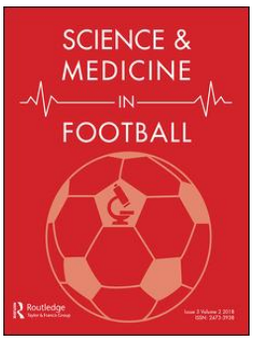

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Israel Teoldo & Felippe Cardoso

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Talent map: how demographic rate, human development index and birthdate can be decisive for the identification and development of soccer players in Brazil

Israel Teoldo and Felippe Cardoso

Centre of Research and Studies in Soccer (NUPEF), Universidade Federal De Viçosa, Viçosa, Brazil

ABSTRACT

Aim: The aim of this paper is to verify how cities' demographic rates and Human Development Index (HDI), as well as the birthdate of Brazilian elite soccer players influenced their identification and development.

Methods: The sample was comprised of 5,359 players from the Brazilian Serie A Soccer Championship between 2003 and 2019. Players' birthdate and birthplace data were collected, as well as the HDI from their hometowns. Descriptive statistics, chi-square, Pearson correlation and linear regression tests were performed.

Results: Results indicated that players born in the first semester of the year, in cities with a demographic rate of up to 100,000 inhabitants and HDI above 0.501, are more likely to play at the highest level (Serie A) of Brazilian soccer. Correlations were observed between birth quartile and HDI ($r = -.059$; $se = 0.04$; $p < 0.001$), birth quartile and demographic rates ($r = -063$, $se = 0.03$; $p < 0.001$), and between HDI and demographic rates ($r = 0.458$; $se = 0.02$; $p < 0.001$). The linear regression method yielded a valid model that included all three variables in this study ($F_{(2)} = 9.512$; $p < 0.001$).

Conclusion: Based on these findings, it is possible to conclude that birthdate, demographic rate and HDI are important factors in the identification and development of soccer players in Brazil.

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KEYWORDS
Talent identification; player selection; HDI; demographic rate; relative age

Introduction

The development of young soccer talents in Brazil has been a major challenge for clubs in recent years, as several institutions still do not have a developmental curriculum and a strategic plan to optimize the allocation of financial resources for talent identification and development. Consequently, clubs ended up not making maximum profit with the investments made in their youth academies, either by selling players abroad or utilizing them in the first team (Burgess and Naughton 2010; Sieghartsleitner et al. 2019). With respect to the process of talent identification and development, some clubs have struggled to set up departments of market analysis and talent search, in attempting to maximize investments and minimize losses (Sieghartsleitner et al. 2019). In this scenario, it is important to be aware of all factors that involve the process of talent identification and development, such as the personal and environmental characteristics crucial for improving the effectiveness of this process. (Buekers et al. 2015; Johnston et al. 2018)

Talent identification and development are associated with variables that represent the different stages players go through to achieve elite level (Abbott et al. 2005). The development stage is associated with the opportunities players are provided with during their formation, including their diverse experiences in the sport (Williams and Reilly 2000). In turn, identification refers to the process of recognizing potential players who are to play in the elite of the sport (Williams and Reilly 2000). Both identification and development are directly affected by different individual and environmental variables (Burgess and Naughton 2010; Johnston et al. 2018).

This topic has led researchers worldwide to consider three aspects that facilitate the identification and development of young soccer players (Howe et al. 1998; Côté et al. 2006; Teoldo et al. 2013). The main studies on this theme subject point out that developing a talented player depends primarily on: i) the social environment in which players are born and raised; ii) the biological conditions and the acquisition of the skills (i.e., tactical, technical, physical and psychological) necessary for playing the game and, finally iii) the experiences in the sport (related to the acquisition of skills through training and other experiences) (Howe et al. 1998; Côté 1999; Williams 2000; Johnston et al. 2018; Bergkamp et al. 2019). Thus, to develop talented players, these three aspects must interact in a sustainable and complementary manner over time, so as to enable the player to achieve high performance at national and/or international levels (Côté 1999; Williams and Reilly 2000; Bergkamp et al. 2019). Among these three aspects mentioned above, the first needs particular attention due to its relation to characteristics that cannot be controlled by the club, i.e., the player's birthdate and birthplace, his family structure, health conditions, education, among others (Côté et al. 2006; Teoldo et al. 2013). In this respect, the club usually intervenes only in the identification of a prospect, who is subsequently nurtured until achieving his/her full potential (Teoldo et al. 2013; Baker et al. 2018).

