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ATHLETES' DROPOUT FROM SLOVAK FOOTBALL – SOCIAL IMPACT OF THE SPORT DETERMINED VIA ITS GEOGRAPHICAL PERSPECTIVE*

Michal Varmus ¹, Dominika Toman ², Martin Mičiak ³, Michal Šarlák ^{4*}, Lucia Pančíková ⁵

^{1,2,3,4} Department of Management Theories, Faculty of Management Science and Informatics, University of Žilina, 010 26 Žilina, Slovakia

⁵ Department of Macro and Microeconomics, Faculty of Management Science and Informatics, University of Žilina, 010 26 Žilina, Slovakia

E-mails: ^{4*} Michal.Sarlak@fri.uniza.sk (Corresponding author)

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Abstract. The article focuses on athletes' decision to leave organized football in Slovakia. It reveals the impact of this sport on society from a sports geography perspective, understood as the spatial distribution of football participation, accessibility of clubs and infrastructure, and regional disparities affecting athletes' retention, which is still underdeveloped in research. We aim to explore selected aspects to understand the current decrease in the young athletes' participation in the Slovak Football Association's (SFA) competitions. The quantitative methods applied to the data include logistic regression and correlation analysis, with the models being assessed by their accuracy, sensitivity, and specificity. We used an exclusive data set provided directly by the SFA, as well as data extracted from the Sportnet API. This created a unique primary material for our research needs, complemented by official Sport in Figures reports (2015–2021) as secondary data sources. We identified variables significantly influencing the likelihood of athletes staying in organized football (including the age of starting with football, basic line-up, and yellow cards). Based on the results, we defined recommendations for effective athletes' retention strategies so that the sport's social impact, quantified by its geographical dispersion, can be maximized.

Keywords: sports; sports geography; Slovakia; sports management; football

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JEL Classifications: J24, R12, Z13

1. Introduction

Sports represent a dynamic area affecting employment and economic activity (Barbu et al., 2020; Chadwick, 2022; Guidotti et al., 2023). Embedded in mainstream business, sports developed links with politics, education, and economy, having a major social and cultural impact in a broad context (Patatt & Sandes, 2025). The growing economic importance of sports created the need for a governance structure (Tomino et al. 2020) provided by sports management (Hammerschmidt et al., 2023). It is the decisions of national sports organizations' managers that form the current situation in a particular sport in the country, affecting society via the sport's spatial coverage (its geographical perspective), which in this study is understood as the territorial accessibility of sport, regional distribution of clubs and infrastructure, concentration of athletes, and differences in opportunities for participation across regions. The more dominant the sport is in the country and the greater area it covers, the

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greater responsibility is put on the sport's national authority. This is exactly the case of football in Slovakia, being formed by the decisions of managers in SFA.

Sports management must define core knowledge to provide adequate competencies for sports managers and other stakeholders (Liu & Lin, 2012). The basis for its expansion is multidisciplinary sports' research put into broader social context (McCullough et al., 2020). However, this remains a small sub-discipline of managerial and social studies (Masteralexis & Hums, 2023). For its further development, utilization of economics, sociology, psychology, political science, and geography is necessary (Gammelsaeter & Anagnoustoupoulos, 2022). Sports management research expanded beyond traditional approaches, exploring different perspectives (Rich et al., 2021; Bodin et al., 2022; Kim et al., 2024), including sports geography. According to Bale and Dejonghe (2008), the link between these fields' dates to 1879, but such studies usually focus solely on sports. This limits the possibility of harnessing the capacity of research from geography for novel findings with true social impact. The complementarity between geography and sports lies in the geographic components of sport activities (Hall & Lin, 2024). Methods specific to geography are used to ascertain the sports activities' social impact (Koch, 2018; Hall & Lin, 2024), including cartographic approaches (Chirazi, 2019). Their application enables a systemic understanding of phenomena, leading to smoothly working spatial systems (Ilies et al., 2014). Bale (2002) adds that sports geography is understood as examples of systemic mechanisms, exploring the changing landscape characteristics and the symbiosis between the sports environment and its participants to develop new strategies. However, it is not just the direct participants of sports activities. The total impact sports have on society is extended via the sports fans and spectators, youths' meaningful leisure time activities, and the people's healthier and more active lifestyles. All this is built on the sport's popularity as well as its accessibility throughout the country. This is where sports affected by their governance structures meet the geographical aspect in the effort to enhance sports' positive effects on modern societies.

Sports geography needs to be combined with the socio-economic factors in sports management research and practice. Sports became an everyday-life element with corresponding socio-economic risks (Bourg & Gouguet, 2023). Applying this framework explains both basic social and economic motives connected to the participation of society in sports (Ejekwumadu, 2025). However, these factors are difficult to identify because they relate to people's characteristics, often varying within the same community or between groups (Karney, 2021). Moreover, these variables are dynamic by design (Ginevicius et al. 2021; Conger et al, 2021). Including socio-economic factors in research provides a comprehensive picture of sports in a particular region (O'Neil, 2022; Lera-Lopez & Marco, 2022), helping identify areas where interventions are necessary to promote social equity as another part of the sports' impact on society (Prudky, 2022; Dická & Lipták, 2024). Sports' socio-economic and geographical characteristics are studied within geopolitics, socialization as well as housing and migration (Galindo, Vega, 2024; Meneses et al., 2024; Torres, 2024). Still, the research addressing geography of sports connected to sports management for greater social impact is limited (Wise & Kohe, 2020; Kohe & Wise, 2023).

The approached topic gets even more complex with the inclusion of the data available and the ways they can be analyzed. Data analytics are crucial, and its importance grows as technology advances. Strategic emphasis is on the use of data analytics in supporting managerial decision-making with consequent social effects. Szukits and Moricz (2024) motivate towards the building of an analytical decision-making culture. This promotes better use of data at every stage of decision-making. Data analytics is currently revolving around Big Data. This is transforming the decision-making process (Koman et al., 2018; Pittenger et al., 2023), increasing the decisions' quality (Li et al., 2022). Organizations are recommended to popularize Big Data, improving corresponding employees' skills (Staffenova & Kucharcikova, 2023). This is also applicable in sports organizations, leading to better focus on the sports managers' decisions with greater social impact. Data analytics supporting organizational decision-making is an ever-developing area. Pu et al. (2024) focus on Artificial Intelligence (AI) analytics, bringing innovative approaches even to football.

Our study focuses on the analysis of data provided by the SFA exclusively for this research in connection with the geographical aspect determining the sport's broader impact on the whole society. We followed the identified gap, analyzing spatial and managerial factors influencing the dropout of athletes from Slovak organized football with the corresponding social consequences. Our aim is to examine these aspects to better understand their dynamics, leading to the decline in athletes' participation after the age of 15. This research focuses on

identifying the factors contributing to the problem of young athletes leaving organized football. Thus, it provides a basis for effective strategies to retain young people in organized sport, supporting the corresponding social value of their participation. Leaving organized football is understood as not participating in competitions organized by the SFA.

Our motivation for including sports geography is to address the research gap identified and apply the geographical perspective in the determination of football's impact on society. The study is based on theoretical backgrounds and previous research described in the following chapter. The selected problem has not been sufficiently addressed within Eastern Europe yet. Furthermore, our research responds to the request of the SFA identifying this issue as its key priority. The SFA highlighted the declining participation of youths as a critical challenge and emphasizes the need for a deeper understanding of the underlying factors. This concern is shared by several experts from the Ministry of Tourism and Sports of the Slovak Republic (MTSSR), aware of the long-term consequences of the decline in youths' participation in professional football. Studying the issue is essential not only for the development of football, but also for the wider social and regional dynamics of recreational sports. Our results serve as a guide for targeted strategies to increase youth retention in football. The research also contributes to a more accurate understanding of the factors influencing youths' dropout from football, supporting the national football policy. Previous research in this area has focused mainly on socio-economic factors. We focus on understanding the dropout after the age of 15, combining sports performance, socio-economic background, and regional differences in Slovak football. This is embedded in the broader context of football's social impact, determined via the geographical perspective. We formulated the following research RQ: How can the football association and the clubs influence the dropout of athletes from organized football, considering the context of sports geography and the socio-economic environment?

