
6	II. Steps developed for the standardization of the Defensive Golden Index formula variables
	III. Questionnaire development for the validation and determination of the variables weight of Defensive Golden Index (in Portuguese)

Capítulo 2

Estudos

Estudos

No presente capítulo, os dois estudos serão inseridos na forma de artigos científicos.

No primeiro artigo, analisamos todos os procedimentos para desenvolver e validar a fórmula DGI, avaliamos a aplicação prática desta fórmula no *Futbol Club Barcelona* 2018/2019, identificamos e classificamos os DGP, procurando investigar a influência da variável situacional “qualidade dos adversários” (alta, média e baixa).

O segundo artigo apresenta a aplicação da fórmula DGI no *Futbol Club Barcelona* em 2015/16, 2016/17, 2017/18 e 2018/19 na Liga dos Campões, procurando investigar a influência “local do jogo” (casa vs fora de casa, analisando o desempenho individual).

Quadro 3. Estudos inseridos na Dissertação

Estudo 1	The Defensive Golden Index: a novel method to rank Football players' performance of <i>Futbol Club Barcelona</i> in the defending plays
Estudo 2	Is Futbol Club Barcelona defensive performance influenced by match location and phase of the competition? Application of the Defensive Golden Index

Estudo 1

Título	The Defensive Golden Index: a novel method to rank Football players' performance of Futbol Club Barcelona in the defending plays
Autores	Rui Ferreira; Sara Pereira; João Ribeiro; Júlio Garganta; Daniel Barreira
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The Defensive Golden Index: a novel method to rank Football players' performance of Futbol Club Barcelona in the defending plays

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Abstract

This study sought to create a formula called Defensive Golden Index (DGI) that allows assigning an index to each player according to its individual and collective defensive performance. This method allows identifying the best-ranked players in the defending play, designated as Defensive Golden Players. The study was organized in two main phases: 1) selection, definition, and validation, including weighting assignment, of a set of variables associated to players' defensive performance, through application of statistical techniques to standardize variables values that compose the DGI formula; and 2) applicability of the DGI formula to rank players' performance of *Fútbol Club Barcelona* (FCB) according to the opponents' level in 38 games of *La Liga* 2018-2019. A set of variables (e.g. tackles, anticipation, successful interception, successful 1x1 defensive) were included in a questionnaire and were (re)conceptualized based on previous literature and author's experience as coaches and match analysts. The survey was applied to 11 football experts to ascertain the importance of variables, to validate and to determine the weight of each variable. Each defensive variable was divided by the time played; then, the individual values were subtracted from the mean and divided by the standard deviation of the variable. The results of the DGI formula are obtained from multiplying the weights given by the experts for each of the standardized variables, followed by the sum of each variable. The DGI was estimated including 12 defensive variables. All statistical analysis were done in IBM SPSS v25. In general, the best-ranked FCB players — Defensive Golden Players — were Gerard Piqué, Clement Lenglet and Sergio Busquets. Moreover, considering the opponents' levels, the same players were best-ranked, however, with different order in the top-three positions. The DGI formula is a valuable method for capturing the individual and collective performance of players in the defending play in football.

Keywords:

Soccer, Defensive Index Formula, Golden Player, Opponent level, Fútbol Club Barcelona

Introduction

Association Football refer to a game played between two opposing teams. The players interact directly and concurrently to achieve an objective that involves team members facilitating the movement of a ball in accordance with a set of rules, in order to score points and to prevent the opposition from scoring (Jones, James & Mellalieu, 2004). The study of tactical behaviors during performance can provide relevant insights on the preparation and training of players and teams (Kostiukevich, Stasiuk, Shchepotina & Dyachenko, 2017). In this scope, match analysis is an important tool for accessing information about performance during football matches (Sarmiento, Marcelino, Anguera, Campaniço, Matos & Leitão, 2014).

As noted by Kormelink and Seeverens (1999) football match analysis encompasses two main processes, namely: (i) the analysis of the opponent and team's performance, comprising the examination of teams' organization (sub-phases of play with and without the ball); (ii) game transitions typically emerging through defensive, middle and attacking lines. Carling et al. (2005) highlighted that both defending and attacking behaviors of competing teams can be analyzed either separately or simultaneously. However, using a less graduated scale of analysis, the player is assumed as a fundamental cell of the game (Garganta, Guilherme Oliveira, Barreira, Brito, & Rebelo, 2013). Castelo (2004) argued that the most valuable player is that who most often intervenes in individual and collective game actions. Information collected through analysis not only from the most valuable players but also the least valuable players is extremely important and allow practitioners (coaches, match analyst, etc.) to: (i) identify the opponent's most valuable players and thus design a strategical game plan in order to condition their performance. (ii) Rank players' performance while ascertaining which type of technical-tactical actions they still need to improve (e.g., lack of positioning to intercept the ball; timing of tackle and interception, dribbling etc.). (iii) Designing training sessions to enhance players' performance (e.g., improving the timing of interception or tackle in the defending phase, or dribbling past the defenders).

On the other hand, knowing that match analysis provides important insights concerning the interactions between players' and teams' performance, Carling et al. (2005) draw attention to the benefits of emerging sophisticated technologies and equipment's that allow recording and processing key data regarding the profiling activity of each individual player of a team, in conformity to a specific team plan. Importantly, the article by Barreira, Garganta, and Anguera (2013) highlighted a clear paucity of literature concerning the study of the defensive phase of the game in contrast with the attacking phase, which is also evident in national and international levels (Mackenzie & Cushion, 2013; Sarmiento et al., 2014).

Furthermore, the majority of studies analyzing defensive performance in football have used simplistic notational analysis variables like the number of tackles or 1x1 defensive actions (Barreira, 2013), which only provide a partial picture of the defensive phase of the game, which does not consider the player's true impact on a given match and/or competition. Nonetheless, assessing defensive effectiveness (Boscá, J. E., Liern, V., Martínez, A., & Sala, R., 2009) in a football team can be made through examination of such performance-related variables. In this particular case, for example, when a player intercepts a pass from the opponent or even when commits a non-dangerous foul may allow the team to reorganize its defensive structure by adjusting positions on field. Alternatively, if a defender succeeds in a 1v1 situation against the attacker by tackling the ball next to his/her net may prevent the team from conceding a goal.

Several authors propose meaningful individual and collective variables that allow ascertaining the defensive phase of the game, and ultimately rank players according to their performance (for details see Amieiro, 2005; Barreira, 2013; Carling, 2005, 2008; Castelo, 1994, 1996; Fernandes, 2017; Garganta, 1997, 2006; Hughes, 2002, 2012). These variables are: number of yellow and red cards received, number of conceived fouls that originated dangerous or non-dangerous situations; number of defensive actions followed by head or body pass; defensive actions resulting in ball out of the field or ball loss to the opponent; tackles; successful interceptions; number of shots blocked; duels and aerial duels; successful or unsuccessful 1x1 defensive actions; anticipation and ball recovery. As stated by Eugster (2012) the combination of different variables may comprise a fine technique to assess individual performance of player's in respect to team collective performance.

Currently, the majority of available performance analysis software's (e.g. GoalPoint, Wyscout, OPTA) allow identifying and characterizing players' performance in both attacking and defending plays. Therefore, several indexes (e.g. game fatigue indexes, physical indexes, tactical performance indexes, technical indexes) have been proposed to rank players' performance according to predefined variables, assuming that these variables are the most relevant to analyze players in their full complexity (see, for example, the study of Fernandez-Crehuet, J. M., Rosales-Salas, J., & Navarro, P., 2019). Although the usefulness of these indexes, at the best of our knowledge, there is no scientific evidence about the validation of the applied formulas underlying such indexes, with the exception of the Golden Index formula, previously developed to analyze player's individual performance in the attacking phase of the football game (Pereira, Barreira, Ribeiro, & Grilo, 2018). Hence, it is crucial to develop and validate a novel formula capable of identifying and characterizing players' individual performance in defending plays. To do that, firstly we need to identify the most relevant variables in order to rank and to predict the performance of players in the defending plays. It is also relevant to probe if the formula allow characterizing players' performance considering the influence of some contextual variables, e.g. quality of opposition, match location or match status (Carling et al., 2005; Taylor et al., 2008; Tucker, Mellalieu, James, & Taylor, 2005), as such variables are considered important influencers of the performance of players and teams during competition.

Given the aforementioned, the aims of this study are twofold: i) to develop and validate a new formula called Defensive Golden Index (DGI), designed to identify and classify players' performance in the defensive phase of the football game; and ii) to apply the DGI formula to identify the Defensive Golden Players (the most valuable defending players) of an elite team (Futbol Club Barcelona 2018/19), considering the opponent's level.

Methods

An experimental approach to the problem

For this study, we collected 9527 defensive technical-tactical actions (high-level, n= 1648; medium-level, n=4470; low-level, n= 3409) from 38 matches categorized according to the opponent's level

(high level= 6; medium level=18 and low level=14) of Fútbol club Barcelona in season 2018-19 La Liga. The reliability of the questionnaire was performed based on the analysis of the experts' answers. For this purpose, Cronbach's alpha was used, with values ranging between 0 and 1, with 1 indicating high confidence, as a measure to determine the internal consistency of the questionnaire (Maroco & Garcia-Marques, 2006). All procedures were in accordance with the Declaration of Helsinki and had approval of the Ethics Committee of Faculty of Sport of University of Porto.

Data Collection

The soccer performance analyst with seven years of soccer experience as match analyst/football coach and with the highest level of the third National league coded the data of all matches. Through manipulation of a professional football platform called Wyscout, for each game of Fútbol Club Barcelona we analyzed all the defensive variables proposed for the DGI formula. The instrument comprised a MS Excel spreadsheet containing the defensive variables values for each player. Each defensive variable was divided by the time played; then, the individual values were subtracted from the mean and divided by the standard deviation of the variable (Pettitt, 2010). The results of the DGI formula are obtained from multiplying the weights given by the experts for each of the standardized variables, followed by the sum of each variable, except for three variables that presented negative weight.

Statistical Techniques and Applicability of the DGI formula.

Phase 1: Development and validation of the Defensive Golden Index formula

The DGI formula development encompass three stages (Figure 1), following previous works (Barreira, Garganta, Prudente, & Anguera, 2012; Pereira et al., 2018; Prudente et al., 2004).

Stage 1 comprises the selection and definition of the variables composing the DGI formula. Here, we also developed the validation questionnaire concerning the proposal of the formula content. Stage 2 consists of the validation of the variables and respective weighting assignment by football experts. Stage 3 includes statistical procedures concerning the variables validated by the survey application to experts.

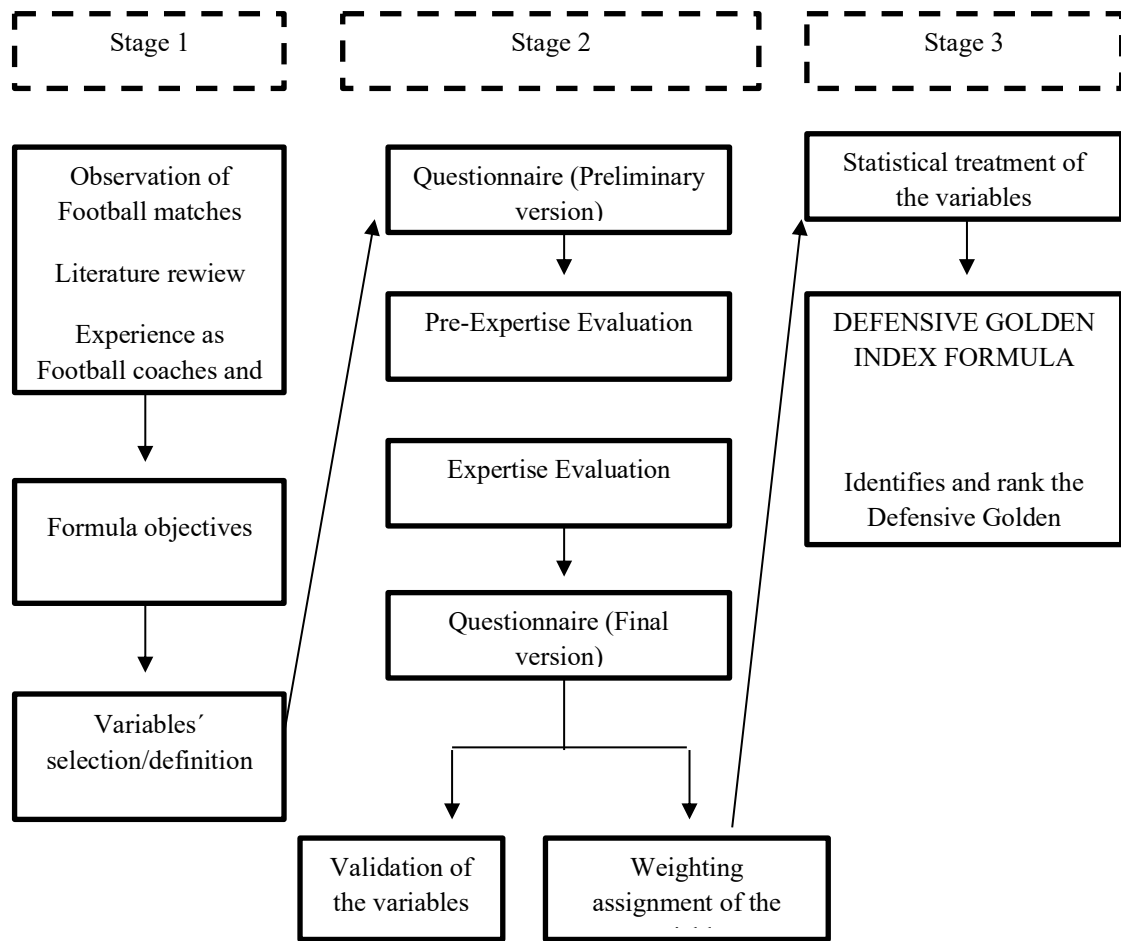


Figure 1. Steps taken in the development and validation of the DGI formula

Stage 1. Selection of the Defensive Golden Index formula content

The selection of DGI formula was based on previous studies (e.g. Garganta, 1997; Barreira, 2013; Fernandes, Camerino, Garganta, Pereira, & Barreira, 2019), and on our experience as match analysts, coaches and researchers in football.