CONTACT Israel Teoldo israel.teoldo@ufv.br Centre of Research and Studies in Soccer, Universidade Federal De Viçosa, Av. PH Rolfs, S/N – Campus Universitário, Viçosa, Brazil

Thus, by focusing its efforts on the available scientific evidence about the characteristics of the social environment in which players are born and raised, clubs can optimize and expand their approaches for detecting and, consequently, improving the development of young talents (Larkin and Reeves 2018; Sieghartsleitner et al. 2019). In general, it seems clear that an optimized and continuous process for identifying and fostering young soccer players is the most promising model for talent development, as it results in reduction of costs for the club, as well as greater financial and sporting gains (Côté and Hancock 2016; Sieghartsleitner et al. 2019). This is because the process becomes more specific and based on scientific support, enabling a better organization on the part of the club to prospect the young talent. Therefore, the identification of players' characteristics regarding their birthplaces and birthdates seems to be relevant to the development process (Teoldo et al. 2013).

In literature, some studies have contributed with relevant information that helps guiding the process of identification and development of talented players (Côté 1999; Côté et al. 2006; Burgess and Naughton 2010; Teoldo et al. 2013; Johnston et al. 2018). In a study by Côté et al. (2006), it was observed that children born in cities with higher demographic rates have more access to resources when compared to their counterparts born in smaller cities. For the authors, this fact results from the abundant options for playing sports, evidenced by the structures of the facilities specific for physical activity and the skilled guidance of coaches in larger cities. On the other hand, children living in smaller cities may be provided with more opportunities, in early years, of becoming acquainted with sports. However, the insufficient amount of sports facilities, limited public investment, in addition to lower competitive and technical levels, can be detrimental to the development of sports skills as these children grow older (Côté et al. 2006). Thus, a large theoretical body of knowledge holds that birthplace may be a key factor in the identification and development of talented players, since the environment favorable for regular sports practice is essential to determine the player's opportunities to develop (Baker et al. 2003; Côté et al. 2006; Teoldo et al. 2013). Several studies have shown that the population size of the birthplace impacts the likelihood of reaching elite status (Côté et al. 2006; Larkin and Reeves 2018). Birthplace also seems to influence young athletes' sport participation in early years, as well as long-term adherence (Baker et al. 2003).

However, in recent years, some authors have questioned the use of population size as a predictor for the process of talent identification and development (Rossing et al. 2016, 2018; Farah et al. 2018, 2019). These studies have suggested that other contextual aspects such as population density, players' childhood sports development environment, quality of life in the city, among others, should be considered as they can play a more important role in developing talent than population size (Rossing et al. 2016, 2018; Farah et al. 2018, 2019). According to this evidence, acknowledging other important variables related to players' birthplace seems reasonable and may result in more solid evidence about the role of this variable in sports education and talent development (Farah et al. 2019). Thus, a potentially coherent possibility is the use of the Human Development Index (HDI) (Asher & Daponte, 2010; Teoldo et al. 2013). The HDI is an indicator that takes health, education and income parameters into account, which suggests that, in a certain way, it reflects aspects related to the quality of life of a given region. This is an important indicator, since it allows to identify criteria with limited reliability, and, therefore, to establish strategies and action plans to improve it (Asher & Daponte, 2010; Teoldo et al. 2013). Thus, in addition to the demographic rate, the HDI is also an important variable for a clearer understanding of the real effects of birthplace (Teoldo et al. 2013). In literature, few studies addressing this indicator have been carried out, despite the fact that it seems capable of providing additional information on the relevant environmental influences for talent identification and development in the early years.

In addition to birthplace and HDI and its inherent factors, birthdate has also been considered a determining aspect for the process of player identification and development (Helsen et al. 2000a; Burgess and Naughton 2010). Research carried out with soccer teams with players from different age groups and performance levels, reported a higher frequency of players born in the first months of the year, when compared to those born in the last months (Helsen et al., 2000b; Helsen et al. 2005; Sierra-Díaz et al. 2017). Studies also suggest that players born early in the year are favored in sports, in comparison to their peers born late in the year (Côté et al. 2006; Augste and Lames 2011; Silva et al. 2018). This advantage (that favors players born in the first months of the year) is known as the Relative Age Effect (RAE) and is mainly related to the player's physical and anthropometric development (Helsen et al., 2000a; Helsen et al. 2005). In addition to the physical and anthropometric advantages, research has highlighted that the longer time of practice as a result of age difference is also a determining factor (Burgess and Naughton 2010). Then, a very strong trend emerges showing the interrelation between relative age effect and the restrictions generated by individual, environmental and task characteristics (Wattie et al. 2015). This trend reinforces the importance of studies aimed at integrated analyses between the RAE, and characteristics of the birthplace of high-level athletes.

