Olympic medalists of the modern summer Olympic games 1896–2016

Vladimír Bačík

Department of Economic and Social Geography, Demography and Territorial Development, Faculty of Natural Sciences, Comenius University in Bratislava, Bratislava

ABSTRACT
The aim of the work in the presented paper was the creation and subsequent distribution of a database of Olympic medallists of the modern Summer Olympic Games in the period 1896-2016. We examined historical statistics from the perspective of an individual approach; or more specifically, for each Olympic medallist as an individual athlete awarded with an Olympic medal. The results are presented on a map showing the number of medallists in each country. In total, we recorded 33152 Olympic medals in the database altogether, which were won by a total of 24287 athletes. These represented a total of 149 countries, including those that no longer exist due to geopolitical changes in the last century. All medals awarded at the level of states and individual sports are displayed in a detailed preview on the website, which is an integral part of the submitted paper.

1. Introduction
The Olympic Games are a social phenomenon that goes far beyond the dimensions of sport. Economic aspects, global tourism, gastronomy, industry, architecture, and technology are just a few of the many areas that are influenced by the immediate implementation of the Olympic Games themselves as a global sporting event. Therefore, in the scientific literature, various aspects of the Olympic Games and Olympic medallists are given considerable attention. The achievements of the athletes themselves are the subject of many behavioural and psychological studies. One interesting example is the work of Medvec et al. (1995), in which they compare the emotional reactions of Olympic medallists during the 1992 Olympics in Barcelona. Interestingly, they point to the fact that bronze medallists tend to be happier than silver medallists. The authors attribute these results to the fact that the most compelling counterfactual alternative for the silver medallist is winning the gold, whereas for the bronze medallist, it is finishing without a medal. This study is also supported by the work of Kalwij (2018), who pointed out that the average life expectancy of silver medallists is approximately 2.4 and 3.9 years lower than that of gold medallists. These findings are readily explainable by insights from behavioural economics, psychology, and human biology, which suggest that (perceived) dissatisfactory competition outcomes may adversely affect health (Kalwij, 2018). Fernández-Dols and Ruiz-Belda (1995) conducted a microanalysis of the feeling of happiness by evaluating the emotional expressions of 22 Olympic gold medallists during the award ceremony. A feeling of happiness and pride, however, is described from a different perspective (for the example of the people of Germany) in the study by Hallmann et al. (2013), which found that up to 65.6% of respondents felt proud when German athletes succeeded at a major sporting event. A more detailed evaluation of the research sample showed that women, people with lower education, low incomes, or people with a migrant background felt a higher degree of pride. These results show that the funding of elite sports and elite athletes may be regarded as a political tool for social inclusion.

Some authors argue that a relationship exists between winning an Olympic medal and an athlete’s place of birth (Tozetto et al., 2017). Using the example of 186 Brazilian athletes, they pointed out that a place of birth with better living conditions plays an imperative role. A certain demographic approach from the point of view of assessing the age of athletes has been mapped previously by Elmenshawy et al. (2015). The author observed whether the age at which peak performance has increased in recent decades. He observes a significant difference between men and women. For men, the peak performance age did not change significantly at most sporting events (except for the 100 m sprint run). In contrast, after examining all athletic events, the age of peak performance in women has increased significantly since
the 1980s (Elmenshawy et al., 2015). Many studies also deal with the mechanics of movement and physical preconditions for performing a particular type of sport (Čuk & Šibanc, 2018; Garhammer, 1985).

A significant part of the articles is devoted to the issue of evaluating the success of countries at the Olympic Games. The evaluation methodology can be interpreted in different ways. Usually, the number of individual medals determines the degree of success, but in principle, there is no method of assigning weight to individual medals (Saaty, 2010). The issue of overvaluation of gold medals in such a classification is pointed out by de Mello et al. (2008). The author also points out that different sports can have different meanings and, therefore, it is appropriate to introduce a certain weight for individual sports. The final evaluation of the success of individual countries is therefore of considerable interest to the multitude of authors. The creation of a methodology for a comprehensive evaluation of success is based on several factors (Li et al., 2008). Wu et al. (2008, 2009) worked with a model that took into account two inputs: GNP per capita and population size; as well as a single output: the weighted sum of the amounts of medals obtained, which was later adjusted by the number of medals of individual values (Wu & Liang, 2010). Population size and GDP per capita are also key factors for assessing countries’ success according to Bernard and Busse (2004). Emrich et al. (2012) point to the fact that GDP is more important for success at the Winter Olympics, while population size plays a more important role in success at the Summer Olympics. The relation between GNP and population (inputs) and number of gold, silver and bronze medals (outputs) was used by Lozano et al. (2002) to measure the performance of the nations participating at the last five Summer Olympic games (before 2002).