In Table 1 are listed and defined the defensive variables proposed in the expertise evaluation stage.

Table 1. Description of the defensive variables proposed in the expert evaluation stage.

Variable	Description
Number of yellow cards received	Number of times the player receives a yellow card in the course of a football game (adapted from game laws of football)
Number of red cards received	Number of times the player receives a red card in the course of a football game (adapted from game laws of football)
Number of conceived fouls performed that originated dangerous situations	Number of times that a defending player commits a foul that directly causes a dangerous situation to the defending team, at the level of the ball arrival in the first defending third of the pitch, in the course of a football game (adapted from game laws of football)

Number of conceived fouls performed that originated non-dangerous situations	Number of times that a defending player commits a foul that directly cause a non-dangerous situation to the defending team, at the level of the ball arrival in the first defending third of the pitch, in the course of a football game (adapted from game laws of football)
Tackle	Direct duel situation with an opponent in the attacking phase, who tries to maintain the ball possession (Garganta, 1997)
Successful interception	Start through an: i) interception of a pass performed by the opponent; ii) interception of a pass performed by the opponent to the empty space; and iii) interception of a shot performed by the opponent (adapted from Barreira, 2013)
Number of Shots blocked	Number of times that a defending player blocks the opponent shot (adapted from Wyscout codification)
Duel	Dispute of the ball between the defending player and the opponent(s) (e.g., a ball in an aerial trajectory non-controlled by any of the players) (Barreira, 2013)
Aerial Duel	Action of direct fight for the ball in an uncontrolled aerial trajectory (adapted from Barreira, 2013)
Successful 1x1 defensive	The defending player isn't overtaken by the direct opponent, managing to regain the possession of the ball or gain position/space over the opponent, not allowing the opponent to continue the attack (adapted from Barreira, 2013)
Defensive action followed by a head pass	Starts with an action of a defending player (e.g., heading a ball in an aerial trajectory non-controlled by any of the players), which is immediately followed by a pass, without interruption of the game. It is considered a passing action, deliberately or not, to another player of the same (defending) team, without the beginning of ball possession (adapted from Barreira, 2013)
Defensive action followed by body pass, except the head	Starts with an action of a defending player (e.g., interception), which is immediately followed by a pass, without interruption of the game. It is considered a passing action, deliberately or not, to another player of the same (defending) team, without the beginning of ball possession (adapted from Barreira, 2013)
Defensive action resulting in the ball out of the field	Starts with an action of a defending player (e.g. interception, heading a ball in an aerial trajectory non-controlled by any of the players), which is immediately followed by a pass. It is considered a passing action, deliberately or not until the ball taking off to the field, without the beginning of ball possession (adapted from Barreira, 2013)
Defensive action resulting in ball loss to the opponent	Starts with an action of a defending player (e.g. interception, heading a ball in an aerial trajectory non-controlled by any of the players), which is immediately followed by a pass. It is considered a passing action, deliberately or not until the ball loss to the opponent, without the beginning of ball possession (adapted from Barreira, 2013)
Anticipation	Identification of emerging signals from the game situation by the defending player, acting accordingly, consequently having success in defensive behaviour (adapted from Afonso, J., Garganta, J., and Mesquita, I., 2012)
Ball Recovery	Number of times that a defending player intervenes recovering the possession of the ball (Barreira, 2013)

Stage 2. Validation of the Defensive Golden Index formula content

In this study the procedures of Barreira et al. (2012), Prudente et al. (2004) and Pereira et al. (2018) were followed for the validation of the selected variables and, consequently, the development and validation

of the DGI formula. Gil (2008) statements about questions to include in a survey were attended, so we asked a group of football experts, predefined according to inclusion criteria (please consult table 2), to collect their opinions about a specific subject. Each question of the survey contained a video demonstrating the variable and the respective explanation in the form of “help”.

The survey was constructed to be answered online and to not exceed 15 minutes until completion. The questionnaire was structured in three parts:

- i) Identification of the respondents;
- ii) Attribution of the importance of the variables to be included in the DGI formula;
- iii) Evaluation of the survey by the respondents.

a) Pre-Expertise evaluation

Two coaches with more than 10 years of experience and UEFA-A accreditation were selected to answer the preliminary questionnaire in order to detect possible errors in the survey construction, particularly in the definitions of the established concepts (Barreira et al., 2012), and to estimate the time needed to complete the survey. Both coaches contributed with suggestions for the completion of the questionnaire. The final version of the survey has been revised numerous times by the authors (Figure 1).

Successful interception: Start through an: i) interception of a pass performed by the opponent; ii) interception of a pass performed by the opponent to the empty space; and iii) interception of a shot performed by the opponent (adapted from Barreira, 2013)



<http://youtube.com/watch?v=tNqdnBqMIKk>

17. Choose only one

- ☐ 1 (nothing important)
- ☐ 2 (little important)
- ☐ 3 (Important)
- ☐ 4 (very important)
- ☐ 5 (extremely important)

Figure 2. Example of a question of the survey applied to football experts in the expertise evaluation stage.

b) *Expertise evaluation*

The board of experts was selected according to the following criteria (adapted from Barreira et al., 2012) (Table 2):

1. Level III (UEFA-A) accreditation or higher. Also, complying three of the following conditions:
 - i. Coach experience in the second division or higher;
 - ii. Master or higher academic degree with specialization in Football;
 - iii. Collaboration in Professional Football (10 years or more).
 - iv. Experience as player in the third division league or higher;
 - v. Experience as Professional Football (10 years or more).

Table 2. Characterization of the panel of Football experts

Coach	UEFA License	Academic degree	Experience as Coach	Experience in Football as professional (years)	Experience as Player (level)	Experience in Football as player (years)
1	UEFA PRO	Master	National Team	27	Amateur	4
2	UEFA PRO	Graduation	1 st League	7	1 st League	17
3	UEFA PRO	Master	National Team	12	Youth	0
4	UEFA PRO	Master	International Competitions	26	Amateur	3
5	UEFA PRO	Doctorate	1 st League	34	3 rd League	10
6	UEFA PRO	Doctorate	International Competitions	34	Amateur	4
7	UEFA PRO	Graduation	International Competitions	29	2 nd League	10
8	UEFA PRO	Doctorate	National Team	30	3 rd League	6
9	UEFA A	Graduation	National Team	15	Amateur	12
10	UEFA A	Doctorate	1 st League	11	Amateur	3
11	UEFA PRO	Master	2 nd League	35	Amateur	15

Eleven football experts were solicited to answer several questions using a 1 to 5 Likert scale (Dalmoro & Vieira, 2014), with 1 corresponding to “nothing important” and 5 to “extremely important” (Table 3). With this procedure, experts evaluated the importance of the variables in identifying the most valuable player in the defensive phase of the game and assigned the weight of the selected variables.

Table 3. Experts’ answers regarding the variables of the Defensive Golden Index formula

Variables	Likert Scale (1 to 5)					%
	1	2	3	4	5	
NYCR/tp	0	3 (27,3%)	6 (54,5%)	2 (18,2%)	0	72,7
NRCR/tp	1 (9,1%)	0	2 (18,2%)	4 (36,4%)	4 (36,4%)	91,9
NFPOGS/tp	0	1 (9,1%)	4 (36,4%)	6 (54,5%)	0	91,9

NFPDOGS/tp	0	3 (27,3%)	2 (18,2%)	5 (45,5%)	1 (9,1%)	72,7
Tackle/tp	0	0	1 (9,1%)	3 (27,3%)	7 (63,6%)	91,9
Successful interception/tp	0	0	0	3 (27,3%)	8 (72,7%)	100
NSB/tp	0	1 (9,1%)	3 (27,3%)	5 (45,5%)	2 (18,2%)	91,9
Duel/tp	0	0	1 (9,1%)	5 (45,5%)	5 (45,5%)	100
Aerial Duel/tp	0	0	0	5 (45,5%)	6 (54,5%)	100
Successful 1x1 defensive/tp	0	0	0	1 (9,1%)	10 (90,9%)	100
Failed 1x1 defensive/tp	2 (18,2%)	0	2 (18,2%)	3 (27,3%)	4 (36,4%)	81,9
DAFHP/tp	0	1 (9,1%)	2 (18,2%)	4 (36,4%)	4 (36,4%)	91,9
DAFBPEH/tp	0	0	2 (18,2%)	6 (54,5%)	3 (27,3%)	100
DAFBF/tp	0	2 (18,2%)	7 (63,6%)	2 (18,2%)	0	81,8
DAFLO/tp	1 (9,1%)	2 (18,2%)	2 (18,2%)	3 (27,3%)	3 (27,3%)	72,7
Anticipation/tp	0	0	0	3 (27,3%)	8 (72,7%)	100
Ball Recovery/tp	0	0	0	6 (54,5%)	5 (45,5%)	100

Legend: %: percentage of answers given by experts; NYCR: Number of yellow cards received; NRCR: Number of red cards received; NFPOGS: Number of conceived fouls that originated dangerous situations; NFPDOGS: Number of conceived fouls that originated non-dangerous situations; NSB: Number of shots blocked; DAFHP: Defensive action followed by a head pass; DAFBPEH: Defensive action followed by body pass, except the head; DAFBF: Defensive action resulting in ball out of the field. DAFLO: Defensive action resulting in ball loss to the opponent.

A cohort value of 75% (Barreira et al., 2012) was applied. With this, 9 of the 11 experts should consider their answers at least in level 3 of the Likert scale, thus considering the variable important to be included in DGI formula. The variables: “successful interceptions”, “duel”, “aerial duel”, “successful 1x1 defensive” and “defensive action followed by body pass, except head” obtained 100% of the answers given by the experts. The authors opted to maintain the variables “number of yellow cards” (72,7%) and “number of conceived fouls that originated non-dangerous situations” (72,7%) because of the proximity to the minimum value (75%), the importance stated in literature, and the strict relation to defending efficacy.

Experts suggested the addition of seven variables to the formula: 1) closing empty spaces; 2) defending coverage; 3) basculation; 4) recovering the position after losing the ball in forward zones; 5) constraining the opponent with a pressure movement or closing the passing lines; 6) sectorial alignment; and 7) performing coverage and balance actions, both associated to the second and third specific defensive principles of play (Sampaio & Maças, 2012). Nonetheless the importance of all these behaviours, in our perspective they are difficult to measure and to collect, hence their inclusion would make the formula very difficult to apply, for example during a whole season. Five (54%) of the eleven experts did not announce any variable.

Twelve defending variables were selected to include in the DGI formula (please consult table 2): i) number of yellow cards received; ii) number of conceived fouls that originated non-dangerous situations; iii) defensive actions followed by head pass; iv) defensive actions followed by body pass, except the head; v) defensive actions resulting in ball out of the field; vi) tackle; vii) successful interception; viii) number of

shots blocked; ix) *duel-mean* (duel + aerial duel); x) successful 1x1 defensive actions; xi) anticipation; and xii) ball recovery. The *duel-mean* variable corresponds to it is the sum of the duels with the aerial duels. Where the authors consider that it is very relevant and meaningful to join the two variables and creates only one variable. The creation of this variable (*duel-mean*) was established because it isn't relevant whether the duel is won in the air or on the ground, what matters is to know how many successful duels the player has against this opponent.

About the importance of the DGI formula, the experts answered very important (18,2%), important (45,5%) and with average importance (36,4%).

Furthermore, the experts considered the variable successful 1x1 defensive actions as the most important, followed by anticipation, successful interception and *duel-mean*. Between the fifth and ninth position four defensive variables were found: tackle, ball recovery, defensive actions followed by body pass, except head, defensive actions followed by head pass and number of shots blocked. In the tenth, eleventh and twelfth positions there are 2 variables related to game laws and a defensive variable: number of conceived fouls that originated non-dangerous situations, defensive actions resulting in ball out of the field and the number of yellow cards received, respectively.

The reliability of the questionnaire was performed based on the analysis of the experts' answers. For this purpose, Cronbach's alpha was used, with values ranging between 0 and 1, with 1 indicating high confidence, as a measure to determine the internal consistency of the questionnaire (Maroco & Garcia-Marques, 2006). Using the IBM SPSS v24 software, the consistency of the respondents (n=11) was verified, thus presenting a moderate value of 0.714.

Stage 3. Statistical of the formula variables

After the validation and weight assignment of the variables composing the DGI formula, the ratio of the variables and their standardization was established using proper statistical techniques.

i) *Ration of the variables*

Simple variables quantities (see table 4) divided by the time played per player.

Table 4. Weight of the variables in the Golden Index formula, organized by the mean.

Ranking	Variables	Weight
1	Successful 1x1 defensive	4.91
2	Anticipation	4.73
3	Successful interception	4.73
4	<i>Duel-mean</i>	4.55
5	Tackle	4.55
6	Ball Recovery	4.45
7	DAFBPEH	4.09
8	DAFHP	4.00
9	NSB	3.73

10	NFPDOGS	3.36
11	DAFBF	3.00
12	NYCR	2.91

Legend: NYCR: Number of yellow cards received; NFPDOGS: Number of conceived fouls that originated non-dangerous situations; NSB: Number of Shots blocked; DAFHP: Defensive action followed by a head pass; DAFBPEH: Defensive actions followed by body pass, except the head; DAFBF: Defensive action resulting in ball out of the field.

ii) *Standardization of the variables*

In descriptive statistics, the standardization or normalization of a variable is used as a commonly procedure (Reis, 1996; George, Jagannath, Joshi, & Jagadeesh, 2015).