It is important to highlight that, despite the already proven importance of RAE and birthplace characteristics, few studies have investigated the relationship and roles of birthdate, demographic rate and HDI in elite sport. In Brazil, it is worth mentioning a pioneering study that addressed this subject was developed by Teoldo et al. (2013), and included players who played in the Serie A of the Brazilian Soccer Championship, with the purpose of investigating the interaction between these three measures. This study was carried out during one season of the Brazilian Championship and verified that the demographic rate, relative age and HDI are directly associated with the players' likelihood of achieving the top tier of Brazilian soccer. In general, the authors observed that soccer players born in the first quarter of the year, in cities with demographic rates lower than 200,000 inhabitants and with a 0.73 HDI, are more likely to play at the top national level. In order to put forth the findings of the aforementioned study and, considering the impact of the topic on the process of player identification and development, it is important to expand this study, using the entire universe of Brazilian players who participated in the

round-robin format of the Brazilian Serie A Soccer Championship, between 2003 and 2019. Based on this analysis, more conclusive claims should be drawn about how demographic rate, relative age and HDI are associated with players' odds of achieving the elite level of Brazilian soccer. Thus, the present study aims to verify how cities' demographic rates, HDI, and players' birthdate influenced the identification and development of talented Brazilian players.

Materials and methods

Sample

A total of 16,643 data points were collected from players enrolled in the Brazilian Serie A Soccer Championship between 2003 and 2019. Of this total, 5,359 players were included in the sample and analyzed (454 goalkeepers, 1,725 defenders, 1,840 midfielders and 1,340 forwards), whereas duplicate data of players who participated in more than one edition of the tournament were excluded. Players had an average age of 22.49 ± 4.00 years. The average population of players' birthplaces was 1,769,617 ± 3,041,372 inhabitants, with average HDI of 0.66 ± 0.09.

As inclusion criterion, players should be registered for at least one season and included in at least one Serie A match between 2003 and 2019. For players who participated in the competition for more than one season, only the first season when they met the above criteria was taken into account, in order to avoid duplication of data.

Data collection procedures

Players' birthplaces and birthdates were obtained through the official websites of the clubs participating in the competition, as well as through the website of the Brazilian Football Association – *Confederação Brasileira de Futebol* – (CBF) (http://www.cbf.com.br). Data were provided by both sources (clubs and CBF's websites), and compared in order to verify their accuracy. Duplicated player data and data that differed from the sources above were excluded from the analysis.

Regarding cities' HDI and population, data were collected, through the official websites of the United Nations Development Program (UNDEP) (http://www.pnud.org.br) and the Brazilian Institute of Statistical Geography – *Instituto Brasileiro de Geografia Estatística* (IBGE) (http://www.ibge.gov.br), respectively. For the analysis of these variables, the 2002 census was considered, due to its greater proximity to the birthdates of the players in this sample. For analysis purposes, HDI data were categorized in three intervals [T1 – Low (<0.500); T2 – Medium (0.501–-0.700) and T3 – High (>0.701)], as suggested by Asher and Daponte (2010). This subdivision enables to identify some general characteristics of the quality of life of the population. Cities with high HDI are those with a marked standard of living, and that display fewer social problems, inequalities, and poverty. Cities with medium HDI have a reasonable standard of living and infrastructure, an advanced level of industrialization, and are therefore predominantly urban. However, they still face some social problems as a higher rate of social inequality and poverty. Finally, the cities with low HDI are those that present serious socioeconomic problems, negatively impacting the quality of life (Asher & Daponte, 2010).