Further, the GDP-population evidence is not the only evidence that predicts the Olympics. It is also important to mention that there are various social factors (such as health of population, Index of equality of child survival or corruption), countries’ income classification, or country’s Olympic team size are different predictors to analyze Olympic success. More complex criteria by evaluating countries success were used by Vagenas and Vlachokyriakou (2012). Medal totals were log-linearly regressed on land, population, GDP, urban population, inflation, growth rate, unemployment, labour force, health expenditures, ex-host, and team size. In addition to the traditional evaluation of success based on winning medals, some authors have used other classified positions. According to Flegl and Andrade (2018) the Olympic success was measured regarding medal ranking of each country. The traditional model has been supplemented by medal ranking up to 8th position. Such model structure enables also to measure performance of lower performed countries that are traditionally not ranked in the medal rankings. Li et al. (2015) measured the performance of participating nations at the Olympics, considering the quest for medals as a two-stage Olympic process. The first stage is characterized as athlete preparation and the second stage as athlete competition. The need to consider more complex evaluation criteria is also described by Askarian and Dokhtbagher (2015).

When assessing the success of countries, the fact of a high concentration of results in several sports must also be considered (Seiler, 2013). Many countries have not yet won an Olympic medal at any games. Sports with lower competitiveness bring options for entering these statistics, and thus it is here that there is a potential space to focus on these sports in less successful countries (Salmon & Harrison, 2017). Certain support in the evaluation of countries based on the number of medals can be observed in the work of Saaty and Sagir (2015). For the time being, however, the authors are considering weighing not only medals, but also individual disciplines within sports. From the literature overview above, it is clear that the issue of Olympic medallists and country evaluation is extremely interesting for experts from various fields of science, who can use their research methods and subsequent studies for their own contribution to the analysis of this global sporting event and its key personalities.

2. Research objectives

In the previous part of this article, various aspects of monitoring the issue of the Olympic Games, as well as to a certain extent, Olympic medallists, were shown. In our paper, however, we will not focus on a comprehensive evaluation of countries based on long-term statistics, but instead try to look at Olympic medallists as specific individuals who have successfully entered the statistics of Olympic medallists. The evaluation of the Olympics states: ‘The US Olympic gold medal was won by the team of USA’ (and 1 gold medal for the USA will be added to the statistics). However, we can also view this in such a way that behind this success lies 12 personalities (as well as the destinies of these 12 of athletes), whose lifelong efforts and hard training were transformed into an Olympic gold medal. These exclusive athletes act as role model admired by generations of people, quickly becoming an inspiration for young promising athletes, ambassadors of various humanitarian projects, advertising faces of global brands, and many other functions resulting from their popularity and success. The aim of our contribution is an effort to map all Olympic medallists regarding sport, gender, the value of the medal obtained, and the period in which they received it. We will try to present the database of all Olympic
medal winners in the form of a map (Main Map), as well as on a website created by the authors of the paper. The purpose of this web page is to display specific medallists for individual countries and sports, because the specific names are not identifiable from the map. This provides a summary projection of the number of medallists for each country; however, in our case, the key element of success is represented by specific athletes and their precise identification, which is therefore necessary in terms of the objectives of the article. Such an approach with an emphasis on the individual athletes is relatively unique, but at the same time, it may be of interest and inspiration for researchers dealing with the history of various sports.