Table 5. Steps developed for the standardization of the Defensive Golden Index formula variables (adapted from Pereira, Barreira, Ribeiro, & Grilo, 2018).

Steps	Name	Description	Formula
1	Mean of each variable on the team (x1)	Values of each individual player, after being added up, and divided by the number of players.	$X1 = \frac{\sum X}{n}$ $\sum X$: sum of the values of each player. N: number of players
2	Difference between the player's ration and the mean of the team in each variable (X2)	The player's individual value is measured by subtracting his ration value for the mean of the team in the variable (1), obtaining negative or positive values, being below or above the mean of the team in the variable.	$X2 = X0 - M$ Xo: player's ratio in the variable M: mean of the variable
3	Standard deviation of the values of all team players for each variable (S)	The determination of the standard deviation (S) of the variable allows verifying the measure of dispersion relative to the means. This can only assume non-negative values, and the greater is value, the greater is the dispersion of the sample.	$S = \sqrt{\frac{\sum (xi - x)^2}{n - 1}}$ Xi: value at position I in a data X: mean of the data n-1: amount of data minus 1
4	Standardization of each variable (Z)	The value of the player (2) is subtracted by the mean value of all players for each variable (1), divided by the standard deviation of all players for each variable (3)	$Z = \frac{x - \mu}{\sigma}$ x: value of the player (2) μ : mean of all players in the variable (3) σ : standard deviation of the players in the variable (4)

Defensive Golden Index Formula =

$$\begin{aligned}
 &= 4.91 * \left(\frac{\text{Successful 1x1 defensive}}{\text{Time played}} \right) + 4.73 * \left(\frac{\text{Anticipation}}{\text{Time played}} \right) + 4.73 * \left(\frac{\text{Successful interception}}{\text{Time played}} \right) + \\
 &4.55 * \left(\frac{\text{Duel-mean}}{\text{Time played}} \right) + 4.55 * \left(\frac{\text{Tackle}}{\text{Time played}} \right) + 4.45 * \left(\frac{\text{Ball recovery}}{\text{Time played}} \right) + 4.09 * \left(\frac{\text{DAFBPEH}}{\text{Time played}} \right) \\
 &+ 4.00 * \left(\frac{\text{DAFHP}}{\text{Time played}} \right) + 3.73 * \left(\frac{\text{NSB}}{\text{Time played}} \right) - 3.36 * \left(\frac{\text{NFPDOGS}}{\text{Time played}} \right) - 3.00 * \left(\frac{\text{DAFBF}}{\text{Time played}} \right) - \\
 &2.91 * \left(\frac{\text{NYCR}}{\text{Time played}} \right)
 \end{aligned}$$

Legend: DGI: defensive golden index; *duel-mean*: duel + aerial duels; DAFBPEH: defensive action followed by body pass, except head; DAFHP: defensive action followed by head pass; NSB: number of shots blocked; NFPDOGS: number of conceived that non-originated dangerous situations; DAFBF: Defensive action resulting in the ball out of the field; NYCR: Number of yellow cards received

Phase 2: Applicability of the Defensive Golden Index formula to rank Futbol Club Barcelona 2018/19 players' defensive performance in *La Liga*

Through the application of the DGI formula, the defensive performance of FCB players in *La Liga* 2018/19 was ranked, with the exception of the goalkeepers due to their specificity, restricted area of play and reduced participation in the defending play (adapted from Dutch et al., 2010). Over the 38 matches analyzed, FCB opposing teams were divided into three levels according to Liu, Gómez, Gonçalves and Sampaio (2015) and Schultze and Wellbrock (2018): a) high level (teams classified from 1st to 4th places); b) medium level (teams classified between 5th and 13th places); and c) low level (teams classified between 14th and 20th places) (table 6).

Table 6. Observed games of *Futbol Club Barcelona* 2018/19 in *La Liga* and the opponents' level

Match	Result	Opponent Level
Valencia Club de Fútbol— FCB	1-1	High
FCB – Real Madrid Club de Fútbol	5-1	High
Club Atlético de Madrid— FCB	1-1	High
FCB— Valencia Club de Fútbol	2-2	High
Real Madrid Club de Fútbol— FCB	0-1	High
FCB— Club Atlético de Madrid	2-0	High
FCB— Deportivo Alavés	3-0	Medium
Real Sociedad de Fútbol— FCB	1-2	Medium
Club Deportivo Leganés— FCB	2-1	Medium
FCB— Athletic Club de Bilbao	1-1	Medium
FCB – Sevilla Fútbol Club	4-2	Medium
FCB – Real Bétis Balompié	3-4	Medium
R C D Espanyol de Barcelona, S.A.D— FCB	0-4	Medium

Getafe Club de Fútbol— FCB	1-2	Medium
FCB – Sociedad Deportiva Eibar	3-0	Medium
FCB— Club Deportivo Leganés	3-0	Medium
Athletic Club de Bilbao— FCB	0-0	Medium
Sevilla Fútbol Club— FCB	2-4	Medium
Real Bétis Balompié— FCB	1-4	Medium
FCB— R C D Espanyol de Barcelona, S.A.D	2-0	Medium
FCB— Real Sociedad de Fútbol	2-1	Medium
Deportivo Alavés – FCB	0-2	Medium
FCB— Getafe Club de Fútbol	2-0	Medium
Sociedad Deportiva Eibar— FCB	2-2	Medium
Rayo Valladolid Club de Fútbol – FCB	0-1	Low
FCB— Sociedad Deportiva Huesca	8-2	Low
FCB – Girona Fútbol Club	2-2	Low
Rayo Vallecano de Madrid, S.A.D— FCB	2-3	Low
FCB – Villarreal Club de Fútbol	2-0	Low
Levante Unión Deportiva – FCB	0-5	Low
FCB – Real Club Celta de Vigo	2-0	Low
Girona Fútbol Club – FCB	0-2	Low
FCB— Rayo Valladolid Club de Fútbol	1-0	Low
FCB— Rayo Vallecano de Madrid, S.A.D	3-1	Low
Villarreal Club de Fútbol – FCB	4-4	Low
Sociedad Deportiva Huesca— FCB	0-0	Low
FCB— Levante Unión Deportiva	1-0	Low
Real Club Celta de Vigo – FCB	2-0	Low

Legend: CB: Futbol Club Barcelona; RCD: Real Club Deportivo

Results

The results of the DGI formula application to FCB are organized by ranking and have identified the players Gerard Piqué (GP) (DGI value: 63,009), Clement Lenglet (CL) (DGI value: 54,784) and Sergio Busquets (SB) (DGI value: 52,806) as the Defensive Golden Players of the team (Table 7). We will focus our analysis on the best-ranked three players.

Table 7. Futbol Club Barcelona 2018/19 players' ranking in La Liga matches' (season, high-level, medium-level and low-level opponents using the Defensive Golden Index formula

	PLAYER	DGI INDEX	NYCR	NFPDOGS	T	SI	NSB	DM	S1X1D	DAFHP	DAFBPEH	DAFBF	A	BR
S E A S O N	G Piqué	63,004	-0,260	-1,110	0,265	2,114	1,708	1,280	-0,158	2,728	1,259	1,461	1,668	3,671
	C Lenglet	54,784	1,338	-0,766	0,386	0,936	2,591	1,281	1,552	0,901	1,151	0,817	1,586	3,022
	S Busquets	52,806	1,064	0,011	1,902	0,877	0,373	1,202	1,314	1,132	1,563	-0,467	0,738	3,149
	A Vidal	32,007	0,665	3,037	2,676	0,382	-0,139	1,347	1,931	-0,152	0,947	-0,565	0,149	2,113
	S Umtiti	29,943	0,777	-0,287	0,109	0,512	1,048	0,216	-0,092	0,955	1,073	1,821	1,498	3,158
H I G H	C Lenglet	41,785	1,496	-0,578	0,401	1,427	3,380	0,753	1,419	0,378	0,360	-0,525	1,250	0,483
	G Piqué	34,892	-0,192	0,079	-0,203	2,129	1,057	1,237	-0,065	1,317	1,554	0,924	0,188	1,451
	S Busquets	25,121	0,604	-0,042	0,832	-0,021	-0,016	1,130	1,326	0,691	1,203	-0,525	-0,357	0,874
	A Vidal	24,080	-0,753	-0,365	1,586	0,066	-0,483	2,072	1,758	-1,138	-0,341	-0,525	0,253	0,013
	S Umtiti	20,546	2,562	-1,240	-0,803	-0,293	-0,483	0,265	0,273	2,213	1,339	2,333	2,879	1,614
M E D I U M	G Piqué	50,325	-0,287	-0,647	0,798	1,644	0,562	1,475	0,240	2,229	1,374	0,742	1,362	1,611
	C Lenglet	40,434	-0,015	-0,601	0,037	0,791	0,240	1,602	1,463	0,993	1,249	0,627	1,268	1,326
	S Busquets	38,004	0,116	-0,306	1,446	0,824	0,054	1,079	1,180	0,558	1,405	0,013	0,695	1,057
	A Vidal	29,561	0,474	1,232	2,708	0,671	-0,246	1,523	1,870	-0,178	0,768	-0,331	0,246	-0,044

	S Umtiti	28,274	0,457	0,167	1,060	0,702	0,237	0,635	0,010	1,038	1,327	0,401	0,557	1,616
L O W	G Piqué	51,401	0,394	-0,676	-0,144	2,454	1,357	1,203	-0,419	3,224	0,859	1,771	2,374	1,915
	C Lenglet	38,375	2,129	-0,405	0,335	0,888	2,869	1,471	1,452	0,456	0,611	0,803	1,433	0,961
	S Busquets	36,752	1,094	0,058	1,278	0,887	-0,025	1,627	1,149	1,270	1,551	-0,576	-0,354	1,280
	A Vidal	27,859	0,659	0,950	1,364	0,216	0,050	1,329	1,700	0,144	1,291	-0,576	0,182	0,610
	N Semedo	14,602	0,790	-0,048	-0,406	-0,337	0,531	0,749	1,554	0,018	0,812	-0,576	0,268	0,175

Legend: SEASON: *Futbol Club Barcelona* 2018/19 players' ranking in La Liga matches' using the Defensive Golden Index formula; HIGH: *Futbol Club Barcelona* 2018/19 players' ranking against high-level opponents, using the Defensive Golden Index formula; MEDIUM: *Futbol Club Barcelona* 2018/19 players' ranking against medium-level opponents, using the Defensive Golden Index formula; LOW: *Futbol Club Barcelona* 2018/19 players' ranking against low-level opponents, using the Defensive Golden Index formula; DGI: Defensive Golden Index; NYCR: Number of yellow cards received; NFPDOGS: Number of conceived fouls that originated non-dangerous situations; T: tackle; SI: successful interception; NSB: Number of Shots blocked; DM: *duel-mean*; S1x1D: successful 1x1 defensive; DAFHP: Defensive action followed by a head pass; DAFBPEH: Defensive action followed by body pass, except the head; DAFBF: Defensive action resulting in ball out of the field. DAFLO: Defensive action resulting in ball loss to the opponent; A: Anticipation, BR: Ball recovery

The results of the DGI formula application to FCB are organized by ranking and have identified the players Gerard Piqué (GP) (DGI value: 63,009), Clement Lenglet (CL) (DGI value: 54,784) and Sergio Busquets (SB) (DGI value: 52,806) as the Defensive Golden Players of the team (Table 7). We will focus our analysis on the best-ranked three players.

The DGI values indicated that GP (Center-Back) was the Defensive Golden Player of the team in the defending plays in *La Liga* 2018/19. GP obtained the best indexes concerning the NFPDOGS: -1.110, SI: 2.114, DAFHP: 2.728, A: 1.668 and BR: 3.671. Moreover, GP obtained high ratios on DM: 1.280, being also considered the second player of the team with high value in NSB: 1,708 and DAFBPEH: 1.259, per time played. In the second position appears CL (Center-Back), presenting the highest ratios of the team on the following variables SI: 0,936, DAFHP: 0,901, DAFBPEH: 1.151, A: 1.586, BR: 3.022, and NFPDOGS: -0.766. Moreover, CL obtained the highest index in NSB: 2.951, being the second player of the team with high values in DM: 1.281 and S1X1D: 1.314.

In the third position appears SB (Center Midfield) with the highest indexes of DAFBPEH: 1.563. Also, SB has the highest ratios of the team in DM: 1.202, S1x1D: 1.314 and A: 0.738. This player was considered the second player of the team in DAFHP: 1.132, T: 1.902 and BR: 3.149 variables.

High-Level opponent

The results of the DGI formula application to FCB while playing against high-level opponents indicated CL (DGI: 41,785), GP (DGI: 34,892) and SB (DGI: 25,121) as the Defensive Golden Players of the team. CL was considered the Defensive Golden Player since he obtained the highest values of the team in the NSB: 3.380 and DAFBF: -0.525. In addition, he scored high values in the NFPDOGS: -0.578, SI: 1.427, DM: 0.753, S1x1D: 1.419, and A: 1.250.

Ranked in the second position, GP presented the highest value of the team in the variable DAFBPEH: 1.554 and SI: 2.129. This player also obtained high values in the NSB: 1.057, DM: 1.237, DAFHP: 1.317 and BR: 1.451 variables.