Demographic rate data were categorized in 17 intervals, according to the number of cities' inhabitants (continuous variable) [I-1 ($_{Min}$1,350 – $_{Max}$30,000); I-2 ($_{Min}$30,001 – $_{Max}$50,000); I-3 ($_{Min}$ 50,001 – $_{Max}$100,000); I-4 ($_{Min}$100,001 – $_{Max}$200,000); I-5 ($_{Min}$ 200,001 – $_{Max}$300,000); I-6 ($_{Min}$300,001 – $_{Max}$400,000); I-7 ($_{Min}$ 400,001 – $_{Max}$500,000); I-8 ($_{Min}$500,001 – $_{Max}$600,000); I-9 ($_{Min}$ 600,001 – $_{Max}$700,000); I-10 ($_{Min}$700,001 – $_{Max}$800,000); I-11 ($_{Min}$ 800,001 – $_{Max}$900,000); I-12 ($_{Min}$900,001 – $_{Max}$1,000,000); I-13 ($_{Min}$ 1,000,000 – $_{Max}$1,500,000); I-14 ($_{Min}$1,500,001 – $_{Max}$2,000,000); I-15 ($_{Min}$2,000,001 – $_{Max}$2,500,000); I-16 ($_{Min}$2,500,001 – $_{Max}$6,000,000); I-17 ($_{Min}$6,000,000 – $_{Max}$10,434,252)]. This categorization followed a mix of Brazilian Federal Government proposal and one proposed by Teoldo et al. (2013), which allows a better interpretation of the results, by presenting in more detail the specific characteristics of cities with different population sizes. The distribution of players in relation to their state of birth is also taken into account. For this purpose, the 26 Brazilian states were considered.

Birthdate data were categorized into quartiles [Q1 (Jan-Mar); Q2 (Apr-Jun); Q3 (Jul-Sep) and Q4 (Oct-Dec)], following the date range from January 1st to December 31st, applied in all international competitions organized by the *Fédération Internationale de Football Association* (FIFA).

In order to provide detailed information on the effect of birthplace (i.e., demographic rate and HDI) and relative age, players were grouped according to their respective positional roles (Goalkeepers, Defenders, Midfielders and Forwards). These categories enable a more careful analysis of the specific characteristics of birthplace and birthdate that might be associated with the development of players with different positional roles. This evidence can be easily transferred to practice, as clubs can now access more detailed information that will help them identify where (i.e., specific characteristics of birthplace and birthdate) to look for players better suited to a specific positional role (Teoldo et al. 2013).

Statistical analysis

Descriptive analyses (absolute and relative frequencies, means and standard deviation) were performed. The chi-square test (χ^2) was used to verify differences between the proportions of players, according to their positional roles, in the 17 population intervals (demographic rate), birth quartiles and HDI tertiles. Pearson correlation was used to verify correlations between cities' HDI and demographic rates, and players' birth quartile. Correlation values were interpreted as: weak (below 0.30); moderate (between 0.31 and 0.60); strong (0.61 to 0.90); and very strong (above 0.91) (Pagano and Gauvreau 2018). Significance level was set to $p < .05$. Linear regression was used to provide an estimate of the associations between the study variables. Positional role was considered a dependent variable, whereas demographic rate, birth quartile and HDI were the independent variables. All statistical procedures were

performed through *SPSS (Statistical Package for Social Science)* for *Windows®*, version 24.0.

Results

Cities' demographic rates

Results indicate that 34.3% of players, i.e., more than a third of the sample are from cities with up to 100,000 inhabitants, 33.6% from cities between 100,001 and 1 million inhabitants, and 32.1% were born in cities with more than 1,000,001 inhabitants (see Table 1). Also, 54.5% of players were born in cities with a demographic rate of up to 400,000 inhabitants, indicating a greater potential of small and medium-sized cities in the process of talent identification and development.

In addition, it is possible to infer from the results that there is an inverse relationship between the odds of success to the elite of Brazilian soccer and cities' demographic rates. In that sense, the higher the demographic rate, the lower the odds of ascending to the top level. When comparing players born in the interval (I-1) with players born in the interval (I-17), there is a difference of up to 8,663 times in the odds of ascension for players from cities located in the interval (I-1). This difference implies that players born in the last population range (I-17) are less likely to turning professional than players born in cities with lower demographic rates (I-1).

Also, it is possible to observe that, when comparing the proportion of players from different playing positions, according to their respective population range, significant differences were found in 9 of the 17 population ranges [$\chi^2 = 2420.157$; $p < 0.001$] as displayed in Table 1. This comparison shows that in cities with a lower demographic rate (I-1) there is greater heterogeneity in the development of players, since no statistical differences were observed in this interval (similar results can be observed in the intervals I-3 and I-6, in the cities where chances of ascension are greater). This indicates that in these cities players' development involves all positional roles.