3. Methods

Scientific contributions devoted to a detailed analysis of individual Olympic medallists are for the most part, almost unavailable. This may be caused due to the absence of a complete and accurate database of these medallists on the Internet. And so, at the beginning, we consider it important to draw attention to the fact that even though the database we have compiled is not completely accurate, we have attempted to draw our database as close as possible to the real situation when completing it. The basic moment for the creation of the final map (Main Map) was the acquisition and subsequent effective processing of individual Olympic medallists from all the modern Summer Olympics (1896-2016). We compiled our database primarily from two Internet sources: www.olympic.org and www.olympedia.org For corrections and/or resolution of various disagreements, many Wikipedia1 subpages were also used (informing mainly about individual competitions). Important source of Olympic competitions and results was a book written by Miller (2008), which covers Olympics from 1896 to 2008. For several years, databases were available directly in xls format (at www.olympics.org), while others were written in the same format. Because the results are distributed on the website www.sodbtn.sk/olympics, the entire database was imported to the server into the MySQL database. It includes 4 main database tables (medallists, sports, discipline, event) and several auxiliary ones (used to test scripts), which however, are not relevant from the point of view of the websites visitor. While browsing the Internet, we also discovered a complete database of Olympic medallists available on the portal ‘Kaggle’.2 After defining the necessary filters, this contains a total of 33630 records on Olympic medallists. Its use for our contribution was not suitable, however, as there was a problem with this database with the display of diacritics for specific names (some letters were completely omitted from the names of athletes). This error was not fixed even when using different code pages; the problem likely arose during the primary creation of this database. Due to our need for unambiguous identification of each medallist, it was not possible to use this database. Our final database contains a total of 33152 records of medallists, and we used this when creating the main map, as well as when creating our own website. In order to visualize the results on the map, the method of a circular structured diagram was used - the size of which represents the total number of Olympic medals awarded to individual medallists of a given country. The colour of the country corresponds to the sport in which the country won the most medals. Given that our objective was to point out specific personalities, we did not weigh the importance of individual medals, since the key moment was simply winning an Olympic medal of any value. Likewise, some countries have not yet won a gold medal, or have one, which may be more a matter of chance than the dominance of the sport in this country.

3.1. Supporting web page

Primary data collection enabled the construction of a rich database on Olympic medallists. In addition to the number itself, we also recorded in the database the location of the games (year), the country, gender, as well as details about the sport and discipline in which the athlete succeeded. Since the print map provides a limited space for display of the obtained data, we decided to present the obtained results in an online environment. For this purpose, a website was created, which is available at www.sodbtn.sk/olympics The individual data are stored in a MySQL database and their listing on the client page is implemented using the PHP language. The site was created to allow the visitor to get as much information as possible about the Olympic medallists. For this reason, we have placed a search form on the page (with the possibility of entering several criteria), which displays the number of medals for individual countries, as well as individual sports. All information is supplemented by graphical visualization. This is done using the HTML-Graphs library (created by Gerd Tengler) and Highcharts.js. The site also contains map outputs (a display of the number of medals - all, gold, silver, bronze), which use the D3 library and the TopoJSON data format for geometry storage (the original map layer of states was displayed for this purpose in a generalized form, using the Bend simplify algorithm used in the ArcGIS). The web page also includes four interactive chord diagrams showing the numbers of individual Olympic medals for individual countries, as well as for specific sports. The advantage of such a graphical representation is the ability to display a large amount of data in a very user-friendly design, which in recent years has become a very popular visualization tool on the Internet (Lima, 2017).
4. Results

By collecting data, we obtained 33,143 records of Olympic medallists. Despite the previously mentioned shortcomings that were encountered during the creation of the database, we can assume that this number is very close to the actual number of medals awarded during the individual Summer Olympics since its inception. On the page included in this paper where the ‘Charts’ section can be found, several graphs are displayed documenting the number of medals awarded in the individual Olympics. In terms of medals distribution, the stability of the sports included in the Olympic itinerary plays an important role. In total, we identified 42 sports, which were then divided into several disciplines and specific events and subsequently occurred during the individual Olympics with different frequencies (Figure 1).

Only 8 sports have been included just once in the Summer Olympic games program, in all cases until 1924. These sports include ice hockey, which had its Olympic premiere at the Summer Olympic Games in Antwerp (Hansen, 1996). On the other hand, we have a group of 5 sports that were part of each Olympics (Athletics, Aquatics, Cycling, Fencing, Gymnastics) and in the case of Rowing and Wrestling it was 27 Olympics. In these cases, these are sports not only with the most frequent occurrence, but also with a significantly dominant number of sports disciplines and events. These consequently affected the long-term statistics on the number of medals awarded significantly (Figure 2).