SB was classified in the third place, achieving the highest indexes of FCB in the variable T: 0.832, DM: 1.130, S1x1D: 1.326, DAFHP: 0.691, DAFBPEH: 1.203 and DAFBF: -0.525.

Medium Level

The application of the DGI formula to FCB playing against medium-level opponents ranked GP (DGI: 50,325), CL (DGI: 40,434) and SB (DGI: 38,004) as the Defensive Golden Players of the team. Gerard Piqué obtained the highest indexes of the team in SI: 1.644, NSB: 0.563, DAFHP: 2.229 and A: 1.362. Furthermore, SB obtained a high index in DM: 1.475, DAFBPEH: 1.374 and BR: 1,611.

CL appears in the second position. This player obtained the highest index of the team in DM: 1.602, showing as well high values in the NFPDOGS: -0.601, SI: 0.791, DAFHP: 1.249, S1x1D: 1.463 and ball recovery (BR: 1,326).

SB was ranked in the third position, scoring the highest index in DAFBPEH: 1.405 and with high values in T: 1,446, S1x1D: 1.180 and DM: 1.079.

Low Level

The application of the DGI formula to FCB playing against medium-level opponents ranked GP (DGI: 51,401), CL (DGI: 38,375) and SB (DGI: 36,752) as the Defensive Golden Players of the team.

GP presented the highest values of the team in the following variables: NFPDOGS: -0.676, SI: 2.454, DAFHP: 3.224, A: 2.374 and BR: 1.915. This player also achieved high values in the NSB: 1.357 and DM: 1.203.

CL was ranked in the second position, displaying the highest values of the team in the NSB: 2.869, and scored high values in the NFPDOGS: -0.405, S1X1D: 1.452, DM: 1.471, DAFHP: 0.456 and A: 1.433.

In the third position appeared SB as one of the Defensive Golden Players exhibiting high values in the following variables: T: 1.278, DM: 1.627, S1X1D: 1.149, DAFHP: 1.270, DAFBPEH: 1.551 and BR: 1.280.

Discussion

The present study aimed to develop and validate a novel formula (DGI) to identify the individual contribution of each player (i.e., the defensive golden players) in the defending sub-phases of play. The DGI formula was applied to rank players' performance of FCB in *La Liga* 2018/19 according to the opponent's level.

The Defensive Golden Index formula contains variables with positive and negative connotations that will either determine a higher or lower defensive index of individual performance for each player. According to Santos (2019), when statistical results have positive and negative coefficients, they indicate a higher or lower propensity to increase or decrease, respectively, performance variables.

Gerard Pique (Centre-back), Clement Lenglet (Centre-back) and Sergio Busquets (Defensive Midfielder) (Season, Medium and Low levels) and Clement Lenglet, Gerard Pique and Sergio Busquets (High level), were classified as the defensive golden players of FCB in the defensive phase. In our study, we observed that the defensive golden players played, preferably, in the central corridor of the field, which means that they might had a prominent role in preventing the opponents from creating goal-scoring opportunities or even from scoring from that sector of the field.

On the other hand, Gerard Pique (in all levels) Clement Lenglet (season and Low-Level) and Sergio Busquets (Season, High Level and Medium level) obtained higher indexes in defensive action followed by head pass, defensive action followed by body pass, expect head, and defensive action resulting in ball out of the field. Such information is valuable and indicate that these players recover ball-possession to quickly initiating the offensive phase. Indeed, the players showing high values in the aforementioned variables have a prominent role in establishing passing networks with other teammates allowing an effective defense-attack transition (Drust, 1998). Clement Lenglet and Sergio Busquets (high, medium and low levels) scored high values in *duel-mean* and successful 1x1 defensive actions, meaning that they performed effective 1x1 duels against their direct opponents, thus increasing defensive efficacy.

Liu et al. (2015) observed that, in the group stage of the FIFA World Cup 2014, the teams that performed more tackles significantly increased their chances of winning. In our study, whenever the defensive golden players (in all levels) attained positive values in the variable tackles, the index of other variables were negative, which means that the more tackles the less yellow cards and fouls players will commit, then the more ball possession the team will have.

The variables ball recoveries, anticipation and interceptions, provide information on how players are able to anticipate the opponents' actions (Barreira et al., 2014), through picking-up relevant contextual information. If the index of the variables ball recovery, anticipation, and successful interceptions is high, then the index of the variable number of conceived fouls number of conceived fouls that originated non-dangerous situations will be higher too.

The information provided by the DGI formula is valuable and can be used by the game analyst as well as by the head coach in assigning players with specific defensive roles and strategies according to their competencies and abilities, allied with the tactical-strategical plan of the team (Santos & Lago-Penas, 2019).

Conclusions and Practical applications

The applicability of the Defensive Golden Index formula allowed ascertaining Gerard Pique, Clement Lenglet and Sergio Busquets as the defensive golden players of FCB in the defensive play in *La Liga* 2018/19. Therefore, we conclude that the DGI formula provides an adequate and novel method to identify and classify the individual performance of players in the defending phase. Furthermore, this formula can be applied to any context, competition and age. Nonetheless, the DGI formula only provides information regarding the individual performance of players in the defending plays. The formula allows setting the most and least valuable player of each team also considering the relation to collective performance.

Future research

For future research we suggest researchers to apply the DGI formula in: i) a greater sample, studying more players, matches and/or teams; ii) different professional and youth leagues and UEFA / FIFA tournaments; and iii) players with same positional status, in order to identify the Defensive Golden Players of a league and/or a tournament. Importantly, it would be important to create a formula to investigate the behaviour of each defensive sector (defensive, midfield and attacking) in the defensive phase.

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Conflict of interest

Rui Ferreira, Sara Pereira, João Ribeiro, Júlio Garganta and Daniel Barreira declare that they have no conflicts of interest relevant to the content of this article.

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Estudo 2

Título	Is <i>Futbol Club Barcelona</i> defensive performance influenced by match location and phase of the competition? Application of the Defensive Golden Index
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Title: Is Futbol Club Barcelona defensive performance influenced by match location and phase of the competition? Application of the Defensive Golden Index

Running Title: Effect of match location on Futbol Club Barcelona defensive performance

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ABSTRACT

This study aimed to analyse the effects of match location on Futbol Club Barcelona (FCB) players' defensive performance. This objective was inspired by the difference of results obtained by FCB over recent UEFA champions league (UCL) home and away matches. FCB 42 matches and 35 players in the defensive play were analysed in UCL seasons 2015/16, 2016/17, 2017/18 and 2018/19. Matches were classified in two groups: i) home; and ii) away, considering the matches played in all the competition stages. Defensive Golden Index (DGI) formula procedures were followed to identify and rank FCB players on their defensive performance. The top-3 best ranked FCB defensive players at home matches were Gerard Piqué (central defender, DGI: 48,602), Javier Mascherano (central defender, DGI: 39,600) and Sergio Busquets (defensive midfielder, DGI: 36,037), respectively. Javier Mascherano (central defender, DGI: 64,045), Sergio Busquets (defensive midfield, DGI: 41,363) and Gerard Pique (central defender, DGI: 40,173) were classified as the top-3 best players in the group stage, while in the playoffs were Gerard Pique (central defender, DGI: 82,507), Samuel Umtiti (central defender, DGI: 77,539) and Arturo Vidal (central midfield, DGI: 61,855). In away matches, Daniel Alves (right back, DGI: 46,165) was considered the Defensive Golden Player, while in the second and third places were ranked Javier Mascherano (central defender, DGI: 43,867) and Samuel Umtiti (central defender, DGI: 39,492), respectively. The 3 best defensive golden players in the group stage were Daniel Alves (full back, DGI: 54,778), Sergio Busquets (defensive midfield, DGI: 46,598) and Jordi Alba (full back, DGI: 42,208). In home matches, all Defensive Golden Players played in the central corridor of the field, whilst in away matches, the players performed, preferably, through the right corridor of the field. The FCB players' defensive performance at home and away matches allowed to observe that FCB defending plays varied considerably according to match location in UCL recent competitions. Future studies need to examine how performance of players may vary in match location according to groupal, sectorial, inter-sectorial, and collective scales of performance.

Keywords: Golden Index Formula, Defensive Golden Player, Match Location, UEFA Champions League, Competition Stage, Match location

Introduction

The selection and/or combination of variables that aim to evaluate individual and collective performance of players and teams is of major importance for match analysts and coaches (Hughes & Bartlett, 2002). Performance analysis should focus on indicators related to successful performance which typically include team structures (e.g. 1-4-2-3-1; 1-4-4-2; 1-4-4-3), odds of winning, defensive patterns of play, situational variables and defensive/offensive individual actions, (Hughes & Bartless, 2002; Lago & Martín, 2007; Lago, 2009; Lago-Ballesteros & Lago-Penas, 2010; Castellano et al., 2012; Bradley et al., 2013; Mackenzie & Cushion, 2013).

These indicators can be used to rank and predict players' performance according to their positional status and in different competitions (Pollard et al., 2004; Yiannakos & Aramats, 2004; Bloomfield et al., 2005; Armatas et al., 2007; Lago, 2007; Lago & Martín, 2007; Lago et al., 2010; Lago-Ballesteros & Lago-Penas, 2010; Lago-Penas & Dellal, 2010).

Research has shown that performance variables have often been measured as a result of effectiveness, rather than developing a deeper understanding of the game (Mackenzie & Cushion, 2013). The aim has been to describe a framework of analysing defensive and offensive behaviours related with the individual performance in a structured way to objectively assess defensive patterns of play (Hewitt et al., 2016). Wade (1998) argued that when teams exert defensive pressure immediately after losing the ball to their opponents, closing down passing lines and restricting spaces is an initial defensive principle that aim to delay the opposition's offensive play. Increasing player density in a particular zone of the field is a common strategy employed by teams to increase the effectiveness of defensive structures (Piltz & Launder, 2013).

For the DGI formula (Ferreira et al, submitted), the analysis of variables such as defensive 1x1 actions, tackles, interceptions, anticipations (Barreira, 2013; Garganta, 1997) allow ascertaining the real contribution of a player to the team at the level of the success attained in the defensive phase (Duch, J et al., 2008; MacHale & Relton, 2018; Schultze & Wellbrock, 2018). Having this in mind, some researchers have sought to create formulas (Duch, J et al., 2008; Ferreira et al, submitted; Taylor et al., 2008; MacHale & Relton, 2018; Schultze & Wellbrock, 2018), capable of measuring player's performance in both defensive and offensive sub-phases of play. Such formulas are known to provide useful information for understanding players' outcomes in different phases of the football game.

On the other hand, the playing position is considered a strong indicator that can influence players' performance (Carling et al., 2005; Kormelink & Seeverens, 1999). Also, the match location (Home vs. Away) comprise another major contextual variable that strongly impacts on player's and team's performance (Lago, 2009; Taylor et al., 2008; Taylor et al., 2010). Of fundamental importance is that these variables constrain defensive performance of players as they are typically linked to changes in team's defensive strategy (Bloomfield et al., 2005; Dennis & Carron, 1999; Tucker et al., 2005), therefore, they need to be considered when determining player's performance (Nevill & Holder, 1999). Several studies (Almeida CH, Ferreira AP, Volossovitch A, 2014; Bloomfield J., Polman R., O'Donoghue, 2005; Jankowski T, (2015); Tucker, Mellalieu, James & Taylor, 2005) refer that the best teams playing at home (Match

Location) employ more effective defensive methods. In addition, match location is associated with superior technical-tactical and strategic behavior when teams play at home (Lago-Peñas and Lago- Ballesteros, 2011).

Regarding playing positions or tactical roles, specific behavioral outcomes have been identified as measures of performance that characterize each positional statuses (Hughes and Bartlett, 2002) Moreover, previous research (Gonçalves, B. V., Figueira, B. E., Maças, V., & Sampaio, J., 2014; Taylor et al, 2004) stated that despite the specificity of individual defensive behaviors that distinguish performance of players according to different tactical positions (fullbacks, center backs, midfielders and forwards), there are some defensive variables common to all defensive positions (e.g. tackles, interceptions, anticipation, ball recoveries, 1x1 defensive actions).

Given the aforementioned, the aims of this study are twofold: (1) To apply the Defensive Golden Index (DGI) formula to identify and classify the Defensive Golden Players (e.g. the most valuable players in defending plays) of Futbol Club Barcelona (FCB) in UEFA Champions League in 2015-2016, 2016-2017, 2017-2018 and 2018-2019 seasons: (2) To analyse if player's individual performance is influenced by Match location.

Material and Methods

Sample

Forty-two FCB matches played in UEFA Champions League (UCL) seasons 2015/16, 2016/17, 2017/18 and 2018/19 were analysed. Matches were divided according to the competition stage (group, n= 24; and playoff= 18) and match location (home, n= 21; away, n=21, Table 1).

Table 1. Matches played by Futbol Club Barcelona (FCB) in UEFA Champions League, seasons 2015/16, 2016/17, 2017/18 and 2018/19.