It is noteworthy that, among the 27 Brazilian states, six stand out as the main sources of top-level players: São Paulo (26.6%), Rio de Janeiro (13.5%), Minas Gerais (9.0%), Rio Grande do Sul (8.6%), Paraná (7.2%) and Bahia (7.1%).

Cities' Human Development Indexes (HDI)

With respect to birthplaces' HDIs, 49.6% of players were born in cities with HDI between 0.501 and 0.700. Also, 42.8% were born in cities with HDI between 0.701 and 0.820. Cities with HDI lower than 0.500 are not very representative, as only 7.7% of players who go on to become professionals were born in cities with these conditions. The Brazilian states with the higher number of elite players were (in parentheses, states' average HDIs ± standard deviation): São Paulo (0.71 ± 0.04), Rio de Janeiro (0.69 ± 0.05), Minas Gerais (0.66 ± 0.06), Rio Grande do Sul (0.68 ± 0.05), Paraná (0.78 ± 0.06) and Bahia (0.55 ± 0.09).

When comparing the frequency of players from different positional roles, according to HDI tertiles, significant differences were found for goalkeepers, defenders and midfielders (See Table 2). For all these groups, we noticed a prevalence of players born in T2 and T3, respectively. Only forwards did not differ statistically from other players.

Table 2. Frequency of players of each positional role in the three HDI classification ranges.

	HDI tertiles				Intra-interval comparison	
Position	<0.500	Between 0.501 and 0.700	>0.701	Total	χ^2	*p*
Goalkeepers	*23*	*241*	*190*	454	12.304	.002
Defenders	*128*	*868*	*729*	1725	13.719	.001
Midfielders	*134*	*894*	*812*	1840	22.170	<.001
Forwards	*125*	*655*	*560*	1340	2.015	.365
Total	*410*	*2658*	*2291*	*5359*	39.886	<.001

Table 1. Frequency of players in each population interval, significance levels and players' odds of ascending to the elite level of Brazilian soccer.

	Population of Cities		Absolute Frequency						Intra-interval comparison			
Intervals	Minimum	Maximum	Goalkeepers	Defenders	Midfielders	Forwards	Total Players	Relative Frequency	χ^2	*p*	Odds of Success*	
I-1	1350	30,000	84	284	277	197	842	15.7	6.309	.097	2	36
I-2	30,001	50,000	31	113	141	95	380	7.1	9.528	.023	79	132
I-3	50,001	100,000	65	218	189	146	618	11.5	7.684	.053	81	162
I-4	100,001	200,000	51	172	169	139	531	9.9	12.773	.005	188	377
I-5	200,001	300,000	30	69	98	69	266	5.0	11.624	.009	752	1128
I-6	300,001	400,000	25	91	96	73	285	5.3	5.830	.120	1053	1404
I-7	400,001	500,000	13	81	83	63	240	4.5	9.848	.020	1667	2083
I-8	500,001	600,000	16	36	41	30	123	2.3	3.551	.314	4065	4878
I-9	600,001	700,000	3	23	19	15	60	1.1	2.631	.452	10,000	11,667
I-10	700,001	800,000	7	29	56	28	120	2.2	11.440	.010	5833	6667
I-11	800,001	900,000	6	22	25	25	78	1.5	7.302	.063	10,256	11,538
I-12	900,001	1,000,000	2	36	29	29	96	1.8	11.820	.008	9375	10,417
I-13	1,000,001	1,500,000	26	114	130	90	360	6.7	8.548	.036	2778	4167
I-14	1,500,001	2,000,000	10	27	38	23	98	1.8	2.547	.467	15,306	20,408
I-15	2,000,001	2,500,000	28	114	121	94	357	6.7	9.899	.019	5602	7003
I-16	2,500,001	6,000,000	25	147	179	122	473	8.8	21.621	<.001	5285	12,685
I-17	6,000,001	10,434,252	32	149	149	102	432	8.1	5.784	.123	13,889	292,855
			454	*1725*	*1840*	*1340*	*5359*	*100*				

* The odds of success were calculated by dividing the number of professional players and the minimum and maximum population within each population range.

Table 3. Absolute and relative frequencies according to players' positional roles and birth quartiles.

