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Review Article

The Effect of Country Population, Economy and Scientific Research on Country's Olympic Success

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Abstract: This study aimed to examine the relationship between the number of gold/total medals obtained by the top 20 countries in the gold medal rankings at the Athens 2004, Beijing 2008, London 2012, Rio 2016, Tokyo 2020, and Paris 2024 Summer Olympic Games, and the population, economy, and scientific research of these countries. The descriptive survey model, one of the quantitative research methods, was used in the study. Data were obtained through scientific studies and document analysis. To evaluate the quantity of research in the field of sports sciences, scientific research published in Web of Science (WOS) over the four years between the two most recent Olympics was analyzed, and documents suitable for the purpose of the research were identified. For data on population and economy, the latest available data for all the Olympics were used. There are many variables that affect the Olympic success of countries. Many variables, such as economy, population, socio-cultural structure, science and technology, facilities, club development, athlete incentive policies, and extraordinary talents, can influence outcomes. In this study, scientific research, population, and the economy were examined as factors affecting Olympic success (gold medals and total medals). Pearson correlation analysis, chi-squared (χ^2) analysis, and regression analysis were used to evaluate the data obtained. As a result, economic factors were found to be the factors that most influenced gold and total medal rankings. The number of gold medals was found to be influenced by population, while the total number of medals was influenced by scientific research. Scientific research influenced the number of gold medals, while population influenced the total number of medals overall. These results may shed light on future research and the development of Olympic strategies.

Keywords: Olympic games, medal, success.

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1. Introduction

The Olympic Games, which have a long history, are analyzed in two periods: the Ancient Olympic Games and the Modern Olympic Games. Although there are different dates in the sources, the Ancient Olympic Games are reported to have been held 292 times at four-year intervals, from 776 BC until they were terminated by the Roman Emperor Theodosius I in 396 AD. After the Olympic Games were interrupted for a long time, Baron Pierre De Coubertin, who was interested in the ancient Olympic Games when he was studying in London, started to work to revive the Olympics (Seçilmiş, 2004). There is no sporting event as exciting as the Olympic Games. This is what Coubertin had in mind when he set out to establish the modern Olympic movement 2,500 years after the first sports festival started in ancient Greece (Payne, 2013). In 1894, the basic principles of the Olympics were determined in a meeting with 2,000 guests at the Sorbonne. The principle is that the Olympics will be held every four years. 2. Only adults will take part in the competitions. 3. Amateurism rules are essential. 4. Each Olympics will be held in a different country. 5. The Olympics will be open to everyone. 6. The president of this committee will be Baron Pierre de Coubertin. Under these rules, the International Olympic Committee (IOC) was founded, and subsequently, the first Olympics were held in Athens in

1896. The modern Olympic Games, which are held in a different country or city every four years, could not be held in 1916 due to World War I and in 1940 and 1944 due to World War II (Seçilmiş, 2004). Due to the COVID-19 pandemic affecting the whole world, the Tokyo 2020 Olympic Games were held in 2021.

The Olympic Games, which are the most important and meaningful events in the world of sports, have been organized by various entities throughout history, with modern iterations organized by countries, to meet economic, political, and social expectations beyond sporting success (Karaküçük, 1989). In our era, many large-scale sports events such as the Olympic Games, Continental Cups, and World Cups are organized. While being successful in the Olympic Games and hosting the Games are considered displays of propaganda, power, and image for countries, over time, the great financial contribution, country promotion, and tourism mobility provided by the Games have been added to these perceptions. We can see that the prestige and power of countries increase in parallel with the successes and medals they win from major sports organizations, especially the Olympics (Akgül, 2016). After the 2000 Sydney Olympics, John Morse, director of the Australian Tourism Commission, said "The Olympics are the best thing that has ever happened to the Australian tourism industry" and "The Olympics changed the world's view of Australia forever" (Payne, 2013). In summary, it is understood that both hosting the Olympics and achieving success in the Olympics are important for the promotion and prestige of the country. Olympic hosting was analyzed by Knott and Tinaz (2022). In their study, the hosting of large-scale and mega sports events by developing countries was evaluated in five main areas related to sports heritage. These are categorized as 1. social development, 2. politics, soft power and sport for peace, 3. tourism economy, image and branding, 4. infrastructure and urban development, and finally, 5. sport development (Knott & Tinaz, 2012). Table 1, (IOC, 2025) shows the continents where the host cities of the Olympic Games have been located since the beginning of the modern Olympic Games, the number of Olympic Games held in these continents, and the countries that have hosted them.