The article's structure includes theoretical background, methodology, research results, discussion and conclusion. The theoretical background covers the link between football's social impact expressed by the geographical perspective and the decisions sports managers can make to support the youth's participation in this sport. The methodology explains the process of data preparation and analysis to obtain the results interpreted below. The discussion compares our findings with relevant research, and the conclusion summarizes the most significant findings and recommendations drawn from them.

2. Theoretical background

The issue we studied was addressed in the past in several countries, including England or Germany (Bale, 2002). However, there is shortage of knowledge from the perspective of Slovakia's geographical setting. Despite numerous researchers who approached the topic (Bale, 2002), there is still a need for further research on sports geography applied to determine the sport's social impact and its maximization via proper decisions and policies. Such research should focus on the sports environment, athletes' decisions to stay in the sport, and other related characteristics. This need arises in response to socio-economic factors causing the problem that have already been analyzed. The current situation is described within the theoretical background.

2.1 Sports geography perspective in the determination of the sport's social impact

In the context of this study, the geographical perspective of sport is defined as the way sport is distributed and experienced across space, including regional differences in infrastructure, club availability, accessibility for participants, and uneven retention of athletes. This perspective allows the social impact of football to be interpreted not only through participation numbers, but also through its territorial reach and inclusiveness. Although this direction is not currently dominant, it offers scope for studying the causes and consequences of athletes leaving organized football, allowing for the desired interdisciplinarity in research (Rauch, 2022; Menge et al., 2024; Valiyeva et al., 2024). The field studies spatial organization of sports, geographical density of football, and the impact of infrastructure on the retention of athletes in professional and amateur competitions. The analysis of these aspects involves the connection of sociology, economics, and geography (Bale, 2002). Although geographers made significant contributions to sports research, their studies mainly approach political or urban geography. This limits broader interdisciplinary collaboration in the analysis of social factors leading to the termination of athletes' careers in football (Smith et al., 2023).

The economic aspects of sports geography are related to the analysis of professional football markets, investment in clubs, and their regional impact. Additionally, this part of sports geography studies issues funding youth academies and the uneven distribution of resources between elite and amateur football. This contributes to early careers' termination (Hem et al., 2022). Economic inequality among large clubs and smaller regional teams can lead to insufficient support for talented athletes.

The spatial organization of football is influenced by historical, social, and economic factors. Some regions produce more professional athletes due to infrastructure investments, cultural traditions or their training systems. In other areas, athletes have limited opportunities for growth, leading to early careers termination. The concept of sports capes highlights how the availability of stadiums, training centers, and quality youth programs influences athletes' retention in football. Insufficient infrastructure and limited access to training opportunities belong to the key factors forcing athletes to leave organized sport prematurely. This background shows the close interconnections of geographical and social factors, affecting the final sports' position in society. Later in the results, we build on this, depicting the sports' (particularly football's) social impact via the geographical perspective.

2.2 Athletes' dropout affected by the sports managers' decisions

Sports management plays a pivotal role in the process of retaining athletes in organized football. Effective club management, properly set incentives, and quality care can minimize the talents' premature dropout (Zelenkov & Soltsnev, 2023; Hammerschmidt et al., 2024). Social media and marketing impact the creation of strong bonds between athletes, clubs, and fans. This helps keep athletes in football longer (Behrens & Uhrich, 2022). Research studying this focuses on linking sports management with geography, creating space for collaboration among clubs, coaches, and wider community to reduce premature termination of athletes' careers in football (Galindo & Vega, 2024).

Sports managers also need education in geographical aspects to be able to make decisions on the development of athletes' careers. Hall and Lin (2024) point to the need for a better pedagogical understanding of sports geography regarding the sports careers' termination. DeChano-Cook and Hallett (2024) recommend including human and physical geography in teaching to help analyses the factors leading to the athletes' dropout from the organized sports. According to Girginov (2001), it is essential to support teaching with research so that knowledge can be transferred to education and sports management, creating better conditions for longer sports careers.

Athletes' dropout from organized sports is caused by multiple factors. These include the lack of enjoyment, excessive pressure, and negative experiences (Schlesinger et al., 2018; Eliasson & Johansson, 2020; Back et al., 2022a). Psychological stress, burnout, and physical exhaustion contribute significantly to careers' termination in competitive environments (Back et al., 2022a; Soares & Carvalho, 2023). Socio-economic barriers, issues with commuting to training and competitions, changing interests, and injuries are influential here (Espedalen & Seippel, 2022). Parental influence, early specialization, and inadequate support systems increase adolescents' disengagement from sports (van Yperen et al., 2022; Bergin & Lagestad, 2023). Addressing this requires coaching strategies and an inclusive sports environment (Back et al., 2022b). A proper analysis of data is essential to identify the main factors causing the problem in a specific region.

3. Methodology

There is a link between data analysis and managerial decision-making in sports organizations. Individual mobility and human patterns analyzed from multidisciplinary studies are not sufficiently applied within sports geography. Areas of concern include the evaluation of Big Data representing individual behavioral patterns (Rauch, 2022). Focus on further application of data analytics in sports geography is vital. Hoyer et al. examined the decision-making role within Canadian national sports organizations. They studied the processes facilitating decision-making. As revealed, sports managers focus on strategy development using data analytics (2023). Decision support in sports organizations in Latin America was addressed by Pérez et al. (2023). They identified gaps in the decision-making process, recommending a decision support model for sports managers ensuring a methodical and operational approach. This is where our study follows, approaching the issue of athletes' dropout

from organized football in Slovakia, showing applicable results with potential social consequences based on advanced data analytics.

Our research utilizes data mining on a unique primary dataset with further statistical modelling. The dataset used for this procedure was provided exclusively for this research by the national football governing body, the SFA. The arguments that the data from the SFA were not used in any other research and that they were collected in close cooperation with the research team members support their primary nature. Accompanying the primary data, relevant sources of secondary data were used as well, being described later. The problem's specification is the youths' dropout from organized football after the age of 15. The aim is to identify the factors contributing to this phenomenon. The research hypothesis was defined based on previous research in the field as follows, H: The selected variable x_i significantly influences athletes' dropout from organized football. Thirteen independent variables ($x_i, i = 1 - 13$) were examined within the hypothesis's verification. These are defined later in the text. The research harnessed multiple software (SW) tools. These were used to calculate the selected statistics, process data sources, and create graphical outputs. MongoDB and MongoDB Compass were applied to process the JSON files from the SFA and the Sportnet API data. Postman was used to send requests to the Sportnet API server. Python was applied for data modification. RStudio was used for modelling. Other data operations were performed in MySQL.

Data Processing – Data sources included mainly the SFA data collection, the Sportnet API, and Sport in Figures (“Šport v číslach”) reports (2016a, 2016b, 2018, 2019, 2020, 2021, 2022). Figure 1 illustrates the data processing procedure as a complex approach from the initial data acquisition to the final analysis. The SFA data collection contained the data from the matches covered by the SFA since the 2012/2013 season in object form (JSON – array). The file included data types of number, string, Boolean, or object and array. Another data source was the API (Sportnet API, 2023) with data on players, clubs, and organizations. We used the Sportnet APIs denoted Transfer and User.