Birth quartiles	Goalkeepers	Defenders	Midfielders	Forwards	Total
1st Q	155 (34.1%)	554 (32.1%)	634 (34.5%)	428 (31.9%)	1771 (33.0%)
2nd Q	122 (26.9%)	473 (27.4%)	541 (29.4%)	377 (28.1%)	1513 (28.2%)
3rd Q	92 (20.3%)	411 (23.8%)	375 (20.4%)	331 (24.7%)	1209 (22.6%)
4th Q	85 (18.7%)	287 (16.6%)	290 (15.8%)	204 (15.2%)	866 (16.2%)
Total	454 (100%)	1725 (100%)	1840 (100%)	1340 (100%)	5359 (100%)

Players' birthdate

Results regarding players' birthdates indicate that those born in the first semester represent approximately 61.2% of the players who play, or played, in the top tier of the Brazilian Championship. These results are reinforced by the observed proportion of players, according to their respective positional roles (see Table 3), whereas a decreasing relationship is observed between the number of players as the quartiles advance.

Regarding the comparison between the numbers of players born in each quartile, some significant differences were found [χ^2 = 341.502; p < 0.001]. In general, it was observed that the frequency of players born in Q1 was higher when compared to the frequencies of players born in other quartiles (see Table 4). Significant differences were found when comparing the results of the general distribution of the players among the quartiles: (Q1vs.Q2; Q1vs.Q3; Q1vs.Q4; Q2vs.Q3; Q2vs.Q4 and Q3vs.Q4). Note that all these differences favored players born in the initial quartiles.

When proportions were compared according to players' positional roles, the following differences were found: goalkeepers (Q1vs.Q2; Q1vs.Q3; Q1vs.Q4; Q2vs.Q3 and Q2vs.Q4), defenders (Q1vs.Q2; Q1vs.Q3; Q1vs.Q4; Q2vs.Q4 and Q3vs.Q4), midfielders (Q1vs.Q2; Q1vs.Q3; Q1vs.Q4; Q2vs.Q3; Q2vs.Q4 and Q3vs.Q4) and forwards (Q1vs.Q3; Q1vs.Q4; Q2vs.Q4 and Q3vs. Q4). This indicates that relative age effect influences players, regardless of their positional roles.

Correlation between HDI, demographic rate and players' birthdates

Results of the correlations between these three variables showed that players' birth quartile has a low and negative correlation with HDI (r = −.059; se = 0.04; p < .001) and with the demographic rates of players' birthplaces (r = −.063, se = 0.03; p < .001). A moderate and positive correlation was observed between HDI and the demographic rates of players' birthplaces (r = .458; se = 0.02; p < .001).

Linear regression

The results of the linear regression indicate a valid model ($F_{(2)}$ = 9,512; p < .001) with moderate strength (determination coefficient) (R^2 = .498). For all variables tested in the model, an association is observed between odds of success according to players' positional role and the following measures: demographic rate (t = 14.219; p < .001); HDI (t = −13.462, p = .001) and birth quartile (t = 15.233, p < .001). This is an indication that demographic rate, HDI and birth quartile are variables associated with the successful development of players of different positional roles.

Discussion

The aim of this paper was to verify how cities' demographic rates and HDI, as well as the birthdate of Brazilian elite soccer players influenced their identification and development. Findings indicate that players who were born in the first semester of the year, in cities with a demographic rate of less than 100,000 inhabitants and HDI above 0.501, have a greater chance of playing in the top tier of the Brazilian Soccer Championship. Hence, these characteristics are important with respect to the identification and development of talented players at national level, as they affect talent identification, their development process and the probability of playing in the most important tournament in the country.

As for the relative age effect, the results of this paper were similar to those of the main studies in this field of knowledge, indicating an asymmetry in the distribution of birthdates, which favors players born in the first months of the year (Côté et al. 2006; Costa et al. 2009; Augste and Lames 2011; Teoldo et al. 2012). Literature points out that these asymmetries are associated with some advantages for players born in the first months of the year (Helsen et al. 1998), especially with respect

Table 4. Comparison of proportions according to players' positional roles and birth quartiles.