Table 1. Distribution of Geographical Continents and Countries in Olympic Hosting since 1896

Geographic Continent	Number of Olympiads	Countries
Africa	0	-
America	7	USA (4), Brazil, Canada, Mexico
Asia	5	China, South Korea, Japan (2), Russia
Europe	16	Germany (2), Belgium, Finland, France (3), Netherlands, Greece (2), Italy, Greece (3), Spain, Sweden, Italy, UK (2)
Australia	2	Australia (2)

There are many variables affecting the Olympic success of countries. Many variables such as economy, population, socio-cultural structure, science and technology, facilities, club development, athlete incentive policies, and extraordinary talents can be identified. For this reason, many studies have been conducted to explore factors that affect Olympic success. Karakuş and Işık (2017) compared the success of Turkey and other European Union (EU) countries in the Rio 2016 Olympics in terms of population and economic factors. In this study, Gross Domestic Product (GDP) per capita, the participation rate in relation to the population, and medal success were analyzed (Karakuş & Işık, 2017). The economy affects many other factors. However, even the most developed and richest countries in the world cannot afford to use their resources inefficiently and without control. Success is possible through the efficient use of resources, not merely having abundant resources. When the medals won by the successful countries are examined, it is seen that they determine priority sports branches, invest in these sports branches and win more than half of their medals in the sports branches they have determined (Tümen, 2022)

A new method of calculating Olympic success based on country populations and the number of medals won has been proposed in studies. It is argued that the current method is advantageous for countries with larger populations. Therefore, it is argued that it would be useful to publish the number of medals, probability rankings, and medals per capita rankings, while highlighting the achievements of countries with small populations. Sports media and public information sources should use probability rankings adjusted for population size when reporting country achievements at the Olympics. It is argued that this would make the Olympics more entertaining, while recognizing the determined efforts of athletes from different countries to achieve Olympic excellence (Parece, 2024).

The aim of this study is to examine the relationship between Olympic medal success (gold/total) and the amount of scientific research, population, and economic status of countries in the field of sports sciences. For this reason, the relationship between the amount of scientific research, population, and economy of the countries, and their Olympic medal success was analyzed.

2. Materials and Methods

2.1. Research Model

This study was conducted using the descriptive survey model, one of the quantitative research methods.

2.2. Data Collection

Data were obtained through scientific studies and document analysis. The medal distributions of the countries in the Athens 2004, Beijing 2008, London 2012, Rio 2016, Tokyo 2020, and London 2024 Summer Olympic Games, organized by the International Olympic Committee (IOC) between 2004 and 2024 (TMOK, 2024), as well as the scientific research in the field of sports sciences produced by the countries within four-year Olympic cycles and published in Web of Science (WOS), were analyzed. For the Athens 2004 Olympics, studies conducted in 2001, 2002, 2003, and 2004 were evaluated. The same method was applied for six Olympics, including the Paris 2024 Olympics. Studies with more than one author and authors from different countries were evaluated separately for each country. Scientific studies conducted prior to 2001 were excluded, and studies planned for 2025 will be excluded. Scientific research data published in Web of Science (WOS) were examined between 10.03.2025- 13.03.2025 and the search criteria with the keywords sport* or training were as follows (Web of Science, 2001-2024). The results obtained according to the specified criteria are shown in Figure 1.