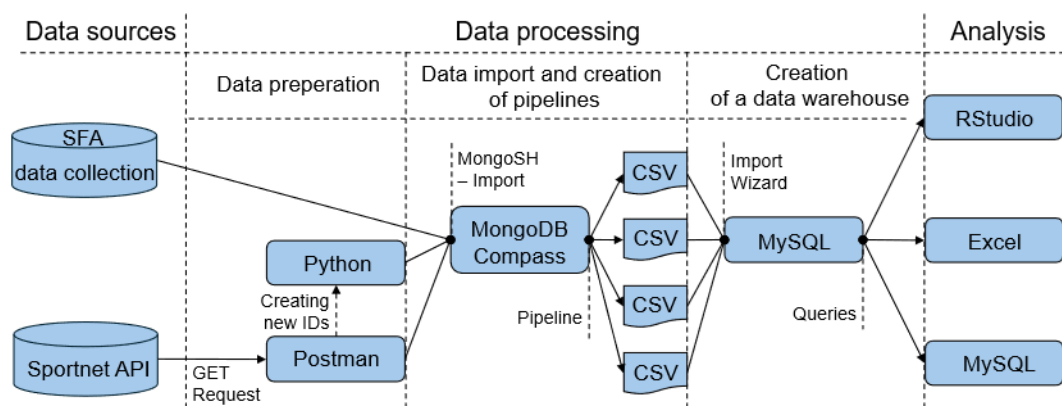


Figure 1. Research data preparation and processing

Source: Own processing

Preparing the Data for Analysis

To get the data from the API, queries were sent to the Sportnet server. Before importing the API data, the Transfer data went through the process of creating a unique ID, as there was an error when trying to import it due to duplicate IDs. This occurred because of the efforts to insert the same ID multiple times. A player ID was used in the transfer record where players can be a part of a transfer multiple times during their careers. To create the composite key, we used Python to cycle through each document, changing the `_id` to `"player_id"`, adding a new string representing `"player_id" + "date_from"` (the start date of the transfer). This was assigned as the new `_id` of the transfer record, solving the problem of duplicate entries. We converted the data from the unstructured to the structured form. We performed the data processing at the NoSQL document level, using the MongoDB tools Compass and mongosh. An example of data processing is the `"protocol"` object containing an `"events"` sheet, with a record of each event from the match.

Creating a Data Warehouse

After creating the data pipelines, the data were exported to CSV files. These were uploaded to MySQL, where each table represented a separate data feed. Before displaying the created ERD model, we defined the basic properties. The unique player identifier was in the “player_id” column. The processed data was viewed in a time horizon with the codebook of the season table. It was convenient to group the data by a numerical identifier of the season (e.g. id – 11; name – 2022/2023). As additional summarization keys and filtering tools, we used “competition_id” (specifying the category and geographical location) and “competitionPart_id” (part of the competition).

Creating the Training and Test Sets

We used MySQL to create the final data set for the training and test sets. Since the tables had tens of thousands of records, the query response did not come in some cases. We solved this via a temporary table with indexes, reducing the computational complexity.

Table 1. Final data cleansing from outliers in MySQL

Season	Number		Discards			Percentage of Discards (%)
	Total	Final	Year	Logic	Goalie	
2	3,245	2,740	9	140	372	4.62
3	3,418	2,887	9	145	391	4.62
4	3,326	2,855	3	126	354	5.21
5	3,405	2,840	6	131	384	5.49
6	3,214	2,770	5	107	341	3.58
7	3,604	3,099	1	119	397	3.36
8	3,350	2,886	1	88	386	2.63
9	3,324	2,800	12	69	350	2.57

Source: Own processing

Table 1 shows the elimination of athletes by season (2 = 2013/2014 to 8 = 2020/2021). The proportion of discarded values is a maximum of 6%. Therefore, the data remained unbiased. Before entering the training and testing data into the RStudio, we filtered out goalkeepers, those whose SFA registration (“old_when_start”) was less than 5 and greater than 14 (possible bias), and those whose year of birth was the highest in the season. Goalkeepers were excluded because of the statistics tracked by them.

We removed invalid and inconsistent values. We also excluded data representing a source of potential errors (e.g. incorrectly recorded player registrations). This increased the reliability of the data and the accuracy of output. Additionally, to ensure cross-validation in our research project, we analyzed the data using decision trees, random forests, and the support vector method. These steps corroborated the correctness of our results but were not included within the scope of this study. The total sample for the research consisted of 22,877 athletes in the given age range. The number of athletes in these categories does not change rapidly during the period studied. However, the issue is their continuation in professional sport.

Modelling

The final step of our methodology was modelling itself. We used logistic regression for binary classification to predict which of the two categories the input belongs to. This model applies a logistic function to the training data, mapping the input values to an interval between 0 and 1. The value is interpreted as the probability that the input belongs to the positive class (1), (Hastie et al., 2008).

The logistics function is defined as follows: $p(x) = 1 / (1 + \exp(-z))$, where $p(x)$ is the predicted probability of the output, $\exp$ is an exponential function, and z is a linear combination of the input features. This is written as: $z = b_0 + b_1x_1 + b_2x_2 + \dots + b_nx_n$, where b_0 is the intercept and b_1 to b_n are the coefficients of the input features.

Logistic regression was selected as an appropriate tool for the problem approached. It is a method used in the past in similar studies (van Yperen et al., 2022; Espedalen, Seippel, 2022; Chen et al., 2023; Schmid et al., 2024). However, in combination with sports geography and sociology, it is still a less common approach allowing the analysis of relationships between spatial factors and sports performance (Wise, Kohe, 2020; Hall, Lin, 2024).

4. Results

Our research is divided into interconnected parts, providing multiple perspectives on the issue. The first part includes the analysis of secondary data. The remainder presents the results of the primary data analysis (the exclusive SFA dataset). We focus on the participation rate of the population in sports, investigating how many people are actively involved in sports activities. This part addresses regional differences in sports participation, with sports geography enabling a deeper examination of the spatial distribution and the actual impact of sports on society. This part explores inequalities in access to sports activities and the disparity of results from different statistical approaches. We also work with relevant secondary data to describe the socio-economic conditions of Slovakia related to football and the popularity of this sport in the country. These arguments justify the overall focus of the study on football, show the impact of this sport on the country's total sports participation, and depict the socio-economic context necessary for the extrapolation of further analysis's results and their applicability in other regions.

The second part of the results starts with the basic statistical analysis of the SFA data, identifying significant trends and patterns. This is followed by correlation analyses, descriptive statistics, and other methods to identify relationships among the variables studied. At this stage, sports geography perspective is crucial, as spatial analyses bring more precise mapping of behavioral patterns and regional differences. The third part focuses on logistic regression we used to model the likelihood of young athletes' continuous participation in sports activities. Logistic regression helped us identify the factors with the greatest influence.

Population's Participation in Sports

Understanding population's participation in sports is pivotal when examining the dropout from organized football. This parameter allows the identification of target groups of players with the highest risk of leaving and reveals regional and social differences in sports participation. This is essential for the development of effective athletes' retention strategies. According to a study by Malm et al. (2019), healthy lifestyles including active sports participation are a benefit of elite sports events. The findings are consistent with the sports development results from the 1984 Los Angeles Olympic Games. However, sports events can only be used to increase the participation rate of the population in sports if the necessary collaborations among sports organizations, event organizers, and non-sport stakeholders are established via the marketing mix (Chaplin et al., 2016). Denmark is an example of using and maximizing the marketing mix in sports. This country strives to become the most physically active nation in the world. The Sport Concept supports the goal that by 2025, 75% of the population will participate in sports and 50% will be active in sports organizations (European Commission, 2024).

This long-term goal in Denmark is reflected in their current achievements, as according to the results from 2019, Denmark and Sweden achieved the highest levels of population's participation in sports in the EU, at 75.8% and 75.3% respectively (Fig. 2). The EU average was 41.05%. At the other end of the ranking, there are countries such as Romania (6.3%) and Bulgaria (13.6%). Slovakia has a participation rate of 32.6% (18th place) with the need to improve the conditions for sports activities. These significant variations point to regional differences in access to sports and varying levels of support for active lifestyles (Eurostat, 2019).