SEASON	STAGE	MATCH	RESULT	
			HOME	AWAY
2015/16	Group	FCB – Bayer 04 Leverkusen Fußball GmbH	2-1	1-1
		FCB – FC BATE Borisov	3-0	0-2
		FCB – Associazione Sportiva Roma S.p.A	6-1	1-1
	1/8	FCB – Arsenal Football Club	3-1	0-2
	1/4	FCB – Club Atlético Madrid	2-1	2-0
2016/17	Group	FCB – Celtic Football Club	7-0	1-2
		FCB – Manchester City Football Club	4-0	3-1
		FCB - Borussia VfL 1900 Mönchengladbach	4-0	0-2
	1/8	FCB - Paris Saint Germain Football Club	6-1	4-0
	1/4	FCB – Juventus Foobtall Club	0-0	3-0
2017/18	Group	FCB – Juventus Football Club	3-0	0-1
		FCB - PAE Olympiacos Syndesmos Filathlon Piraeus	3-1	0-0
		FCB – Sporting Clube Portugal	2-0	0-1
	1/8	FCB – Chelsea Football Club	3-0	1-1
	1/4	FCB – Associazione Sportiva Roma S.p.A	4-1	3-0
2018/19	Group	FCB - Philips Sports Vereniging Eindhoven	4-0	2-4

	FCB – Football Club Internazionale Milano	2-0	1-1
	FCB – Tottenham Hotspur Football Club	1-1	1-2
1/8	FCB – Olympique Lyonnais	5-1	0-0
1/4	FCB – Manchester United Football Club	3-0	0-1
1/2	FCB – Liverpool Football Club	3-0	4-0

Participants

All variables (n= 12) included in the Defensive Golden Index formula (see equation 1) were observed for each player, with the exception of the Goalkeepers. The goalkeepers were excluded from the analysis due to their restricted positioning on the field and reduced participation in defensive plays (Duch, Waitzman, & Amaral, 2010).

Table 2. Time played in the different stages of Futbol Club Barcelona (FCB) players in UEFA Champions League in 2015-2016, 2016-2017, 2017-2018 and 2018-2019

PLAYER	SP	SCP	TP vs T-H	TP vs T-A	TP vs PG-H	TP vs PG-A	TP vs POFF-H	TP vs POFF-A
Daniel Alves	FB		472	251	281	94	191	157
Gerard Piqué	CB		1535	1495	672	734	863	761
Vermaelen	CB		373	-	373	-	-	-
Jordi Alba	FB		1178	1511	509	846	669	665
Ivan Rakitic	CM		1600	1675	818	957	782	718
Sergio Busquets	CM		1606	1764	816	1016	790	748
Sergio Roberto	FB	CM	1128	1262	580	625	548	637
Lionel Messi	W	SS	1578	1560	715	706	863	854
Luis Suarez	FW		1780	1608	920	754	860	854
Neymar Junior	W		854	833	468	455	386	378
Sergi Samper	CM		46	96	46	96	-	-
Marc Bartra	CB		61	190	61	190	-	-
Javier Mascherano	CB		732	725	424	441	308	284
Jeremy Mathieu	CB		138	234	138	96	-	138
Andrés Iniesta	WM		953	863	472	354	481	509
Sandro Ramirez	FW		140	120	140	120	-	-
Munir El Haddadi	W		31	166	31	166	-	-
Gerard Gumbau	CM		18	53	18	53	-	-

Rafinha Alcântara	CM	247	105	135	69	112	36
Wilfrid Kaptoum	CM	-	63	-	63	-	-
Juan Camara	CB	-	20	-	20	-	-
Arda Turan	CM	117	136	73	84	44	52
Samuel Umtiti	CB	927	753	546	377	381	376
Andre Gomes	CM	366	321	311	196	55	125
Paco Alcacer	FW	218	63	183	53	35	10
Lucas Digne	FB	363	216	363	216	-	-
Aleix Vidal	W	177	35	151	5	26	30
Denis Suarez	CM	192	94	183	94	9	-
Paulinho	CM	185	234	127	171	58	63
Nelson Semedo	FB	369	785	302	476	67	309
Ousmane Dembele	W	337	237	232	159	105	78
Philippe Coutinho	W	487	327	265	170	222	157
Clement Lenglet	CB	386	574	95	285	291	289
Arthur Melo	CM	330	250	174	162	156	88
Arturo Vidal	CM	151	236	16	116	135	120

Legend: SP: specific position; SCP: specific second position; TPvsT-H: time played in home matches (total); TPvsT-A: time played in away matches (total); TP vsPG-H: time played in home matches (group stage); TP vsPG-A: time played in away matches (group stage); TP vs POFF-H: time played in home matches (playoffs); TP vsPOFF-A: time played in away matches (playoffs); FB: fullback; CB: center-back; CM: center midfield; OM: offensive midfield; W: winger; FW: forward; SS: second striker;

Procedures

In order to treat and standardize each variable of the DGI formula (Ferreira et al, submitted) for each player over UCL seasons 2015-2016, 2016-2017, 2017-2018 and 2018-2019, all the applied procedures followed the logic of the formula (see equation 1).

Defensive Golden Index (DGI) Formula (1)

$$\begin{aligned}
 \text{DGI} = & 4.91 * \left(\frac{\text{Successful 1x1 defensive}}{\text{Time played}} \right) + 4.73 * \left(\frac{\text{Anticipation}}{\text{Time played}} \right) + 4.73 * \left(\frac{\text{Successful interception}}{\text{Time played}} \right) + \\
 & 4.55 * \left(\frac{\text{Duelmean}}{\text{Time played}} \right) + 4.55 * \left(\frac{\text{Tackle}}{\text{Time played}} \right) + 4.45 * \left(\frac{\text{Ball recovery}}{\text{Time played}} \right) + 4.09 * \left(\frac{\text{DAFBPEH}}{\text{Time played}} \right) + \\
 & 4.00 * \left(\frac{\text{DAFHP}}{\text{Time played}} \right) + 3.73 * \left(\frac{\text{NSB}}{\text{Time played}} \right) - 3.36 * \left(\frac{\text{NFPDOGS}}{\text{Time played}} \right) - 3.00 * \left(\frac{\text{DAFBF}}{\text{Time played}} \right) - \\
 & 2.91 * \left(\frac{\text{NYCR}}{\text{Time played}} \right)
 \end{aligned}$$

Legend: DGI: defensive golden index; duel-mean: duel + aerial duels; DAFBPEH: defensive action followed by body pass, except head; DAFHP: defensive action followed by head pass; NSB: number of shots blocked; NFPDOGS: number of conceived fouls performed that non-originate dangerous situations; DAFBF: Defensive action resulting in the ball out of the field; NYCR: Number of yellow cards received

1) Ratio of the variables

The method of analysis consisted in observing the quantity of each variable then divided by the time played per player, namely: number of yellow card(s) received, number of conceived fouls that non-originated dangerous situations; defensive action followed by head pass; defensive action followed by body pass, except the head; defensive action resulting in the ball out of the field; tackle; successful interceptions; number of shot blocked; *duel-mean*; successful 1x1 defensive; anticipation, and ball recovery. The number of conceived fouls that originated non-dangerous situations, defensive action resulting in the ball out of the field and number of yellow cards has negative coefficient, so the index has to be negative.

2) Standardization of the variables:

The following steps were performed for each player in each of the twelve defensive variables, for both match location and competition stages (group and playoff). A spreadsheet file in Excel was used for statistical treatment.

Table 3. Steps developed for the standardization of the Defensive Golden Index formula variables (adapted from Pereira, Barreira, Ribeiro, & Grilo, 2018)

Steps	Name	Description	Formula
1	Mean of each variable on the team (x1)	Values of each individual player, after being added up, and divided by the number of players.	$X1 = \frac{\sum X}{n}$ $\sum X$: sum of the values of each player. n: number of players
2	Difference between the player's ration and the mean of the team in each variable (X2)	The player's individual value is measured by subtracting his ration value for the mean of the team in the variable (1), obtaining negative or positive values, being below or above the mean of the team in the variable.	$X2 = X0 - M$ Xo: player's ratio in the variable M: mean of the variable
3	Standard deviation of the values of all team players for each variable (S)	The determination of the standard deviation (S) of the variable allows verifying the measure of dispersion relative to the means. This can only assume non-negative values, and the greater is value, the greater is the	$S = \sqrt{\frac{\sum (xi - x)^2}{n - 1}}$ Xi: value at position i in a data X: mean of the data n-1: amount of data minus 1

		dispersion of the sample.	
4	Standardization of each variable (Z)	The value of the player (2) is subtracted by the mean value of all players for each variable (1), divided by the standard deviation of all players for each variable (3)	$Z = \frac{x - \mu}{\sigma}$ x: value of the player (2) μ: mean of all players in the variable (3) σ: standard deviation of the players in the variable (4)

Results

This study applied the DGI formula to FCB in UEFA Champions League seasons 2015-2016, 2016-2017, 2017-2018 and 2018-2019, when playing home and away. Considering the match location, we searched for differences on players' defensive performances regarding the different stages of the competition (group stage and playoff).

Table 4. Futbol Club Barcelona players' defensive ranking in UEFA Champions League 2015-2016, 2016-2017, 2017-2018 and 2018-2019 in home matches and in different stages of the competition, using the Defensive Golden Index formula

	CS	PLAYER	DGI INDEX	NYCR	NFPDOGS	DAFHP	DAFBPEH	DAFBF	T	SI	NSB	DM	S1X1D	A	BR
H O M E	T O T A L	Gerard Pique	48,602	0,071	-0,280	1,951	1,318	0,087	1,640	0,982	1,697	0,131	-0,200	3,079	0,495
		Javier Mascherano	39,600	0,077	-0,116	0,125	0,684	0,287	1,375	0,552	2,135	0,360	0,345	2,659	0,925
		Sergio Busquets	36,037	0,032	0,055	0,549	1,693	0,064	3,134	-0,097	0,162	0,524	0,159	1,904	0,052
		Clement Lenglet	35,840	0,204	0,282	1,507	2,357	1,251	0	1,293	2,699	0,395	0,835	0,720	0,049
		Samuel Umtiti	33,739	0,047	-0,034	1,601	0,852	0	0	0,877	1,405	0	-0,041	2,699	0,466
	G R O U P	Javier Mascherano	64,045	0,311	-0,239	0,108	1,198	0,924	1,813	1,044	3,042	1,738	1,255	2,999	1,945
		Sergio Busquets	41,363	0,001	0,552	0,936	1,951	0,309	3,002	0,119	0,527	0,964	0,415	1,558	0,432
		Gerard Pique	40,173	0,887	-0,643	1,804	1,593	0,452	0,356	0,925	1,919	0,073	-0,367	2,523	1,057
		Vermaelen	36,083	-0,334	1,186	0,984	1,304	4,492	0,894	0,954	3,457	0,596	0,389	1,704	2,056
		Samuel Umtiti	31,348	0,668	-0,141	1,847	1,450	0,638	-0,316	0,492	1,575	0	-0,321	2,717	0,790
	P L A Y O F F	Gerard Pique	82,507	0,550	0,196	2,665	2,560	0,344	1,151	2,458	2,339	1,991	1,184	2,330	3,017
		Samuel Umtiti	77,539	0	0,556	2,415	1,881	0	0	2,920	2,271	2,314	1,931	1,173	3,313
		Arturo Vidal	61,855	0	1,883	2,556	2,212	0	0	2,300	0	2,679	3,936	0	1,558
		Sergio Busquets	61,396	1,203	0,429	1,019	3,099	0,376	1,257	1,146	0	2,404	2,173	1,414	2,530
		Jordi Alba	59,733	0,710	0,317	0,859	1,071	0,888	0,186	3,403	2,586	1,554	1,772	0,668	2,870

Legend: CS: competition stage; DGI: Defensive Golden Index; NYCR: Number of yellow cards received; NFPDOGS: Number of conceived fouls performed that originate non-dangerous situations; T: tackle; SI: successful interception; NSB: Number of Shots blocked; DM: duel-mean; S1x1D: successful 1x1 defensive; DAFHP: Defensive action followed by a head pass; DAFBPEH: Defensive action followed by body pass, except the head; DAFBF: Defensive action resulting in ball out of the field; A: Anticipation, BR: Ball recovery

Table 5. Futbol Club Barcelona players' defensive ranking in UEFA Champions League 2015-2016, 2016-2017, 2017-2018 and 2018-2019 in away matches and in different stages of the competition, using Defensive Golden Index formula

	CS	PLAYER	DGI INDEX	NYCR	NFPDOGS	DAFHP	DAFBPEH	DAFBF	T	SI	NSB	DM	S1X1D	A	BR
A W A Y	T O T A L	Daniel Alves	46,165	0,217	0,827	0,146	0,703	0,602	4,646	1,153	2,150	0,779	0,277	0,860	0,833
		Javier Mascherano	43,867	-0,150	-0,499	0,556	0,424	1,902	2,541	0,311	1,062	0,123	0,731	2,838	1,917
		Samuel Umtiti	39,492	-0,157	0,081	1,448	0,932	-0,001	0,870	1,248	1,019	-0,157	-0,136	2,351	1,430
		Gerard Pique	39,338	0,127	-0,588	0,691	0,891	1,117	1,194	2,758	0,647	0,271	-0,020	1,243	1,584
		Jordi Alba	34,338	-0,158	-0,443	1,146	1,383	0,097	0,397	1,287	0,827	0,051	0,425	1,413	0,589
	G R O U P	Daniel Alves	54,778	1,455	0,335	2,097	0,705	1,349	3,942	0,052	0	2,077	0,521	3,305	1,435
		Sergio Busquets	46,598	0,269	-0,093	0,831	1,232	0,427	2,188	1,060	0,963	0,817	0,672	1,437	1,663
		Jordi Alba	42,208	0,323	-0,205	1,043	2,094	0,205	0,438	1,281	0,289	0,458	0,704	2,533	0,863
		Clement Lenglet	41,068	0	0,723	-0,124	1,864	3,028	1,300	1,675	3,435	0,979	1,585	-0,171	1,672
		Nelson Semedo	40,303	0	-0,400	2,623	2,093	-0,367	0,778	0,339	0	0,616	0,983	1,202	0,060
	P L A Y O F F	Arturo Vidal	65,009	0,746	2,466	2,263	3,390	2,944	1,160	1,988	1,792	2,996	2,262	3,261	0
		Javier Mascherano	57,532	-0,156	-0,166	0,578	0,716	1,244	1,471	0,000	3,785	2,142	1,912	1,654	1,569
		Gerard Pique	55,146	-0,014	-0,476	0,266	0,401	0,928	1,463	1,254	1,413	3,597	1,070	2,057	0,976
		André Gomes	48,342	0,710	2,332	-0,094	3,255	0,565	2,784	0	0	1,327	2,172	2,505	1,188
		Jordi Alba	46,075	-0,156	-0,570	1,241	0,306	1,913	1,675	0,478	0,647	2,412	1,633	2,060	0,447

Legend: CS: competition stage; DGI: Defensive golden index; NYCR: Number of yellow cards received; NFPDOGS: Number of conceived fouls performed that originate non-dangerous situations; T: tackle; SI: successful interception; NSB: Number of Shots blocked; DM: duel-mean; S1x1D: successful 1x1 defensive; DAFHP: Defensive action followed by a head pass; DAFBPEH: Defensive action followed by body pass, except the head; DAFBF: Defensive action resulting in ball out of the field; A: Anticipation, BR: Ball recovery

Home Matches

Results found in FCB home matches classified Gerard Piqué (DGI: 48,602) as the Defensive Golden Player, followed by Javier Mascherano (DGI: 39,600) and Sergio Busquets (DGI: 36,037) in the second and third positions, respectively. In Group stage of the UCL competition, Javier Mascherano (DGI: 64,045) was considered the Defensive Golden Player, followed by Sergio Busquets (DGI: 41,363) and Gerard Pique (DGI: 40,173). Finally, in playoffs (1/8 finals, ¼ finals and semi-finals), Gerard Piqué (DGI: 82,507) was the Defensive Golden Player, followed by Samuel Umtiti (DGI: 77,539) and Arturo Vidal (DGI: 61,855).