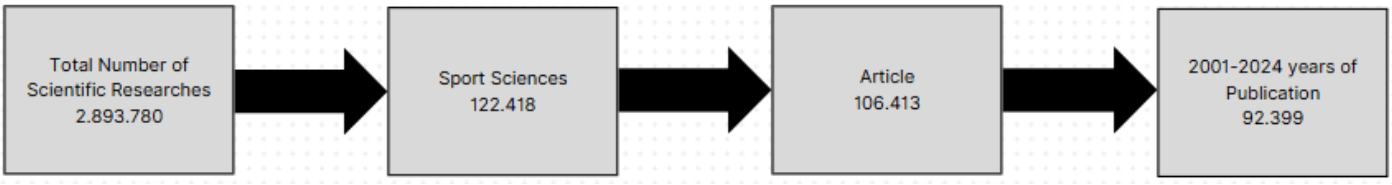

Figure 1. Data Collection Flow Chart.

In this study, the top 20 countries in each Olympics were taken into consideration. Thus, a total of 34 countries appeared in the top 20 performers over the six Olympics analyzed. Olympic success is ranked according to the number of gold medals won by the countries. In case of equality, the number of silver medals and then the number of bronze medals are taken into consideration. Table 2 shows the amount of scientific research, as retrieved from the Web of Science database, from the countries ranked in the top 20 at the Olympics during the Olympic period.

Table 2. Number of Scientific Researches Scanned in Web of Science during the Olympic Period

Athens 2004	2001	2002	2003	2004
(2001,2002,2003,2004)	1.254	1.276	1.444	1.572
Beijing 2008	2005	2006	2007	2008
(2005, 2006, 2007,2008)	1.715	1.874	2.233	2.428
London	2009	2010	2011	2012
(2009, 2010, 2011, 2012)	2.799	3.148	3.153	3.435
Rio 2016	2013	2014	2015	2016
(2013, 2014, 2015, 2016)	3.703	3.843	4.240	4.392
Tokyo 2020	2017	2018	2019	2020
(2017, 2018, 2019, 2020)	4.732	5.224	6.176	6.591
Paris 2024	2021	2022	2023	2024
(2021,2022, 2023, 2024)	7.192	7.167	6.220	6.588

From 2001-2024, there have been differences in country names, participation status, and the years of the Olympics. China's research numbers were collectively evaluated. Survey numbers for Brazil were evaluated as a whole. Belarus

was evaluated together with other countries. The Czech Republic, also known as Czechia, has undergone a name standardization process. Great Britain (England, Scotland, Wales) and the United Kingdom (which includes Northern Ireland and Great Britain) are considered together in terms of their scientific research output. The Russian Olympic Committee was evaluated based on data about the volume of scientific research in Russia. Although the Tokyo 2020 Olympics were held in 2021, due to the Covid-19 pandemic, which affected the whole world, scientific research from 2021 was evaluated for the upcoming 2024 Olympics.

The populations (United Nations Population Fund, 2024) and economic sizes (World Bank Group, 2023) of the countries ranked in the top 20 in the six Olympic Games were assessed within the scope of the research based on current data. The populations, economies, the scientific research output in the field of sports sciences of the countries, and the gold and total medals count in the Olympic Games were categorized. Gold medals 0-5, 6-10, 11 and above; Total medals 0-20, 21-40, 41 and above; Scientific research 0-100, 101-500, 501 and above; Population 20 million and below, 20.000.001-70.000.000, 70.000.001 and above; Economy (million $) 0-500.000, 500.000-2.000.000, 2.000.000 and above. The country's data were analyzed by regression analysis, χ^2 (chi-square) analysis, and correlation analysis. For χ^2 analysis, all data were transformed into categorical form. Then, the relationships between gold medals and other parameters, and between total medals and the same parameters, were analyzed. Pearson correlation analysis was performed, and the results were evaluated. In this study, the effects of countries' economic levels, population, and scientific research activities on gold medals and total medals in the six Olympics held between 2004 and 2020 were analyzed. In the regression analysis, the effect of the independent variable on the variance of the dependent variable was examined. The number of gold medals and the total number of medals were considered dependent variables, while scientific research, population, and the economy were considered independent variables. The total number of gold medals won by the top 20 countries in the last six Olympics is shown in Table 3.