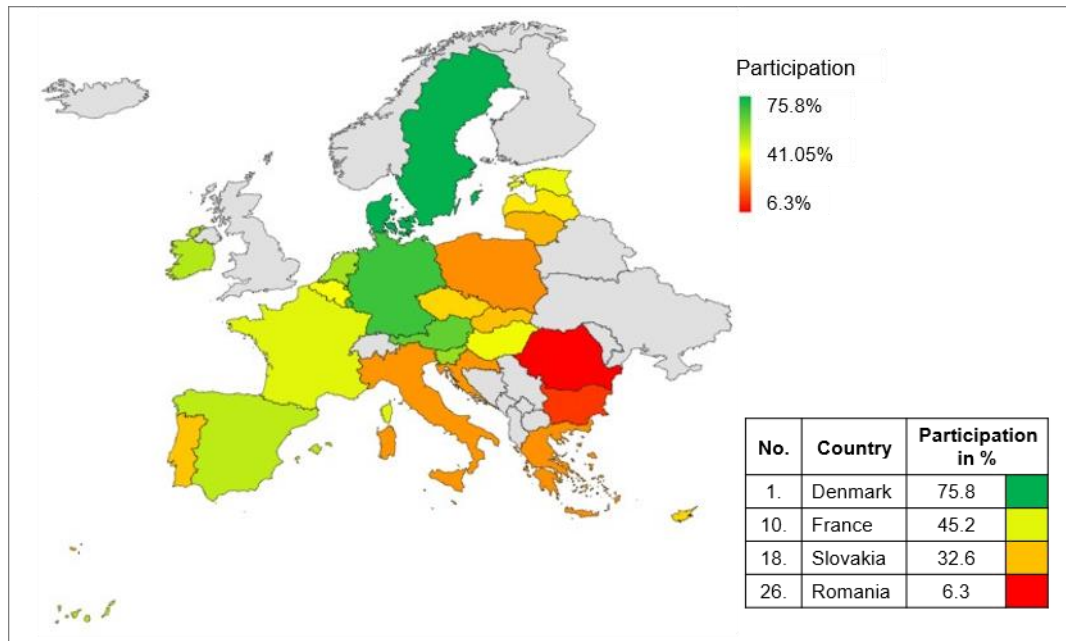


Figure 2. Participation rate of the population in sports
Source: Eurostat, 2019

The results are partially affected by quantitative measurement of physical activity in Eurostat databases (2019). There is another approach (Fig. 3) focusing on combining qualitative and quantitative data collected via interviews to gain insight into people's actual physical activity. The difference is in the percentages of the population participating in sports. According to this approach, Denmark is only in 4th place with 59% and Slovakia has a higher participation rate of 35%. However, this is still low compared to the most-active countries, with Finland reaching the level of 71% (Eurobarometer, 2022).

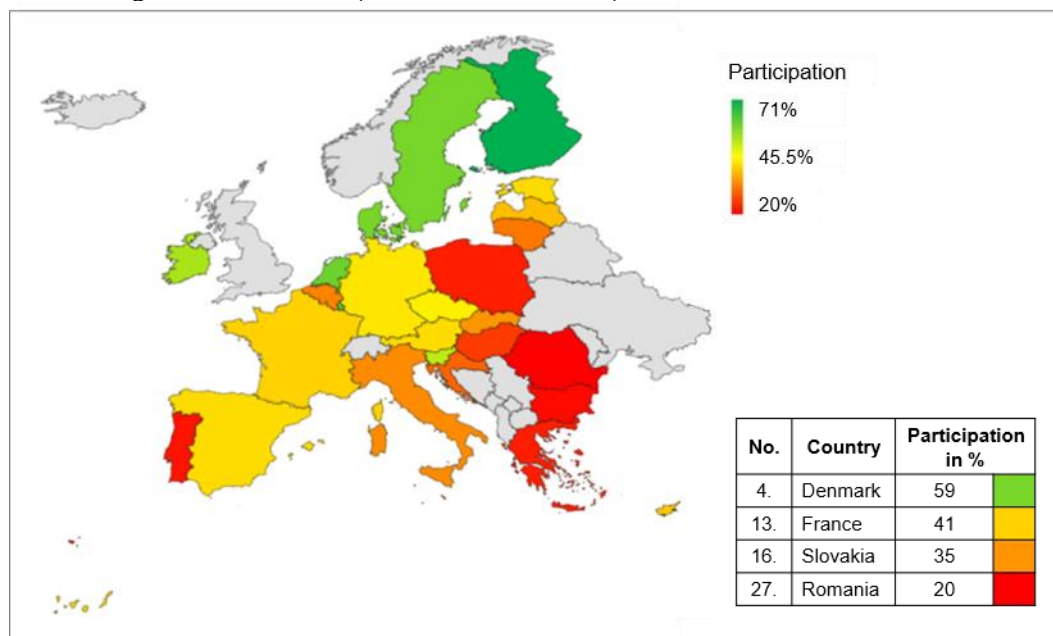


Figure 3. Participation rate of the population in sports
Source: Eurostat, 2022

The different methodological approaches of the European Health Interview Survey and the Eurobarometer (2022) influence the analysis of factors leading to athletes' dropout from organized football. This divergence of surveys shows why data modelling is so important in our study. However, in the case of Slovakia, both approaches show low participation in sports, suggesting that the problem of athletes leaving organized competitions may be related to this.

Socio-economic Characteristics of Slovakia

UEFA, in collaboration with leading universities, research institutes, and football associations, developed the Social Return on Investment methodology to quantify the impact of football on society. In 2019, this was applied in Slovakia in collaboration with the SFA (2020). The study focused on four main areas: economics, health, social affairs, and sports performance. Each of them was analyzed using specific research tools.

Football contributed €54.1 million to the Slovak economy (€19.5 million in investment in football infrastructure; €34.6 million in expenditure by football players). 14,000 people earn an income from football-related activities. The health benefits of football are estimated at €105 million annually. These include savings in the prevention and treatment of various diseases, reduced mental health costs, and the perceived happiness value football brings. The social aspects of football are reflected in the savings of €18.9 million annually related to crime prevention, education, and the value of volunteer work. Football also contributes to increasing the country's sports performance measured by the UEFA rankings. The growing number of players has a direct impact on the quality of the game and the national team's success. The SFA can secure one new football player for every €120 and get a social return of €1,664, generating high social value. The mechanisms and strategies for the effective utilization of these investments are detailed in the SFA's strategic plans. Football's Popularity in Slovakia and Abroad – The Ministry of Tourism and Sports of the Slovak Republic (2024a) conducts a survey every two years to determine domestic interest in individual sports. This interest is assessed based on methodologies serving as a factor in determining funds for individual sports. Foreign interest is assessed similarly. Football has a domestic interest of 7.30%, putting it in second place after cycling. Its foreign interest is 14.50% (the highest value among the sports included). The ratio of domestic to foreign interest in sports has long shown that this sport is the most popular in Slovakia. Football is the most widespread sport globally with a massive fan base. This is evidenced by the online analysis Topend sports (2025), monitoring 13 selected rankings of the most popular sports worldwide.

Slovak football is organized through more than 1,732 clubs, youth development centers, football academies and 64,606 (MTSSR, 2024a) registered players, with significant regional disparities in infrastructure. Bratislava region, while relatively small in its area, concentrates 99 clubs, 5 youth development centers, and 2 academies, reflecting its professional infrastructure. Trnava and Nitra regions have 214 and 272 clubs respectively, with Trnava operating both 1 youth development center and 2 academies, while Nitra has 4 youth development centers but no academy. The Prešov region stands out with the highest number of clubs (268) and 7 youth development centers, yet only 1 academy, illustrating the imbalance between participation and elite pathways. Similarly, the Košice region has 225 clubs and 3 youth development centers but just 2 academies. Western Slovakia overall concentrates a greater part of the professional infrastructure and academies, whereas Eastern Slovakia shows higher grassroots engagement but limited elite opportunities. These uneven geographical and socio-economic conditions form an essential background for analyzing the athletes' dropout from organized football after the age of 15. The exact values for each Slovak region are listed in Table 2.

Table 2. Regional differences within the organized football in Slovakia

Region	Football clubs	Youth development centres	Football academies
Bratislava	99	5	2
Trnava	214	1	2
Nitra	272	4	0
Trenčín	225	3	1
Žilina	233	3	3
Banská Bystrica	196	3	3
Prešov	268	7	1
Košice	225	3	2

Source: SFZ – Youth development centers, 2025; SFZ – Football academies, 2025; Slovak sports portal, 2025

For a better understanding of the regional differences within different parts of Slovakia, the data were visualized in Fig. 4.