Total

Concerning to the variables of the DGI formula, in all matches of UCL Gerard Piqué (1st place) presented the highest values of the team in the following variables: defensive action followed by head pass (DAFHP=1,951), tackle (T=1,640), number of shots blocked (NSB= 1,697) and anticipation (A=3,079). Javier Mascherano, in all matches, showed a defensive performance that ranked him as the second best Defensive Golden Player, displaying the highest values of the team in the following variables: tackle (T=1,375), number of shots blocked (NSB= 2,135) and anticipation (A= 2,659). In the third position appear Sergio Busquets (3rd place) as one of the Defensive Golden Players exhibiting high values in the following variables: defensive action followed by body pass, except head (DAFBPEH= 1,693), tackle (T= 3,134) and anticipation (A= 1,904).

Group stage

Javier Mascherano (1st place) obtained higher values in the variables: number of conceived fouls that non-originated dangerous situations (NFPDOGS= -0,239), tackle (T= 1,813), number of shots blocked (NSB= 3,042), *duel-mean* (DM= 1,738), anticipation (A= 2,999) and ball recovery (BR= 1,945). Sergio Busquets was ranked in the second place with high values in defensive action followed by body pass, except head (DAFBPEH= 1,951), tackle (T= 3,002) and anticipation (A= 1,558). Gerard Pique (3rd place), showed high values in the number of conceived fouls that non-originated dangerous situations (NFPDOGS= -0,643), defensive action followed by head pass (DAFHP= 1,804), number of shots blocked (NSB= 1,919) and anticipation (A= 2,523).

Playoff

Piqué was considered the best defensive player with best scores in the following variables: defensive action followed by head pass (DAFHP= 2,665) and by body pass, except head (DAFBPEH= 2,560), successful interceptions (SI= 2,458), number of shots blocked (NSB= 2,339), anticipation (A= 2,330) and ball recovery (BR= 3,017). Samuel Umtiti (2nd place) presented high values in defensive action followed by head pass (DAFHP= 2,415) and by body pass, except head (DAFBPEH= 1,881), successful interceptions (SI= 2,458), number of shots blocked (NSB= 2,271), *duel-mean* (DM= 2,134) and ball recovery (BR= 3,313). Arturo Vidal (3rd place) exhibited high values in defensive action followed by head

pass (DAFHP= 2,556) and by body pass, except head (DAFBPEH= 2,212), successful interceptions (SI= 2,300), *duel-mean* (DM= 2,679) and successful 1x1 defensive (S1x1D= 3,936).

Away Matches

The DGI formula application to FCB playing in Away Matches (Total, Group and Playoff), highlighted Daniel Alves (DGI= 46,165) as the Defensive Golden Player, followed by Javier Mascherano (DGI= 43,867) and Samuel Umtiti (DGI= 39,492) in the second and third positions, respectively. In the Group stage, Daniel Alves (DGI= 54,778) was the Defensive Golden Player, followed by Sergio Busquets (DGI= 46,598) and Jordi Alba (DGI= 42,208). Finally, in the playoffs, Arturo Vidal (DGI= 65,009) was the Defensive Golden Player, followed by Javier Mascherano (DGI= 57,532) and Gerard Pique (DGI= 55,146).

Total

Daniel Alves was the Defensive Golden Player achieving the highest values of the team in tackles (T= 4,646), number of shots blocked (NSB= 2,150) and successful interceptions (SI= 1,153). In the second place appear Javier Mascherano with high values in the variables: tackle (T= 2,541), anticipation (A= 2,838) and ball recovery (BR= 1,917). Samuel Umtiti (3rd place) obtained high values in defensive action followed by head pass (DAFHP= 1,448), anticipation (A= 2,351) and ball recovery (BR= 1,430).

Group stage

Daniel Alves (1st place) presented high values in defensive action followed by head pass (DAFHP= 2,097), tackle (T= 3,942), *duel-mean* (DM= 2,077) and anticipation (A= 3,305). Sergio Busquets (2nd place) obtained higher values in tackles (T= 2,188) and ball recovery (BR= 1,668). Finally, Jordi Alba (3rd place) presented higher values in defensive action followed by body pass, except head (DAFBPEH= 2,094) and anticipation (A= 2,553).

Playoff

Arturo Vidal was considered the Defensive Golden Player with high values in defensive action followed by head pass (DAFHP= 2,263) and body pass, except head (DAFBPEH= 3,390). Javier Mascherano (2nd place) presented high values in tackles (T= 1,224), number of shots blocked (NSB= 3,785), *duel-mean* (DM= 2,142) and successful 1x1 defensive actions (S1x1D= 1,912). Finally, Gerard Pique (3rd place), showed high values in *duel-mean* (DM= 3,597) and anticipation (A= 2,057).

Discussion

This study aimed to apply the Defensive Golden Index (DGI) formula to identify and classify the Defensive Golden Players of FCB in UEFA Champions League in 2015-2016, 2016-2017, 2017-2018 and 2018-2019 seasons. Moreover, we sought to analyse if player's individual performance is influenced by match location.

Regarding the matches played by FCB at Home in UEFA Champions League 2015-2016, 2016-2017, 2017-2018 and 2018-2019 seasons, according to the competition stage, we observed that the top-ranked 3 players (Home: Season: GP, JM and SB; Group stage: JM, SB and GP; Playoffs: GP, SU and AV) scored higher indexes in ball recoveries and interceptions (Barreira, 2013) in the playoffs than the group stage. This means that successful teams tend to perform better by making more interceptions and ball recoveries against opponents with similar skill level (Tiago F, et al, 2020). On the other hand, against lower-level opponents, the players had more chances to perform successful tackles (Tiago F, et al, 2020). In this study, the top-ranked players in group stage (Javier Mascherano, Sergio Busquets and Gerard Pique) outperformed the top-3 players (Gerard Pique, Samuel Umtiti and Arturo Vidal) of playoffs, performing more tackles against lower-level opponents. The variables defensive action followed by head pass and body pass, except head, presented higher indexes in the playoffs than in the group stage, which suggests that Gerard Pique and Arturo Vidal of the playoffs performed more successful passes, enabling an effective defensive-attacking transition (Grant, Reilly, Williams and Borrie, 1998; Griffiths, 1999; Barreira, Ribeiro, Garganta and Anguera, 2010; Machado, Barreira and Garganta, 2011). Also, the variable defensive action resulting in the ball out of the field achieved higher scores in playoffs than in the group stage. This data suggests that, in playoffs, the players have failed to run with the ball towards the opponent's goal. Regarding the *duel-mean* and successful 1x1 defensive actions, our data showed that the 3 top-ranked players achieved higher indexes in the playoffs than their peers from the group stage. These results suggest that games played against top-level teams allowed players to score better indexes in the *duel-mean* and successful 1x1 defensive actions. Indeed, previous research highlighted that the central defenders, defensive midfielders and full backs had more success in both aerial and ground duels (Dellah et al. 2011).

Furthermore, regardless of matches played at home, the 3 top-ranked players played preferably in the central corridor of the field, having a key role in preventing the opposing team from creating goal-scoring opportunities (Quina, 2001). These players also provided balance to their teammates in the defending plays. This is extremely important, because as stated by Vilar et al. (2011), the teams that tend to maintain defensive stability in zones of the field next to their goal had more success.

Regarding the matches played by FCB Away in UEFA Champions League 2015-2016, 2016-2017, 2017-2018 and 2018-2019 season, we verified that the 3 top-ranked players (Season: DA, JM and SU; Group stage: DA, SB and JA; Playoffs: AV, JM and GP) scored higher indexes in successful interceptions. However, the other two players (Javier Mascherano and Gerard Pique) of playoffs achieved higher indexes in the same variables compared to the players of the group stage (DA, SB and JA). Hence, these results may suggest that Futbol Club Barcelona felt some difficulties when playing away matches, possibly due to players' lack of aggressiveness, reflected in lower scores attained in defensive actions such as interceptions (Lago-Peñas and Lago-Ballesteros, 2011). Also, the values scored for the variable defensive actions

followed by head pass suggest that players were not so effective in transiting from the defensive to the offensive phase. Carlos Humberto A., António F., Anna V, 2014 state that, in playoffs, the lower-level teams were likely to recover more balls due to opponents'. Indeed, in this study, Barcelona performed worse in away matches although showing higher indexes in ball recoveries in group stage.

When comparing Home vs. Away matches, we observed dissimilar results in defensive actions resulting in the ball out of the field and the number of conceived fouls that non-originated dangerous situation, defensive action followed by head pass and by body pass, except head, and anticipation (Barreira, 2013). Importantly, higher indexes were verified for these variables in games played at home than in away matches. In Away matches, the defensive golden players played preferably in the lateral corridor of the field, presenting low scores in the variables defensive actions resulting in the ball out of the field as well as the number of conceived fouls that non-originated dangerous situations. This means that FCB tend to lose the ball more often in games played away than those played at home, making more fouls, and conceding more ball-possession to their opponents.

In sum, the DGI formula can be applied in a diversity of contexts. It provides detailed information to coaches regarding the individual performance of each player. The planning of the training, by the technical staff, can be improved by examining each player weaknesses in regard to specific behaviors to be accomplished in the defensive sub-phase of play, depicted by the defensive variables included in the DGI formula.

Conclusion and practical applications

The DGI formula application to FCB defending plays revealed interesting results. Firstly, in home matches, Piqué, Busquets and Mascherano (total matches); Mascherano, Busquets and Piqué (Group stage matches); Piqué, Umtiti and Vidal (Playoff matches) were identified as the Defensive Golden Players. All players played at the central corridor of the field, and in away matches, Daniel Alves, Javier Mascherano and Samuel Umtiti (Total); Daniel Alves, Sergio Busquets and Jordi Alba (Group stage); Arturo Vidal, Javier Mascherano and Gerard Pique (Playoff), played at the lateral corridor of the field and presented the highest index (Total).

The DGI can be applied in all teams and competitions because the defensive variables included in the formula are common to all defending positions. Information provided by the DGI revealed the strengths and weaknesses of some players regarding the accomplishment of specific defensive behaviors, therefore, it can facilitate coaches' decision-making in regards to the team strategy level, for example, the coach and his assistants are able to plan effective training sessions according to what each player needs to improve individually in the defensive plays. In relation to the opposing teams, it is possible to identify the most valuable players in the defensive phase and thus develop a strategy to know that players can exploit based on information yielded by the variables depicting defensive performance. Moreover, coaches can examine preferred zones of the field used by the opponents to recover ball-possession, which sorts of technical actions are usually employed by the players to recover ball-possession (e.g., through aerial duels, tackles,

interceptions), team style of play (playing more in depth or in width), identification of key players in the defensive phase that perform more ball recoveries, provide more balance, as well as those that tend to destabilize team defensive structure (e.g., lack of positioning).

Finally, the applicability of the DGI formula comprises a potent instrument to identify and classify players' individual defensive performances, helping coaches and performance analysts to understand the individual contribution of each player for the global team performance in respect to the defending sub-phases of play.

Nevertheless, this formula has been conceived only to study the defending plays. Also, only the variables that are introduced in the formula can be analysed. However, we can remove and/or include others whenever necessary. Future studies need to create a formula for each position in both attacking and defending plays, so that the performance analyst and the coaches can have more details about the individual and collective performance.

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Capítulo 3

Discussão Geral

Discussão Geral

Os objetivos deste estudo centraram-se no desenvolvimento e validação de uma fórmula denominada DGI, concebida para classificar jogadores de Futebol em fase defensiva.

Neste processo envolveu-se um número significativo de variáveis técnico-táticas relacionadas com todas as posições, onde se aplicou o DGI para o *Futbol Club Barcelona* na La Liga (Liga Espanhola), na temporada 2018/19 e na Liga dos Campeões na temporada 2015/16; 2016/17; 2017/18 e 2018/19, com o objetivo de: i) identificar os jogadores mais valiosos (DGP) na fase defensiva da equipa; ii) investigar a influência da variável situacional (qualidade do adversário) no desempenho individual dos respetivos jogadores; iii) investigar a influência da variável situacional (localização do jogo) para as diferentes fases da competição.