Table 3. Top 20 Countries by Total Gold Medals in the Last Six Olympics

	Country Name	Number of Gold Medals	Number of Scientific Researches	Population	Economy (Million $)
1	USA	243	26.183	341.237.743	27.360.935
2	China	225	5.092	1.409.670.000	17.794.782
3	Australia	160	9.131	26.707.556	1.723.827
4	United Kingdom	120	11.322	67.026.292	3.340.032
5	Russia	114	485	146.150.789	2.021.421
6	Japan	91	2.626	123.590.000	4.212.945
7	Germany	79	5.159	84.607.016	4.456.081
8	France	65	3.529	68.226.000	3.030.904
9	South Korea	63	1.092	51.439.038	1.712.793
10	Italy	56	4.160	58.919.345	2.254.851
11	Netherlands	55	2.468	17.947.684	1.118.125
12	Hungary	36	291	9.678.000	212.389
13	New Zealand	27	1.760	5.199.100	253.466
14	Cuba	26	12	11.089.511	147.193
15	Canada	23	4.971	41.012.563	2.140.086
16	Brazil	22	6.323	212.583.750	2.173.666
17	Ukraine	21	17	41.130.432	178.757
18	Spain	20	4.453	48.345.223	1.580.695
19	Kenya	20	37	51.526.000	107.441
20	Jamaica	16	8	2.734.093	19.423

2.3. Ethics Committee Permission

This study is a literature review based on previously published research and does not involve the collection of new data from human or animal subjects. Therefore, ethical approval was not required. In general, ethical committee approval is not mandatory for review articles, as long as no experimental procedures or direct involvement of participants are

present. Nonetheless, all sources used in this study are publicly available and scientifically valid, and the study was conducted in accordance with the principles of research ethics.

3. Results

In the study, continuous numerical data were observed, and the VIF value was below 10 in all comparisons. It was determined that the data obtained were in accordance with the normal distribution criteria and that there was a linear relationship between dependent and independent variables

Table 4. Correlation Table

	Gold Medal	Total Medals
Scientific Research	0.551*	0.630*
Population	0.571*	0.450*
Economy	0.857*	0.838*

** p < 0,01*

Analyzing the table above reveals that the highest correlation is between the number of gold medals and the economy. When all parameters are analyzed, significant correlations with gold medals are observed. However, it is recognized that the correlation with the economy is high, while it is medium with both scientific research and population. The highest correlation between the total number of medals, scientific research, population, and economy is with the economy (r=0.838), and the second highest correlation is with scientific research (r=0.630). Accordingly, the correlations between the total number of medals and factors such as the economy and scientific research are at a high level, while the relationship with the population parameter (r=0.450) is at a medium level.

Table 5. Chi-Square Table

	Gold Medal	Total Medals
Scientific Research	12,300**	21,985*
Population	40,770*	58,407*
Economy	43,327*	69,894*

**p < 0.01, **p<0.05*

When Table 5 is analyzed, all parameters associated with chi-squared (χ^2) values are related to gold medals and the total number of medals. Among these relationships, the strongest for gold medals is the economy (italicxitalic2=43.327), the second strongest is the population (italicxitalic2=40.770), and the third strongest is scientific research (italicxitalic2=12.300). When the total number of medals is analyzed, it becomes evident that the strongest relationship is with the economy (χ^2=69.894), the second strongest relationship is with population (χ^2=58.407), and the third strongest relationship is with scientific research (χ^2=12.300).