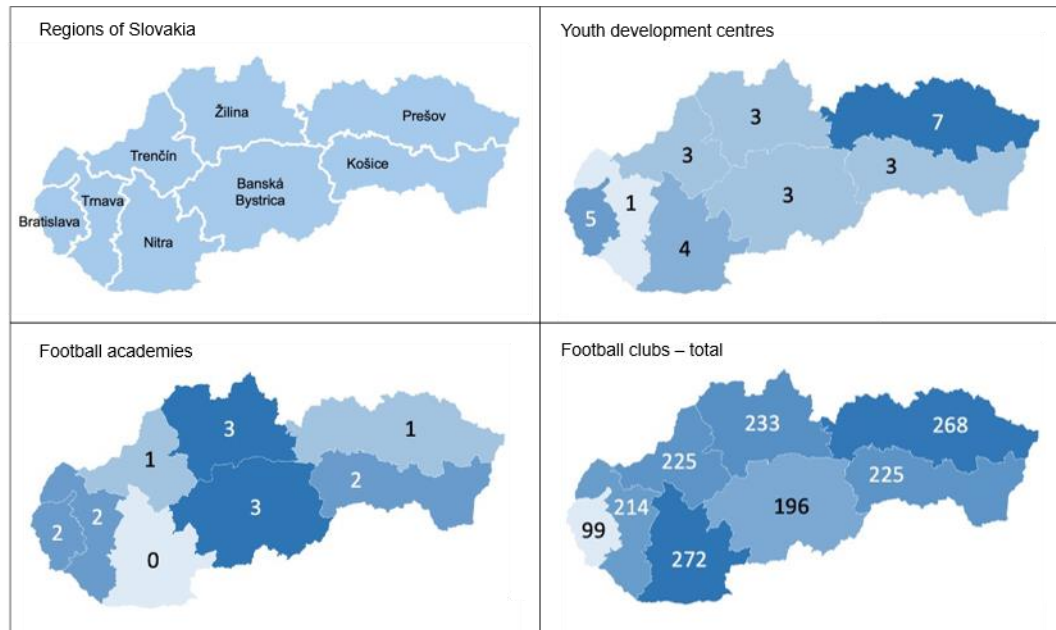


Figure 4. The number of researched elements of Slovak football; created using Bing – Microsoft, OpenStreetMap
Source: SFZ – Youth development centres, 2025; SFZ – Football academies, 2025; Slovak sports portal, 2025

The data on development of the number of registered football players in Slovakia must be analytically processed since 2014. This obligation is in accordance with the Act on Sports. However, it does not concern the entire population of athletes. Only football players registered up to the age of 23 (U23) are included. Analyzing the available development of the number of registered football players (table 3), the decrease between 2016 and 2017 was identified. The number of players decreased from 80,623 to 65,162 (a decrease of 15,461 players, approximately 19%). After 2017, the number increased slightly but did not reach the level of 2016. From 2018 to 2020, it fluctuated around 66,000 to 67,000, while growing only moderately.

Table 3. Decline in the number of athletes in organized football in Slovakia

Year	2015	2016	2017	2018	2019	2020
Number of U23 athletes	75,984	80,623	65,162	66,422	66,746	67,673

Source: NCSR (2015); MTSSR (2024b)

This problem is seen as urgent by the SFA, which led to the request for our study.

Results of Statistical Analysis

Our statistical analysis studied several factors influencing the selected issue in Slovakia. The analyses focus on the number of football players in primary and secondary sports schools by region, the average age of athletes' registration in the SFA, the average number of nominations per match, the average number of matches in the starting line-up, the average number of goals per season, and the differences of other independent variables. A correlation matrix with variables' coding is presented. Coding is important for logistic regression as well.

The analysis shows that the number of pupils attending primary school football classes in Slovakia has decreased by 548 between 2015 and 2021. In 2015, 3,454 pupils were registered in sports classes, while in 2021 this number decreased to 2,906. This downward trend was observed since 2015, but the regular reduction in pupil numbers started in 2018, with an average decrease of approximately 5% per year. The reduction in pupil numbers was influenced by several factors, including the COVID-19 pandemic.

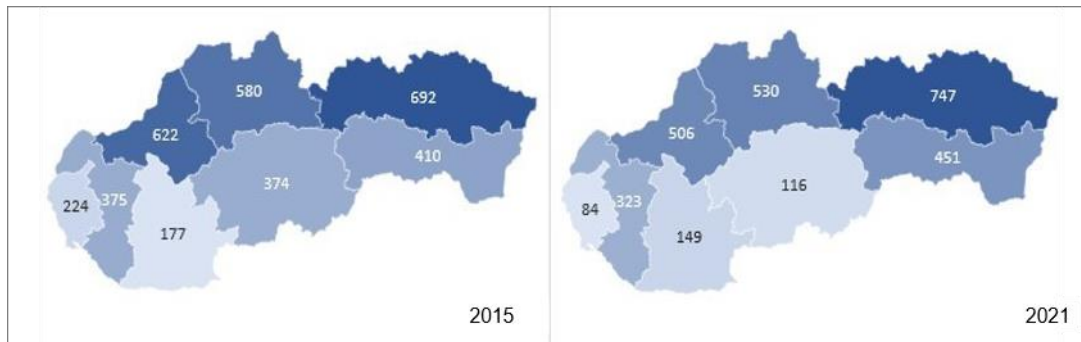


Figure 5. Number of football players in primary sports schools by region – comparison between 2015 and 2021
Source: Sport in Figures reports

Figure 5 shows that Eastern Slovakia was the only region with an increase in the number of pupils in these classes. This growth contrasts with a nationwide downward trend, suggesting regional differences in corresponding factors. A similar downward trend is observed in secondary schools. This can be affected by a change in the methodology of data recording between secondary schools and secondary sports schools. This is confirmed by the data from the counties as well as the distribution of pupils by year group. The number of freshmen in high schools declined each year, which is reflected in the total number of students in high schools with a lag of approximately three years, while maintaining a stable attrition rate between grades.

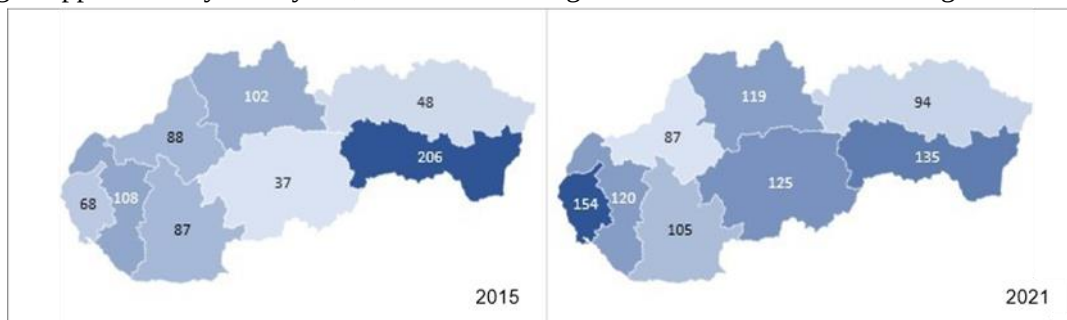


Figure 6. Number of football players in secondary sports schools by region – comparison between 2015 and 2021.
Source: Sport in Figures reports

Figure 6 illustrates the change between 2015 and 2021, where a more even distribution of students between secondary sports schools is evident. There was a general increase in the number of students in such schools over the period studied, with an increase of 115 students in Western Slovakia and 105 students in Central Slovakia. The opposite trend was observed only in Eastern Slovakia, where there was a decrease of 25 students. The data concerning secondary sports schools indicate the opposite trend of students' migration compared to primary schools, again corroborating regional differences.

We also analyzed the athletes' age at registration into organized football. This is crucial in predicting the continuation of a sports career. Fig. 7 (variable x1) shows that the earlier an athlete registers, the higher the probability of continuing with organized football. The decrease in the age of registration may indicate that starting organized football at a younger age is an important factor for further development of athletes and their long-term persistence in the sport. The number of stars an athlete makes in the starting line-up and the number of nominations per match are closely related variables (Fig. 7, x2 and x3). Although these two variables evolve in parallel, the difference between them is stable (in the interval from 4.9 to 6.2), signaling that athletes who start more often in the starting line-up are more likely to continue in the sport. Another significant variable is the number of goals scored (Fig. 7, x5). Prior to the start of the pandemic, the average difference in the number of goals between continuing and non-continuing players was approximately 4.5 goals.

This difference supports the hypothesis that a player's productivity on the pitch can positively influence the chances of continuing with a football career. Other variables (x4 – x7; substitutions, red and yellow cards respectively) have less predictive value. Substitutions show unstable differences between continuing and non-continuing players, suggesting that this variable may not be reliable for predicting further career. Red cards have

a very low incidence (0.01 per player), suggesting no significant impact on players' career progression. Yellow cards are more frequent (0.25 per player), but their impact is equally indeterminate as the differences between groups of players are negligible and unstable. All the variables examined are explained in Table 4 in the following section.