A identificação dos jogadores mais valiosos na fase defensiva do jogo é feita através da fórmula DGI, através da qual se procede à análise do desempenho individual, nas diferentes posições específicas (Duch, Waitzman & Amaral, 2010; Malta & Travassos, 2014). Em relação à localização do jogo e à qualidade do adversário, procurou-se saber quais as variáveis defensivas que influenciam os comportamentos individuais e coletivos (Barreira, 2013; Eccles, Ward & Woodman, 2009; Fernandes, 2017, Garganta, 1997 Gómez, Lago-Peñas, & Pollard, 2013; Mackenzie & Cushion, 2013; Rampinini et al., 2009, Sarmiento et al., 2009).

O primeiro artigo do presente estudo representa todas etapas para o desenvolvimento e validação da fórmula DGI. Foram escolhidos especialistas em futebol, nomeadamente treinadores, investigadores e professores (n = 11) para que esta fórmula se tornasse um instrumento válido.

Estudos de referência de validação de ferramentas de Ciências do Desporto (e.g., Barreira, Garganta, Castellano & Anguera, 2012; López, Gutierrez, Villora & Olivares, 2013; Palao, López & Ortega, 2015; Prudente, 2004; Pereira et al, 2018), utilizaram variáveis selecionadas validadas com consenso (> 75%) (Barreira et al, 2012), exceto as variáveis: 1) número de cartões amarelos recebidos e 2) número de faltas concebidas que não originam

situações de perigo. No entanto, optou-se por manter essas variáveis pela proximidade com o valor mínimo (75%), pela importância afirmada na literatura e pela estreita relação com a eficácia de defesa.

Para determinar o peso de cada variável, foi utilizada uma escala de 1 a 5 e, os especialistas foram solicitados a atribuir um peso a cada um destes fatores, seguindo a escala Likert (Dalmoro & Vieira, 2014). Essa escala foi utilizada para evitar uma tendência da média das variáveis com valores altos e valorizar todos os jogadores nas suas posições específicas. Observando os resultados, as variáveis que mais valorizaram, na opinião dos especialistas foram: 1x1 defensivo com sucesso (4,91) (Barreira, 2013), antecipação (4,73) e interceções com sucesso (4,73) (Barreira, 2013). Com menos peso na fórmula aparece o número de faltas concebidas que não originam situações de perigo (adaptado das leis dos jogos de futebol) (3,73), ação defensiva seguida do envio da bola para fora do terreno de jogo (3,00) (adaptado de Barreira, 2013) e o número de cartões amarelos recebidos (2,91) (adaptado das leis dos jogos do futebol). Com base nestas informações, concluiu-se que não existiram diferenças significativas entre os pesos das variáveis, havendo uma valorização para todos os jogadores nas funções defensivas. Atendendo a todas as etapas de validação e determinação do peso de cada variável, na procura pela criação da fórmula DGI, cada variável foi tratada estatisticamente. Foi possível normalizar cada variável sem perda de informação, conectando-as numa escala semelhante, com base na técnica estatística de standardização de uma variável (Moeller, 2015).

Esta fórmula DGI foi criada para ajudar os treinadores, analistas e investigadores a uma aplicação credível e objetiva, na tentativa de classificar os jogadores de acordo com as suas ações tático-técnicas na fase defensiva.

Aplicação da Fórmula Defensive Golden Index ao Futbol Club Barcelona na Liga Espanhola temporada 2018/19

Após o desenvolvimento e validação da fórmula DGI, tornou-se fundamental proceder à sua aplicação. O objeto de estudo foi identificar os jogadores mais valiosos (DGP) na fase defensiva e optou-se por não considerar

os guarda-redes, pois nos comportamentos que foram escolhidos na fase defensiva, eles teriam uma participação reduzida e assumem um campo bastante restrito (Duch et al., 2010).

A primeira aplicação da fórmula DGI ao *Futbol Club Barcelona* na temporada 2018/19, analisou 38 jogos, e identificou no total, e em níveis médio e baixo, Gerard Piqué (defesa-central), Clement Lenglet (defesa-central) e Sergio Busquets (médio-defensivo) e, enquanto em nível alto, identificou-se Clement Lenglet, Gerard Piqué e Sérgio Busquets (como os jogadores mais valiosos da equipa do FCB na fase defensiva. Como podemos constatar, os jogadores mais valiosos (DGP) jogam no corredor central, permitindo que a equipa esteja equilibrada, em todos os níveis competitivos, na fase defensiva. Podemos verificar que Gerard Piqué foi considerado o jogador mais valioso (DGP) (total, nível médio e baixo) atuando como defesa-central. Através da análise dos seus valores, este jogador apresenta valores elevados, nomeadamente, nas interceções com sucesso (Barreira, 2013), na ação defensiva seguida de passe de cabeça e passe com o resto do corpo, exceto passe de cabeça (adaptado de Barreira, 2013), e antecipação. Gerard Piqué foi um jogador muito importante para fazer a ligação da fase defensiva para a fase ofensiva (Pereira et al., 2018) da equipa do FCB como podemos observar nos valores da variável ação defensiva seguida de passe de cabeça e passe com o resto do corpo, exceto passe de cabeça (adaptado de Barreira, 2013). Além disso, nas interceções com sucesso e recuperações de bola com sucesso, perante os valores apresentados, estes jogadores tiveram sucesso nos duelos defensivos (Fernandes et al., 2020). Essa fórmula contém variáveis defensivas ($n = 12$) que indicam análises individuais com grande detalhe (Eugster, 2012).

Aplicação da Defensive Golden Index formula ao Futbol Club Barcelona na Liga dos Campeões – temporada 2015/16, 2016/17, 2017/18 e 2018/19

No segundo artigo, o desempenho individual foi observado, consoante a localização de jogo nas diferentes fases da Liga dos Campeões, à procura de perceber porque é que o FCB em jogos em casa ($n = 21$) tem 19 vitórias e 2 empates, nos diferentes níveis da competição, e nos jogos fora de casa não

consegue ter o mesmo desempenho. Em primeiro lugar, podemos observar os DGP nas diferentes fases da competição, nos jogos em casa e nos jogos fora.

Nos jogos em casa, os DGP no total de jogos foram Piqué, Busquets e Mascherano, enquanto nos jogos da fase de grupos foram Mascherano, Busquets e Piqué e por fim nos jogos do playoff Piqué, Umtiti e Vidal foram considerados os jogadores mais valiosos. Nos jogos fora (n = 21), os DGP foram Daniel Alves, Javier Mascherano e Samuel Umtiti no total de jogos; Daniel Alves, Sergio Busquets e Jordi Alba nos jogos da fase de grupos; Arturo Vidal, Javier Mascherano e Gerard Piqué nas partidas do playoff

Relativamente, às referências espaço-temporais (Belli, 2014), os resultados podem mostrar que nos jogos em casa, os jogadores mais valiosos jogam no corredor central enquanto no jogos fora são jogados através do corredor lateral (Monteiro, 2014), o que pode proporcionar diferentes comportamentos dos mesmos nas fases de competições da UCL, sugerindo que, nas diferentes localizações de jogo, podemos ter comportamentos defensivos que acontecem nos jogos em casa e, não acontecem tantas vezes nos jogos fora, como as recuperações de bola. Assim, com essas informações, podemos referir que nos jogos em casa, a equipa do FCB na prevenção impede que a equipa adversária crie oportunidades de golo (Quina, 2001) e, proporciona equilíbrio aos seus companheiros nas situações defensivas (Vilar et al., 2011), assim sendo, as equipas que mantiveram a estabilidade defensiva perto das áreas de golo tiveram mais sucesso.

Em resumo, a fórmula DGI afigura-se válida e objetiva para interpretar as informações relacionadas com/ o desempenho individual dos jogadores de futebol na fase defensiva do jogo. Pode ser utilizada por equipas de elite, treinadores, analistas de jogo e jogadores, fornecendo informações sobre o desempenho defensivo individual dos jogadores. Estas informações podem tornar-se importantes no aperfeiçoamento do treino coletivo e individual.

Capítulo 4

Conclusões

Conclusões

O presente estudo centrou-se na análise do desempenho individual, nomeadamente, no desenvolvimento e validação de uma nova fórmula chamada de Defensive Golden Index, capaz de identificar e classificar os jogadores da fase defensiva. A aplicação surgiu no *Futbol Club Barcelona* na La Liga 2018/2019 e na Liga dos Campeões nas temporadas 2015/16, 2016/17, 2017/18 e 2018/19, identificando os jogadores mais valiosos na fase defensiva da equipa, nos termos gerais, e condicionados pela qualidade do adversário e pelo local de jogo nos diferentes níveis da competição.

Foi possível concluir que:

1. A fórmula DGI respeitou, com detalhe, todas as etapas para a validação científica, assumindo-se como uma ferramenta válida para o desempenho individual dos jogadores da fase defensiva no futebol.
2. Gerard Piqué (defesa-central) foi considerado o DGP do *Futbol Club Barcelona* na La Liga 2018/19, sendo o jogador mais valioso na fase defensiva da equipa e, assumindo também a ligação defensiva à fase ofensiva. Foi identificado como o jogador mais valioso (DGP) de nível medio e baixo. Clement Lenglet foi apontado como o jogador mais valioso quando o adversário era de nível alto, assumindo um papel importante na prevenção de situações ofensivas dos adversários. Independentemente do nível do adversário, verificou-se que os jogadores que atuaram no corredor central, surgem com alta supremacia na fase defensiva (Gerard Piqué, Clement Lenglet e Sergio Busquets).
3. Na Liga dos Campeões (2015/16; 2016/17; 2017/18; 2018/19), nos jogos em casa, Gerard Piqué foi considerado o jogador mais valioso (DGP) no total e nos playoffs enquanto Javier Mascherano foi considerado o jogador mais valioso na fase de grupos (DGP). Nos jogos fora de casa, os jogadores mais valiosos (DGP) foram Daniel Alves e Arturo Vidal, o primeiro no total e na fase de grupos enquanto o segundo nos *playoffs*. Verifica-se que existe uma diferença na localização de jogo, enquanto nos

jogos em casa, os jogadores mais valiosos jogam no corredor central nos jogos fora de casa, jogam no corredor lateral.

Aplicações Práticas

A fórmula DGI pode ser aplicada:

- Numa equipa para identificar as referências e o desempenho defensivo individual dos jogadores;
- Para explorar as fraquezas e entender as referências defensivas da equipa adversária.
- Nas diferentes equipas, onde se pode analisar os índices mais elevados referentes à fase defensiva, e na qual poderemos identificar o melhor jogador por setor em contexto de treino e competição;
- Com variáveis situacionais, ou seja, verificar como tende o desempenho defensivo dos jogadores em função de, por exemplo, o resultado momentâneo do jogo, fase da competição ou local do jogo;
- Na análise diária de treinos e jogos, comparando-se o desempenho dos jogadores ao longo das épocas desportivas.

Limitações e Estudos Futuros

Como limitações do presente estudo deve referir-se que a fórmula Defensive Golden Index não considera:

- Diferentes momentos defensivos – esta fórmula não discrimina cada momento defensivo, apenas a totalidade dos dados da fase defensiva. Os treinadores, analistas e jogadores, se quiserem encontrar dados sobre cada momento defensivo (Organização defensiva, Transição defensiva e Bolas Paradas defensivas), terão que utilizar esta fórmula para cada um destes momentos.

- Nível competitivo de uma equipa: um jogador do *Futbol Club Barcelona* não é valorizado comparativamente a um jogador de uma liga inferior, por pertencer a este clube. Assim, a comparação e os critérios devem ser delimitados pelo pesquisador.
- Variáveis defensivas – Os treinadores, analistas e jogadores, caso não tenham acesso a dados, referentes aos componentes da fórmula para o futebol profissional (e.g., Wyscout), terão que fazer a sua recolha e processamento que no que concerne ao tempo despendido, são elevados. Sugere-se, então, a criação de bases ou códigos em programas como o Excel para um correto, rápido e eficaz processamento da informação.

Para estudos futuros, torna-se necessário criar uma fórmula para cada posição tanto no ataque como na defesa, de forma a que o analista de desempenho e os treinadores consigam recolher dados sobre o desempenho individual do jogador, onde também podemos incluir variáveis físicas.

Capítulo 5

Referências

Referências

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Capítulo 6

Anexos

Anexo I. Desenvolvimento de questionário para validação e determinação do peso das variáveis do Defensive Golden Index

GOLDEN INDEX DEFENSIVO: Jogador mais valioso na Fase Defensiva em Futebol

Caro Respondente,

Bem-vindo ao questionário que ajudará à definição de uma fórmula para avaliar e/ou escalonar os futebolistas, tendo em consideração os seus comportamentos defensivos em Futebol, denominada "Golden Index Defensivo". O questionário encontra-se dividido em três partes: 1) Identificação do respondente; 2) Opinião do respondente sobre a importância de cada variável defensiva; 3) Avaliação/opinião do respondente sobre a fórmula e o tema do trabalho. Às questões da parte 2 do questionário solicita-se que responda de 1 a 5, de modo a atribuir o grau de importância relativa a cada variável defensiva em Futebol. Todas as variáveis serão contabilizadas tendo em consideração o tempo de jogo de cada jogador. No final de cada questão poderão ser encontradas ajudas.

Neste questionário não existem respostas certas nem erradas. Trata-se de recolher a opinião de cada perito. Recomenda-se que antes de iniciar a resposta ao questionário, se leia atentamente cada questão.