	Goalkeepers		Defenders		Midfielders		Forwards		Total	
Comparison between Quartiles	χ^2	*p*	χ^2	*p*	χ^2	*p*	χ^2	*p*	χ^2	*p*
1st Q vs. 2nd Q	3.931	.047	6.389	.011	7.361	.007	3.231	.072	20.269	<.001
1st Q vs. 3rd Q	16.069	<.001	21.191	<.001	66.483	<.001	12.397	<.001	105.988	<.001
1st Q vs. 4th Q	20.417	<.001	84.767	<.001	128.069	<.001	79.392	<.001	310.590	<.001
2nd Q vs. 3rd Q	4.206	.040	4.348	.037	30.083	<.001	2.989	.084	33.952	<.001
2nd Q vs. 4th Q	6.614	.010	45.521	<.001	75.813	<.001	51.513	<.001	175.960	<.001
3rd Q vs. 4th Q	0.277	.599	22.029	<.001	10.865	.001	30.148	<.001	56.698	<.001

to maturational aspects (i.e., physical capacities and anthropometric characteristics) as well as to the accumulation of practice time in sport, beneficial to chronologically older players (Helsen et al. 1998, 2000a, 2005). In general, these advantages in practice time, as well as in physical and anthropometric traits, systematically reported in soccer and other sports, is detrimental to the process of talent selection and development, as, by selecting players with these characteristics, clubs can overlook other key aspects of performance, such as technical, tactical and cognitive attributes (Helsen et al. 1998, 2005; Sierra-Díaz et al. 2017).

This fact is corroborated by Teoldo et al. (2010) who verified the associations between relative age effect and tactical performance. In this study, the authors observed that chronologically older players displayed an advantage in the execution of defensive behaviors, whereas chronologically younger players, especially those born in the last 3 months of the year, were better at performing offensive behaviors (Teoldo et al. 2010). Reinforcing these findings, in a study carried out by Barbosa et al. (2016) with young players competing in elite tournaments in Brazil (at state and national levels), the authors found that players born in the last quartile of the year participate in matches for longer periods of time, even though they are a minority within the squad. These results highlight that other aspects, aside from the physical capacities and anthropometric characteristics, need to be taken into account in the process of talent identification and development, by emphasizing, above all, the tactical and cognitive aspects, exemplified by the ability to read the game and make decisions (Helsen et al. 2005; Teoldo et al. 2013; Silva et al. 2018). It should be noted that for the present sample the effect of relative age is a variable that significantly affects all players, regardless of their positional roles.

As for players' birthplace, the findings of this study suggest that cities' demographic rates and HDI are factors that influence the odds of playing in the elite of Brazilian soccer. Being born in cities with up to 100,000 inhabitants and with HDI above 0.501 may result in some advantages, especially with respect to informal soccer practice during the first years of life (Côté et al. 2006, 2007; Teoldo et al. 2013). In cities with these characteristics, sports practice is normally more usual, as cities' landscapes provide the possibility of greater familiarity with the sport, ensuring more experiences and positively influencing the acquisition of sports skills. (Côté et al. 2006). This happens because smaller cities with better HDI tend to be safer, and to provide citizens with greater access to health and education, in addition to incorporating more free spaces appropriate for the practice of sports activities, allowing children to participate in these sports activities for longer periods of time, and without adult supervision. Furthermore, the better safety, health and education conditions are directly associated with cognitive development, a key factor for sports performance (Côté et al. 2006; Côté and Hancock 2016). It should be pointed out that the characteristics of players' birthplaces seem to influence different positional roles in a similar way, *i.e.*, the characteristics considered ideal for the sports development process favor players of all playing positions.

Our findings also indicate that among all states, São Paulo is the one with the best characteristics for identifying and developing players capable of playing at the top tier of the Brazilian Soccer Championship. The state of São Paulo provided 26.6% of the players who have already participated in the competition. With respect to population characteristics, in the state of São Paulo, 90% of the cities have demographic rates of up to 100,000 inhabitants (568 of the 645 cities in the state) and high HDI (0.78, on average). In addition, high investments in education and sports, which indicates that public policies are concentrated in these aspects, substantially contribute to a favorable projection for the identification and development of soccer talents. In addition, it is possible to note that the states that have contributed more players to the elite of Brazilian soccer are also those with the highest number of Serie A clubs.

It is important to consider that, in Brazil, the main training centers are mostly located in big cities and, therefore, despite being born in cities identified as favorable for the development of sports skills in the early years of life, Brazilian players, at a certain stage, need to migrate to large urban centers in search of access to systematized training and better sports infrastructure (Teoldo et al. 2013). In these training centers, players are given the opportunity to undergo many hours of specific training (deliberate practice), that meet the demands of their latent development stages, in addition to 'exposing' them to a more demanding competitive environment. (Ericsson et al. 1993; Teoldo et al. 2013; Côté and Hancock 2016).