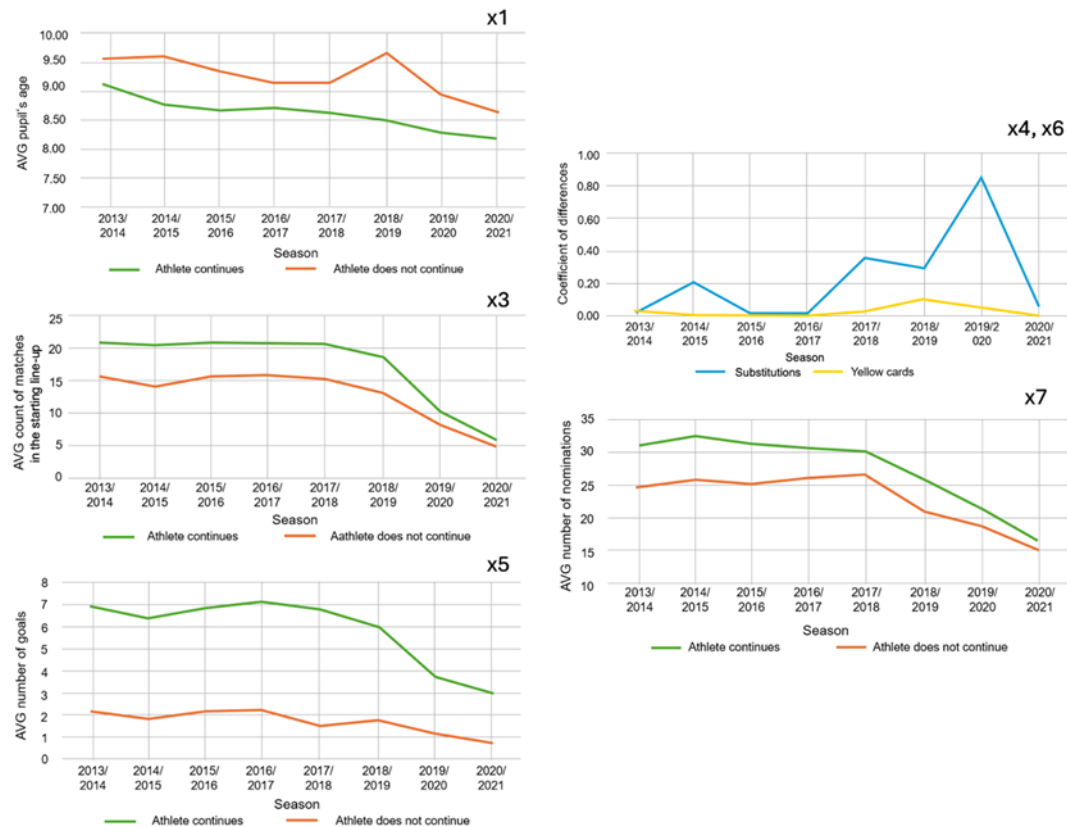


Figure 7. Overview of variables x1, x3, x4, x5, x6, x7 in the period studied

Source: Own elaboration

Logistic Regression – Before the modelling, individual variables were coded. The dependent variable “y” was labelled “Continues,” indicating whether the players continue in their sports careers. The independent variables were coded as follows: “x1” represents the age the athletes started playing football (“old_when_start”), “x2” and “x3” indicate the number of nominations and starts in the starting line-up (“app_in_nom” and “app_in_basic”). Variables “x4” to “x6” track statistics such as substitutions (“Substitution”), number of goals (“Goal”), and yellow cards (“YellowCard”). Other variables include the number of red cards (“RedCard” – x7), playing at the position of a defender, midfielder or forward (x8, x9, x10), ability to play at multiple positions (“multiple_positions” – x11), a transfer to another club last season (“transfer_past” – x12), and normalized data on the player’s birth (“norm_birth” – x13).

Table 4. Coding of dependent and independent variables.

Variable	Name	Variable	Name
y	Continues	x7	RedCard
x1	old_when_start	x8	Defender
x2	app_in_nom	x9	Midfielder
x3	app_in_basic	x10	Forward
x4	Substitution	x11	multiple_positions
x5	Goal	x12	transfer_past
x6	YellowCard	x13	norm_birth

Source: Own elaboration

The second step was to create a correlation matrix (Fig. 8). The correlation analysis reveals significant relationships between the dependent variable y (career continuation) and the explanatory variables. The variable y shows a negative correlation with the age of starting with organized football (x_1 : -0.16) and normalized age (x_{13} : -0.27), indicating that a higher age reduces the likelihood of career continuation. Conversely, the positive correlations with nominations (x_2 : 0.18), starting line-up (x_3 : 0.24), number of goals (x_5 : 0.22), and the ability to play at multiple positions (x_{11} : 0.10) indicate that success on the pitch increases the chances of continuing a football career. Among the explanatory variables, the strongest correlation was between the number of nominations and the number of games in the starting line-up (x_2 and x_3 : 0.53), reflecting the logical relationship between nominations and the playing experience. Significant correlations were observed between the number of goals and positions (forward: 0.23, defender: -0.20), indicating players' different roles according to their positions. Furthermore, there was a high correlation between playing at multiple positions and midfielders (x_{11} and x_9 : 0.38). Conversely, low or insignificant correlations were found for red cards (x_7) or the defender position (x_8).

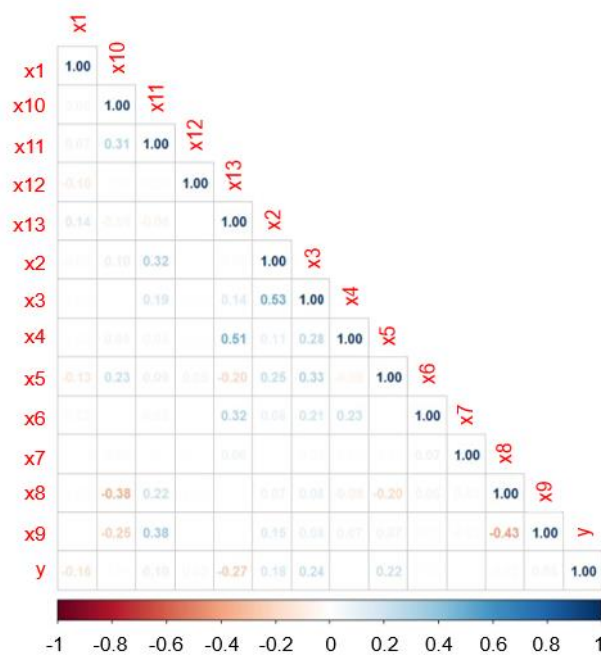


Figure 8. Correlation matrix of the training set

Source: Own elaboration

The last stage was the actual logistic regression. Its results show that the variables x_1 , x_2 , x_3 , x_4 , x_5 , x_6 , x_{12} , and x_{13} are statistically significant ($p < 0.05$). Variables x_1 and x_{13} have a negative effect on the dependent variable, with x_{13} showing the strongest negative effect (coefficient = -2.976937, $p < 2e-16$). The other statistically significant variables (x_2 , x_3 , x_4 , x_5 , x_6 , and x_{12}) have a positive effect with varying degrees. In contrast, variables x_7 , x_8 , x_9 , x_{10} , and x_{11} are not statistically significant ($p > 0.05$). The standard deviation of all coefficients is relatively low, increasing the ultimate estimates' reliability.

Coefficients:

	Estimate	Std. Error	z value	Pr(> z)
(Intercept)	-0.207506	0.242842	-0.854	0.3928
x1	-0.157619	0.010977	-14.359	< 2e-16 ***
x2	0.006039	0.002389	2.528	0.0115 *
x3	0.052230	0.002861	18.256	< 2e-16 ***
x4	0.088627	0.007502	11.813	< 2e-16 ***
x5	0.086058	0.005227	16.464	< 2e-16 ***
x6	0.131941	0.027928	4.724	2.31e-06 ***
x7	0.017295	0.195866	0.088	0.9296
x8	0.214440	0.217536	0.986	0.3242
x9	0.097992	0.218453	0.449	0.6537
x10	-0.161535	0.217456	-0.743	0.4576
x11	0.156819	0.228248	0.687	0.4920
x12	0.162432	0.067805	2.396	0.0166 *
x13	-2.976937	0.084542	-35.213	< 2e-16 ***

Figure 9. Logistic regression output – coefficients.