Desde já agradecemos o tempo dedicado a este trabalho.

Parte 1 - Identificação do respondente

As respostas serão analisadas de forma anónima neste questionário, portanto não será mencionada nenhuma informação que identifique o respondente.

1. Idade (em anos)

2. Nível de instrução

- ☐ Ensino básico
- ☐ Ensino secundário
- ☐ Licenciatura
- ☐ Mestrado
- ☐ Doutoramento
- ☐ Outra: _____

3. Grau de curso de treinador de Futebol

- ☐ I (UEFA C)
- ☐ II (UEFA B)
- ☐ III (UEFA A)
- ☐ IV (UEFA PRO)
- ☐ Nenhum

4. Experiência enquanto Profissional de Futebol (Treinador Principal, Treinador adjunto, Analista, Scout, outros) (em anos)

5. Nível mais alto de experiência enquanto Profissional de Futebol (Treinador Principal, Treinador adjunto, Analista, Scout, outros)

- ☐ Futebol de Formação
- ☐ Distrital sénior
- ☐ Campeonato de Portugal
- ☐ 2ª liga
- ☐ 1ª liga
- ☐ Provas internacionais
- ☐ Selecção nacional

6. Experiência enquanto Jogador sénior de Futebol (em anos)

7. Nível mais alto de experiência enquanto Jogador sénior de Futebol

- ☐ Futebol de Formação
- ☐ Distrital sénior
- ☐ Campeonato de Portugal
- ☐ 2ª liga
- ☐ 1ª liga
- ☐ Provas internacionais
- ☐ Selecção nacional

Parte 2 - Opinião do respondente sobre a importância de cada variável defensiva

Por favor, indique o grau de importância que atribui às diferentes variáveis para a identificação do jogador mais valioso na fase defensiva em Futebol. Por baixo de cada variável pode encontrar um vídeo e/ou uma ajuda.

NÚMERO DE CARTÕES AMARELOS: número de vezes que o jogador recebe cartão(ões) amarelo(s) no decurso do jogo de Futebol

CARTÃO AMARELO: utiliza-se para comunicar uma advertência; um jogador recebe um cartão amarelo do árbitro por realizar falta, infração persistente, bola na mão, jogo perigoso, retardar o recomeço de jogo.

8.

- ☐ 1 (Nada Importante)
- ☐ 2 (Pouco Importante)
- ☐ 3 (Importante)
- ☐ 4 (Muito Importante)
- ☐ 5 (Extremamente Importante)

NÚMERO DE CARTÕES VERMELHOS RECEBIDOS: número de vezes que o jogador recebe cartão vermelho no decurso do jogo de Futebol

CARTÃO VERMELHO: utiliza-se para comunicar uma expulsão (quando o árbitro mostra o cartão vermelho diretamente ou por acumulação de amarelos); um jogador recebeu cartão vermelho direto do árbitro por impedir o adversário de marcar um golo ou anular uma clara oportunidade de golo de um adversário, tocando com a bola ou cujo o movimento geral seja em direção a baliza do infrator; usar conduta violenta; usar linguagem ou gestos ofensivos.

9.

- ☐ 1 (Nada Importante)
- ☐ 2 (Pouco Importante)
- ☐ 3 (Importante)
- ☐ 4 (Muito Importante)
- ☐ 5 (Extremamente Importante)

NÚMERO DE FALTAS REALIZADAS QUE ORIGINA SITUAÇÃO DE PERIGO: número de vezes que um jogador, em fase defensiva, comete uma falta que origina diretamente uma situação de perigo ao nível da chegada da bola ao último terço, no decurso de um jogo de Futebol

SITUAÇÃO DE PERIGO: livre direto, livre lateral, situação de golo



[v=4KDBO5wn3tQ](https://www.youtube.com/watch?v=4KDBO5wn3tQ)

[http://youtube.com/watch?](http://youtube.com/watch?v=4KDBO5wn3tQ)

10.

- ☐ 1 (Nada Importante)
- ☐ 2 (Pouco Importante)
- ☐ 3 (Importante)
- ☐ 4 (Muito Importante)
- ☐ 5 (Extremamente Importante)

NÚMERO DE FALTAS REALIZADAS QUE NÃO ORIGINA SITUAÇÃO DE PERIGO: número de vezes que um jogador, em fase defensiva, comete uma falta que não origina diretamente uma situação de perigo ao nível da chegada da bola ao último terço, no decurso de um jogo de futebol

SITUAÇÃO DE PERIGO: livre direto, livre lateral, situação de golo



[v=Zu9VICm2IZ4](https://www.youtube.com/watch?v=Zu9VICm2IZ4)

[http://youtube.com/watch?](https://www.youtube.com/watch?v=Zu9VICm2IZ4)

11.

- ☐ 1 (Nada Importante)
- ☐ 2 (Pouco Importante)
- ☐ 3 (Importante)
- ☐ 4 (Muito Importante)
- ☐ 5 (Extremamente Importante)

AÇÃO DEFENSIVA SEGUIDA DE PASSE DE CABEÇA: inicia-se com uma ação defensiva de um jogador da equipa observada (e.g. cabeceamento de uma bola em trajetória aérea não controlada por nenhum dos jogadores), que é de imediato seguida por passe, sem que exista interrupção do jogo. Considera-se passe o envio de bola, de forma deliberada ou não, até um outro jogador da equipa observada, sem que exista início da posse de bola (adaptado Barreira, 2013)



[v=62BaR_Efs3g](https://www.youtube.com/watch?v=62BaR_Efs3g)

[http://youtube.com/watch?](http://youtube.com/watch?v=62BaR_Efs3g)

12.

- ☐ 1 (Nada Importante)
- ☐ 2 (Pouco Importante)
- ☐ 3 (Importante)
- ☐ 4 (Muito Importante)
- ☐ 5 (Extremamente Importante)

AÇÃO DEFENSIVA SEGUIDA DE PASSE COM O CORPO, EXCEPTUANDO A CABEÇA: inicia-se com uma ação defensiva de um jogador da equipa observada (e.g. intercepção), que é de imediato seguida por passe, sem que exista interrupção do jogo. Considera-se passe o envio de bola, de forma deliberada ou não, até um outro jogador da equipa observada, sem que exista início da posse de bola (adaptado Barreira, 2013)



[v=InTDtKHoeSw](http://youtube.com/watch?v=InTDtKHoeSw)

[http://youtube.com/watch?](http://youtube.com/watch?v=InTDtKHoeSw)

13.

- ☐ 1 (Nada Importante)
- ☐ 2 (Pouco Importante)
- ☐ 3 (Importante)
- ☐ 4 (Muito Importante)
- ☐ 5 (Extremamente Importante)

AÇÃO DEFENSIVA COM ENVIO DA BOLA PARA FORA DO TERRENO DE JOGO:
inicia-se com uma ação defensiva de um jogador da equipa observada (e.g. intercepção, cabeceamento de uma bola em trajetória aérea não controlada por nenhum dos jogadores), que é de imediato seguida por passe. Considera-se passe o envio de bola, de forma deliberada ou não até que a bola saia do terreno de jogo, sem que exista início da posse de bola (adaptado Barreira, 2013)



[v=4zyb5nPg2hl](http://youtube.com/watch?v=4zyb5nPg2hl)

[http://youtube.com/watch?](http://youtube.com/watch?v=4zyb5nPg2hl)

14.

- ☐ 1 (Nada Importante)
- ☐ 2 (Pouco Importante)
- ☐ 3 (Importante)
- ☐ 4 (Muito Importante)
- ☐ 5 (Extremamente Importante)

AÇÃO DEFENSIVA COM PERDA DA BOLA PARA O ADVERSÁRIO: inicia-se com uma ação defensiva de um jogador da equipa observada (e.g. intercepção, cabeceamento de uma bola em trajetória aérea não controlada por nenhum dos jogadores), que é de imediato seguida por passe. Considera-se passe o envio de bola, de forma deliberada ou não, até que a bola chegue ao jogador adversário, sem que exista início da posse de bola (adaptado Barreira, 2013)



[BbXOJn7w](http://youtube.com/watch?v=XN-BbXOJn7w)

[http://youtube.com/watch?v=XN-](http://youtube.com/watch?v=XN-BbXOJn7w)

XXX

15.

- ☐ 1 (Nada Importante)
- ☐ 2 (Pouco Importante)
- ☐ 3 (Importante)
- ☐ 4 (Muito Importante)
- ☐ 5 (Extremamente Importante)

DESARME: situação de luta direta com um atacante adversário, que procura conservar a bola (Garganta, 1997).



[v=mU301GWX9zA](https://www.youtube.com/watch?v=mU301GWX9zA)

[http://youtube.com/watch?](https://www.youtube.com/watch?v=mU301GWX9zA)

16.

- ☐ 1 (Nada Importante)
- ☐ 2 (Pouco Importante)
- ☐ 3 (Importante)
- ☐ 4 (Muito Importante)
- ☐ 5 (Extremamente Importante)

Interceção com sucesso: começa com: i) interceção de um passe executado pelo adversário; ii) interceção de um passe executado pelo adversário para o espaço vazio e iii) interceção de um remate feito pelo adversário (adaptado de Barreira, 2013)



[v=tNqdnBqMIKk](https://www.youtube.com/watch?v=tNqdnBqMIKk)

<http://youtube.com/watch?>

17.

Marcar apenas uma oval.

- ☐ 1 (nada importante)
- ☐ 2 (pouco importante)
- ☐ 3 (importante)
- ☐ 4 (muito importante)
- ☐ 5 (extremamente importante)

NÚMERO DE REMATES BLOQUEADOS: número de vezes que o jogador em fase defensiva bloqueia o remate do jogador adversário



<http://youtube.com/watch?v=fwtl8iGpPeQ>

[v=fwtl8iGpPeQ](http://youtube.com/watch?v=fwtl8iGpPeQ)

18.

- ☐ 1 (Nada Importante)
- ☐ 2 (Pouco Importante)
- ☐ 3 (Importante)
- ☐ 4 (Muito Importante)
- ☐ 5 (Extremamente Importante)

DUELO: ação em que um jogador da equipa em fase defensiva disputa a bola com um adversário (e.g. uma bola em trajetória aérea não controlada por nenhum dos jogadores) (Barreira, 2013)



<http://youtube.com/watch?v=p1oKugAeqXU>

[v=p1oKugAeqXU](http://youtube.com/watch?v=p1oKugAeqXU)

19.

- ☐ 1 (Nada Importante)
- ☐ 2 (Pouco Importante)
- ☐ 3 (Importante)
- ☐ 4 (Muito Importante)
- ☐ 5 (Extremamente Importante)

DUELO AÉREO: ação tático-técnica de luta direta pela bola em trajetória aérea descontrolada (adaptado Barreira, 2013)



<http://youtube.com/watch?v=tNtcTydzUJI>

20.

- ☐ 1 (Nada Importante)
- ☐ 2 (Pouco Importante)
- ☐ 3 (Importante)
- ☐ 4 (Muito Importante)
- ☐ 5 (Extremamente Importante)

1X1 DEFENSIVO COM SUCESSO: o jogador em fase defensiva não é ultrapassado pelo adversário direto, conseguindo recuperar a posse de bola ou ganhar posição/espço sobre o seu oponente, não permitindo a continuidade do ataque adversário (adaptado Barreira, 2013)



http://youtube.com/watch?v=v08_vqiE0cE

21.

- ☐ 1 (Nada Importante)
- ☐ 2 (Pouco Importante)
- ☐ 3 (Importante)
- ☐ 4 (Muito Importante)
- ☐ 5 (Extremamente Importante)

1X1 DEFENSIVO SEM SUCESSO: o jogador em fase defensiva é ultrapassado pelo adversário direto, não conseguindo recuperar a posse de bola ou ganhar posição/espço sobre o seu oponente, permitindo a continuidade do ataque adversário (adaptado Barreira, 2013)



<http://youtube.com/watch?v=4KI->

[IA1xMEI](#)

22.

- ☐ 1 (Nada Importante)
- ☐ 2 (Pouco Importante)
- ☐ 3 (Importante)
- ☐ 4 (Muito Importante)
- ☐ 5 (Extremamente Importante)

ANTECIPAÇÃO: identificação dos sinais emergentes da situação de jogo por parte do jogador em fase defensiva, atuando em conformidade, consequentemente tendo sucesso no comportamento defensivo.



<http://youtube.com/watch?>

[v=CYvfonDq0Kk](#)

23.

- ☐ 1 (Nada Importante)
- ☐ 2 (Pouco Importante)
- ☐ 3 (Importante)
- ☐ 4 (Muito Importante)
- ☐ 5 (Extremamente Importante)

RECUPERAÇÃO DA POSSE DE BOLA: é o número de vezes que o jogador em fase defensiva intervêm recuperando a posse de bola (Barreira, 2013)



[hP_xUE](#)

<http://youtube.com/watch?v=qEEK->

24.

- ☐ 1 (Nada Importante)
- ☐ 2 (Pouco Importante)
- ☐ 3 (Importante)
- ☐ 4 (Muito Importante)
- ☐ 5 (Extremamente Importante)

Parte 3 - Avaliação/opinião do respondente sobre a fórmula e tema do trabalho

25. Na sua opinião, que comportamento(s) defensivo(s) acrescentaria à lista em cima colocada? (resposta não obrigatória)

26. Qual a importância que atribui à criação de uma fórmula (Golden Index Defensivo) destinada a identificar o jogador mais valioso na fase defensiva em futebol?

☐ 1 (Muito Baixa)

☐ 2 (Baixa)

☐ 3 (Média)

☐ 4 (Alta)

☐ 5 (Muito Alta)

Obrigado por ter respondido a este questionário.