Furthermore, this study strengthens the findings reported in the first study carried out in Brazil, addressing the associations between birthdate, demographic rate and HDI (Teoldo et al. 2013). In this study, authors pointed out that the individual (birthdate) and environmental (birthplace and HDI) aspects are essential indicators for talent identification and development in Brazil. It is important to stress that the study of Teoldo and colleagues, in 2013 comprised a small sample (one season), while the present study conveys information on the entire universe of players who participated in the main national soccer competition, established in 2003. The results of the present study corroborate the evidence on individual and environmental characteristics that are likely to affect the development process of soccer players. Furthermore, this greater cutout, it allows improving the perspectives of the practical application of the observed results.

In terms of practical applications, our findings contribute to the processes of talent identification and development, regarding the practices currently employed by clubs, as well as the national public policies for sports development, especially in soccer. With respect to the processes of talent identification and development undertaken by the clubs, the present study provides information on the currently most favorable places for the identification and development of potential talents, by uncovering the individual and environmental conditions that influence the emergence of players, from an early age.

As for the public policies, this study describes the main characteristics of the cities that contribute the most to the identification and development of young talents for elite Brazilian soccer. According to these data, it is possible to understand that although these cities are considered ideal, and despite their relevance for the process of talent identification, they usually do not enable a quality sequence for players'

sports education due to the lack of competitiveness, which is abundant in larger cities. Remarkably, this is due to the increased access to specialized structures in these larger areas (Côté 1999; Côté and Hancock 2016).

Hence, through our results, public authorities and/or agencies supporting and promoting sports practice can consider the possibilities of investing in sport development in regions whose cities congregate the necessary characteristics, as observed in the present study. This proposition aims to encourage the creation of a sport development policy in these places, through the construction of regional sports training complexes, that adhere to the content, didactic and methodological guidelines of each development stage. Thus, children would be provided with the opportunity to experience quality training for a longer period of time, which would benefit the progression of their sports development and, consequently, increase their likelihood of social, cultural and economic ascension through sport. (Côté and Hancock 2016).

In addition, aspects related to socioemotional characteristics, such as closeness to the families, as well as to social security, would also be preserved through the projects of regional training centers. This would happen, as children would be closer to, and would receive support from their family and friends. This may result in greater emotional security, and therefore, these children may be more likely to have a promising career in sports. (Côté 1999).

In conclusion, this study provides important information on the individual and environmental characteristics related to the identification and development of talented soccer players in Brazil. It is noteworthy that the direction presented in this work should be used as a reference for optimizing the process of player identification and development, since talent may eventually emerge in cities/locations with different characteristics from those pointed out as ideal in this study. In addition, it is important to emphasize that the processes of identification of potential soccer talents, which are based on physical (e.g., strength, speed, agility, endurance) and anthropometric (e.g., height, weight) criteria, tend to potentialize the relative age effect. This further reflects the importance of not grounding the process of talent identification and development exclusively on these components, but also of considering the technical, cognitive and tactical aspects related to the game of soccer.

As this study takes into account the places where athletes come from, future studies should carry out a broader assessment of the likelihood of players achieving elite status in soccer, using a solid estimate from general population data. In addition, investigating other competitive levels may indicate whether the tendency observed in Brazil is a typical consequence for the sport or if it really allows to differentiate elite players from those competing at lower levels. We also recommend the utilization of complementary statistical procedures such as cluster analysis or modelling, in order to verify in further detail the integration between the variables analyzed in the present study. The lack of data enabling a more in-depth debate about the effect of the variables on the processes of talent development and training is a limitation of the study, as no data on the specific conditions of each region could be obtained. Information related to population density and the number of elite teams in each region could have afforded relevant additional information. Future studies addressing this shortcoming could provide a more detailed account of each observed variable, as well as identify their degree of relevance. For instance, such investigations might allow to ascertain whether the population size is really representative or only a reflection of population density in a given region. Following this approach could result in even more specific and reliable intervention measures.

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ORCID

Israel Teoldo http://orcid.org/0000-0001-9780-3456
Felippe Cardoso http://orcid.org/0000-0002-2861-6777

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