Source: Own elaboration

The results (Fig. 9) show that, within the context of the hypothesis set, the x7 – x11 variables do not significantly affect athletes' dropout from organized football. Other variables, x1, x3, x4, x5, x6, and x13 (coefficient statistically significant at the 0.001 level of significance), significantly influence this phenomenon.

The influence of these coefficients can guide sports organizations in identifying critical factors contributing to athletes' retention. The size and direction of these coefficients indicate that the variables have a meaningful impact on the likelihood of an athlete leaving organized football. For instance, since the coefficient for variable x1 is positive, it suggests that higher values of x1 increase the likelihood of attrition, whereas a negative coefficient for x3 suggests that higher values of x3 might lower the probability of the athlete's dropout. This allows practitioners to prioritize interventions with the greatest effect. By focusing on the most influential variables, sports organizations can make data-driven decisions on resource allocation, coaching practices, and player support systems to better retain young athletes.

In the first logistic model including all variables (Table 5), the AIC score was 19,373. This model was used to analyze overall accuracy, sensitivity, and specificity at different thresholds on the training and testing data. At a threshold of 0.4, the model achieved high sensitivity (97.02%) on the training data, meaning that it could correctly identify most positive cases. However, the specificity was low (23.07%), indicating a poor ability to correctly identify negative cases. At higher thresholds, sensitivity decreased but specificity increased, indicating a better balance between identifying positive and negative cases. However, on the test data, overall accuracy and specificity were lower, especially at higher thresholds where the model showed degraded performance (accuracy of 56.29% at a threshold of 0.6).

Table 5. Output of the logistic model – all variables

Quantity – threshold value	Overall accuracy (%)	Sensitivity (%)	Specificity (%)
Train – 0.4	77.02	97.02	23.07
Test – 0.4	74.76	80.25	45.59
Train – 0.5	77.85	93.28	36.24
Test – 0.5	65.14	66.98	55.33
Train – 0.6	76.98	86.47	51.40
Test – 0.6	56.29	54.52	65.76

Source: Own elaboration

The second model (Table 6), including only statistically significant variables, achieved the AIC score of 19,443. Although this model used a simplified set of variables, the results showed a similar trend to the first model. On the training data, it achieved the highest sensitivity (97.06%) at a threshold of 0.4, while specificity remained low (22.69%). As in the first model, sensitivity decreased with increasing threshold, while specificity improved.

However, on the test data, the model showed lower overall accuracy (56.60% at a threshold of 0.6), suggesting that the model simplification did not lead to a significant improvement in the predictive ability.

Table 6. Output of the logistic model – statistically significant variables.

Quantity – threshold value	Overall accuracy (%)	Sensitivity (%)	Specificity (%)
Train – 0.4	76.95	97.06	22.69
Test – 0.4	74.50	80.00	45.12
Train – 0.5	77.72	93.34	35.58
Test – 0.5	64.43	66.34	54.20
Train – 0.6	76.81	86.42	50.90
Test – 0.6	56.60	54.98	65.31

Source: Own elaboration

The third model (Table 7), based on correlated variables only, achieved the highest AIC score of 19,582, indicating poorer quality compared to the previous models. Although this model contained variables with significant correlation, the overall accuracy, sensitivity, and specificity were very similar to the previous models. High sensitivity (97.54%) was achieved on the training data at a threshold of 0.4, but specificity was even lower (20.67%). On the test data, the overall accuracy was lower, with the best value of 55.50% at a threshold of 0.6. Thus, this model did not yield significant improvement and confirmed minimal differences in metrics between the models.

Table 7. Logistic model output – correlated variables.

Quantity – threshold value	Overall accuracy (%)	Sensitivity (%)	Specificity (%)
Train – 0.4	76.76	97.54	20.67
Test – 0.4	75.36	81.14	44.44
Train – 0.5	77.33	93.41	33.93
Test – 0.5	64.57	66.43	54.65
Train – 0.6	76.85	86.42	51.01
Test – 0.6	55.50	53.63	65.53

Source: Own elaboration

Of the three logistic models, the first model including all variables showed the best performance (the lowest AIC score of 19,373). Although sensitivity was high at lower thresholds, specificity remained low in all models. Simplified models with statistically significant or correlated variables did not yield significant improvement. Including all variables provided the best balance between the model's performance and simplicity.

5. Discussion

The novelty aspect of our study lies primarily in its methodology combining the unique access to exclusive SFA data with advanced modelling. The geographic perspective included helped us detect significant regional disparities affecting the young athletes' dropout from organized football as well as determine the overall social impact of this sport.

Despite our extensive approach, the study still has limitations that must be considered when interpreting the results. These are linked to data quality and availability, methodology, generalizability, and the socio-economic context. Regarding data quality and availability, we used to differentiate, precise data sources. While based on the SFA's databases, our dataset is unique in scope and accessibility, serving as a primary data source for this study. Accuracy is guaranteed by the providers. Nonetheless, some data points may have been incorrectly recorded. The data collection is always subject to random or systematic errors (Wahmed, 2014) possibly distorting the results (Buyse et al., 2017).

Logistic regression assumes linearity between the independent variables and a log odds ratio, the absence of multicollinearity, and proper model specification. Our results are specific to organized football within the SFA, limiting their generalizability to other sports, regions or organizational structures. Our model deliberately excluded socioeconomic, psychological, and cultural factors such as motivational barriers or the influence of family background. Although the combination of sports geography and logistic regression offers an innovative approach, this framework is less developed and may limit the ability to fully understand the spatial context of sports performance and the dropout from organized sports.

The methodology and findings can be applied in research of other sports where similar factors influence athletes' dropout. An example is the decline of young players participating in ice hockey in Canada. There has been a 22% drop in the player base among young athletes in Canada over the past 13 years (Whyno, 2024). The application of methodology and sports geography to research in this regard could help explain the factors why this player dropout from organized ice hockey is occurring. Our research can be done in comparison with other regions, helping identify local specificities in sports. A comparison with the findings of Wilhelmsen (2024) or Hema et al. (2022) is also relevant. Both studies worked with a different methodology but included factors comparable with our results. These highlight that the young athletes' career progression is mainly influenced by sports statistics (number of goals and nominations to the starting line-up). The first study shows that the performance of players in English academies is compromised by the culture shock and high pressure, leading to self-preservation mechanisms. The second study focuses on the burnout of elite female footballers caused by a combination of sport and other responsibilities, with problems related to persistent gender bias. In contrast to our quantitative findings on career progression, both studies identify social and psychological barriers as key factors limiting long-term success in professional football. The juxtaposition of such factors is highly desirable. Our findings on the factors influencing young athletes' participation in organized football are consistent with previous research. These points to a complex network of influences including socio-economic conditions, sports culture, and individual athletes' factors. The research by Schlesinger et al. (2018) confirms that young players' decisions to end their sports careers often stem from a combination of pressure to perform and insufficient support from their clubs. A study by Back et al., (2022b) points out that young athletes face high psychological demands, while the culture shock and unreasonable expectations can lead to their premature retirement from the sport. This factor is demonstrated by the associations we found with the impact of game statistics on athletes. Additionally, research by Eliasson and Johansson (2020) showed that socio-economic conditions have a significant impact on sports participation and that children from disadvantaged backgrounds have limited access to sports. This indicates that to effectively address sports dropout, it is necessary to combine individual, social, and systemic approaches determining the whole sports environment.