Table 6. Regression Table

	Gold Medal		Total Medals	
	Beta	p	Beta	p
Scientific Research	0.093	0.174	0.195	0.009
Population	0.212	0.001	0.101	0.125
Economy	0.686	0.000	0.658	0.000

Regression modeling shows that at least one of the three independent variables (scientific research, population, or economy) explains the dependent variable. Scientific research, population, and economy explain 71% of the variance of the dependent variable: the total number of medals. The levels of variance explained for all parameters were significant (p<0.001). Upon analysis of each parameter, it was determined that the economy (p<0.001) had the most significant effect on the total number of medals, while the amount of scientific research (p=0.009) had a secondary impact. The population parameter (p=0.125) was not sufficient to explain the variance in the total number of medals.

It is understood that variables related to scientific research, population, and economy account for 75% of the number of gold medals. This level of explanation was found to be significant ($p<0.01$). It was determined that economy ($p<0.001$) was the most influential parameter on the number of gold medals, with population ($p=0.09$) being influential at a secondary level. It was determined that the volume of scientific research ($p=0.174$) was not sufficient to explain the variance in the number of gold medals.

4. Discussion

In this study, the aim is to examine the relationship between Olympic medal success (gold medals, total medals) and the number of scientific research articles, population size, and economic size of countries in the field of sport sciences. For this reason, the relationship between scientific research output, populations, countries' economies, and Olympic medal success was examined. The scientific research output, populations, and economies of the countries were analyzed in the context of the last six Olympic Games. The statistical methods used in this study include correlation analysis, chi-squared (χ^2) analysis, and regression analysis.

As a result of the correlation analysis, a significant relationship exists between all parameters and gold medal success, with the highest correlation existing in the economic parameter. When all parameters are analyzed, significant correlations with the number of gold medals are observed. It is understood that the correlation between gold medal success and the economy is high, while the correlations with scientific research and with the population are medium (Table 4).

As a result of the chi-squared (χ^2) analysis, it had been found that all parameters are associated with the number of gold medals and the total number of medals. The strongest relationships for both gold medals and the total number of medals are found with the economy, and these are followed by relationships with population and scientific research (Table 5).

The regression analysis determined that the most influential parameter on the number of gold medals is primarily the economy, followed by population. The volume of scientific research is not sufficient to explain the number of gold medals. It was observed that the parameter that most affected the total number of medals was the economy, followed by scientific research. It was determined that the population parameter was not sufficient to explain the variance of the total number of medals (Table 6).

As a result, countries want to show the promotion and prestige in the global competitive environment through sports. For this reason, it is important for countries to achieve favorable outcomes in the Olympics, the pinnacle of international sporting events. In his study, Tümen (2022) examined the sporting structuring of countries by analyzing the Australian Olympic success system, the United States (USA) swimming system, and the East German talent identification system. He provided examples such as the Spartak tennis club, Bollettieri tennis academy, and Australian basketball, in the context of sports club development. He emphasized the impact of family, coaches, science and technology on sporting success (Tümen, 2022). In order to prepare for the Olympic Games for Turkey, sports organization managers and academicians from different universities working in the field of sports sciences came together at an evaluation meeting on new scientific methods and projects for the development of sports and athletes and expressed their views on the country's Olympic goals with a wide participation (GSGM, 2000).

5. Conclusions

As a result of the research, the most prominent parameter was found to be the economy. The most effective factor influencing both gold and total medal success is the economy; the secondary factor affecting gold medals is the population while scientific research influences the success in total medals. The scientific research can explain 19.5% of the total medal success variance ($p=0.009$). It is understood that the economic scale and welfare levels are very important factors influencing individuals, families, sports clubs, sports federations, and the country's sports organization. The efficient use of limited resources can be ensured through scientific research, and supporting these efforts can contribute to the success of countries in the Olympic Games.

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writing—original draft preparation, S.G.; writing—review and editing, K.A.E.; visualization, S.G. and K.A.E.; supervision, K.A.E.; project administration, S.G.; funding acquisition, S.G. and K.A.E.

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