Nutakor et al. (2023) shown that socioeconomic status (SES) influences quality of life via social capital. In sports, social capital may be an important factor moderating the effect of SES on athletes' decisions to continue or discontinue their sports careers. Hernandez et al. (2023) showed that although the motivation to obtain a sports scholarship is strong, many families face significant barriers to their children's participation in organized sports. The research revealed that the current culture of youth sports further strengthens these barriers, resulting in limited participation of children from socially disadvantaged families. Macintyre et al. (2018) highlight the impact of social and economic inequality on mental health. According to them, higher levels of income inequality led to a higher prevalence of mental illness. Strandbu et al. (2020) showed that socioeconomic resources influence participation in sports for both boys and girls. Boys from minority backgrounds have even higher participation rates compared to those from majority backgrounds. Girls from minority backgrounds are significantly less likely to participate in sports clubs compared to those from majority backgrounds. Socio-economic resources thus significantly explain the differences in sports participation between minority and majority groups. Cerin and Leslie (2008) suggest that comprehensive, multi-level interventions targeting attitudes and skills related to activity, as well as the social and physical environment, are needed to increase participation in physical activity among more disadvantaged segments. This is supported by Asghar et al. (2024).

Research on the issue can apply different parameters of the socio-economic environment. These strongly influence motivations and barriers to engaging in physical activity, crucial for public health policies. These should address financial constraints via subsidies and discounted access to sports facilities, improve work-life

balance to address time scarcity, invest in infrastructure in disadvantaged areas, and promote community-based programs (Pedersen et al., 2021). According to Slade et al. (2020), policies aimed at improving physical activity must compete for limited resources with other development investments. These principles could be applied to policies aimed at promoting physical activity, where comprehensive evaluations combining qualitative, quantitative, and mixed methods provide valuable insight. There is a growing emphasis on researchers not limiting themselves to describing and explaining government systems but also engaging in experimentation and intervention activities contributing to improvement. Linking retrospective research focused on scientific validation and prospective research on creative design offers a new approach to integrating traditional methods with innovative approaches. This is useful in the context of policymaking aimed at promoting physical activity (Romme, Meijer, 2019).

Conclusions

Our research identified several factors influencing young athletes' career progression. The most important were the age at which players started playing organized football, the number of nominations to the starting line-up, the number of goals scored, and other game statistics. Conversely, variables such as the number of red cards or the ability to play at multiple positions were not statistically significant. This research provides valuable insights into the SFA in its efforts to understand and address the causes of young players leaving organized football. Thereby, it contributes to the development of effective measures to retain athletes in the competitions' environment.

Comparison with other research shows that while our findings emphasize individual sports performance, socio-economic and cultural influences create significantly broader context. Thus, sports policies and interventions must be multi-level and focus also on social infrastructure and access to sporting opportunities for all. The connection of our results achieved by mathematical modelling with the analysis of secondary data and the other studies' results brought the answer to the research question set. Sports managers should focus on influenceable factors that emerged as statistically significant in our modelling. In their decisions, they must monitor the current socio-economic context related to a specific sport in the region. From this viewpoint, geographical perspective represents an important managerial tool for identifying underserved regions and improving equal access to organized sport.

It is recommended for the state and local governments to invest in sports facilities in disadvantaged areas to increase accessibility of sports. This also contributes to reducing the dropout of young players from organized football. State or club policies should include programs encouraging the identification and development of talented athletes. Specialized training programs and higher number of coaches can help talented players stay in organized sports. We also propose the introduction of specific subsidies and grant programs to cover the costs of sports equipment and participation in competitions for children from lower-income families. This would reduce barriers to entry and retention in organized sports, promoting equality. We encourage closer cooperation among schools and sports clubs, ensuring that young athletes have a balance between sports activities and their education.

Potential errors in the research were related to data collection and processing. The subject of the research is represented by the data collected on organized football within the SFA administration. Therefore, the results may not be directly applicable to other sports or countries. Geographical, cultural, and organizational differences may influence the variability in the factors of athletes' dropout from organized football. Despite these limitations, our research contributes to the knowledge base by its comprehensive analysis, an innovative methodological approach, and practical application. It offers a comprehensive view of the factors influencing athletes' dropout from organized football, providing valuable information for sports managers, coaches, and other stakeholders. The identification of key determinants of athletes' dropout can assist in the development of strategies to retain young talent in organized football, having long-term positive impacts on the sports community and the whole society.

As this study is at the intersection of two research areas, it opens new avenues for making a real impact in public policy research. It involves not only the design and implementation of new policy measures to promote

physical activity, but also the improvement of existing government structures to better respond to complex socio-economic challenges. This integrated approach can lead to policies that are scientifically sound but also practically effective. In the future, it is planned to use the data collected and analyzed to develop new models of youth dropout from organized football and to focus on other popular sports. Future research should also expand the geographical aspect in social research by incorporating spatial data on travel distances, accessibility of training facilities, and regional funding inequalities, to complement the strong performance-based findings of our study.

Extending the research findings to cover similar sports phenomena in other regions and across different sports events represent an important topic as well. An analysis of the international context allows the identification of common and different determinants of athletes' dropout, considering the cultural, socio-economic, and organizational specificities of each region. This way, more effective strategies and policy measures can be designed to promote sports participation and talent development. This approach will strengthen the interdisciplinary nature of this social research and allow for solutions with a global reach.

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Michal VARMUS is the Professor at the Faculty of Management Science and Informatics, University of Žilina. He is a member of the Department of Management Theories. He is engaged in applied research in the field of innovative management and marketing in sports. He has been a researcher in several national and international research projects (APVV, VEGA, KEGA, projects of the European Structural Funds and Erasmus+), including the position of the main researcher of one APPV and KEGA project and several faculty and university grants. Since 2014, he has been a member of the Executive Committee of the Slovak Tennis Association (STA) and a chairmanship of the Central Slovak Tennis Association. Since 2022, he has been a vice president of STA and a chairman of the Central Slovak Tennis Association. He has worked and he is still active in several professional committees and since 2021 he has been a member of the board of directors of the Fund for the Support of Sport. Within international scientific structures, he is a member of EASM (European Association for Sport Management) and ESEA (European Sport Economics Association).

ORCID: <https://orcid.org/0000-0002-9001-286X>

Dominika TOMAN has been working at the Department of Management Theories of the Faculty of Management Science and Informatics of the University of Žilina (UNIZA) since 2022 (she has been part of UNIZA as an employee since 2021 when she started as a researcher at the university science park). She currently works as an assistant lecturer. She has completed all levels of education up to Ph.D. at UNIZA in the field of Economics and Management. In terms of research activity, she focuses on human resources, organizational behavior, and decision making with the use of ICT, creativity, and innovation. She teaches Human Resource Management 1 and 2 and Managerial Psychology. She has been and continues to be a co-researcher for several projects co-financed by the European and Slovak research grants. She participated in international scientific conferences organized under the auspices of the ESEA (2022 in Helsinki, Finland, and 2023 in Cork, Ireland). In 2023, she also participated in the BIP hybrid international mobility in Kranj, Slovenia, as a foreign lecturer within the Erasmus+ program.

ORCID: <https://orcid.org/0000-0003-2393-2946>

Martin MIČIAK is an assistant lecturer at the Faculty of Management Science and Informatics, University of Žilina (Slovakia). Martin teaches management games and simulations, management theories, sociology, and project management. His main research areas include human resources management, project management, and sports management. Martin cooperates with many businesses in the form of mutual synergistic efficiency, which is reflected in his academic activities.

ORCID: <https://orcid.org/0000-0002-8636-3560>

Michal ŠARLÁK is a PhD student at the Faculty of Management Science and Informatics, University of Žilina. He is a member of the Department of Management Theories. He teaches innovation management, marketing communication, and collaborates on teaching sports management. His main research areas include sports management, funding of sports, ICT in sports, and the position of sports at the local government level. Michal is involved in the political connection of sports at the local government level, from which he also has professional experience. He also worked at the Regional School Administration Office in Žilina in the field of funding, and at the self-governing region (VÚC) in Bratislava in the area of marketing and funding. In addition, he gained work experience in the town of Krasno nad Kysucou as an administrative officer.

ORCID: <https://orcid.org/0009-0003-0865-9598>

Lucia PANČÍKOVÁ is an assistant lecturer at the Department of Management Theories of the Faculty of Management Science and Informatics at the University of Žilina. In her teaching activities, she focuses on Econometrics, Forecasting, Economic and Legal Aspects of Business, Business Economics, Probability and Statistics for Managers, and Data, Information and Knowledge. Her research activities are primarily oriented towards statistical modelling and forecasting economic and financial data.

ORCID: <https://orcid.org/0000-0001-9688-5904>

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