It is therefore not surprising that among the 29 medallists who have won 10 or more medals, there are up to 26 athletes representing sports with many disciplines in which these athletes could participate in one game (for example Michael Phelps had the opportunity to win up to 8 gold medals at the 2008 Olympic Games in Beijing). The number of disciplines in which athletes compete is, of course, a key factor in evaluating the most successful athletes at the Olympic Games. However, we will not address this issue in more detail in our paper. One specific problem was finding out the total number of medallists. In our research, we have identified 33143 medals awarded. In the primary grouping of these records by name, we obtained a list of 24228 athletes. Of course, we assumed the possibility of individual athletes having identical names. Subsequently, we selected multiple medallists and compared them according to the year of obtaining the Olympic medal, the sport in which it was obtained, and the nationality. A certain complication in the identification of medallists here was the entry of the athlete’s name in the results list. After such adjustments, we have gained a total of 24287 Olympic medallists. This value must be perceived again as a certain maximum approximation to the real state. In this task, it was interesting to watch athletes representing several countries and several sports. From the point of view of the representation of several countries, the situation is largely caused by geopolitical changes taking place at different times (the disintegration of Czechoslovakia, the collapse of the Soviet Union and Yugoslavia, the unification of Germany, etc.). For example, Jan Železný represented Czechoslovakia in

Figure 1. Frequency of occurrence of individual sports at the modern Summer Olympic Games (1896-2016).
1988, but represented the Czech Republic at the next games. As a result of these societal changes, we have identified 253 athletes representing two or more countries. 17 athletes represented more countries due to non-political changes. Even in this phase of the research, we encountered the problem of accurately determining nationality. One example is the athlete, Irina Lashko, who won 3 Olympic medals in the water jump. According to olympic.org, all of them were won while she was a representative of the Russian Federation, but according to the portal olympedia.org, she won a medal in 2004 as a member of the Australian Olympic team (Wigo, 2018).

Equally interesting to the identification of duplicates was the monitoring of the number of sports in which athletes won the Olympic medal. Even in this case, we identified several athletes who succeeded (Table 1).

The ability to win medals in two different sports dates to the first editions of modern Olympics - the vast majority are athletes participating in the Olympic

Table 1. Olympic winners who have won an Olympic medal in two or more sports.

| Name                         | State | Medals Count | Sports Medal Years       |
|------------------------------|-------|--------------|--------------------------|
| ANDERSEN Carl Albert         | NOR   | 2            | Athletics 1 (1900), Gymnastics 1 (1908) |
| ÅSBRINK Gusta                | SWE   | 2            | Gymnastics 1 (1908), Modern Pentathlon 1 (1912) |
| BARRETT Edward Edmond        | GBR   | 2            | Tug of War 1 (1908), Wrestling 1 (1908) |
| BOIN Victor                  | BEL   | 3            | Aquatics 2 (1908,1912), Fencing 1 (1920) |
| CARLBERG G. Vilhelm          | SWE   | 8            | Gymnastics 1 (1908), Shooting 7 (1908,1912,1924) |
| COLLAS Jean                  | FRA   | 2            | Rugby 1 (1900), Tug of War 1 (1900) |
| DE LAVAL Georg               | SWE   | 2            | Modern Pentathlon 1 (1912), Shooting 1 (1912) |
| DE MONTIGNAY Fernand         | BEL   | 6            | Fencing 5 (1908,1912,1920,1924), Hockey 1 (1920) |
| DYRSSEN Gustaf               | SWE   | 3            | Fencing 1 (1936), Modern Pentathlon 2 (1920,1924) |
| FINDLAY Conrad Francis       | USA   | 4            | Rowing 3 (1956,1960,1964), Sailing 1 (1976) |
| FLACK Edwin                  | AUS   | 3            | Athletics 2 (1896), Tennis 1 (1896) |
| GONDOUNIN Charles            | FRA   | 2            | Rugby 1 (1900), Tug of War 1 (1900) |
| GRIEB John                   | USA   | 2            | Athletics 1 (1904), Gymnastics 1 (1904) |
| HENRIQUEZ DE ZUBIERRA Constant| FRA  | 2            | Rugby 1 (1900), Tug of War 1 (1900) |
| HERSCHMANN Otto              | AUT   | 2            | Aquatics 1 (1896), Fencing 1 (1912) |
| HOFMANN Fritz                | GER   | 4            | Athletics 1 (1896), Gymnastics 3 (1896) |
| JENSEN Veggo                 | DEN   | 3            | Shooting 1 (1896), Weightlifting 2 (1896) |
| KIRSEY Morris                | USA   | 3            | Athletics 2 (1920), Rugby 1 (1920) |
| KRAUSE Roswitha              | GDR   | 3            | Aquatics 1 (1968), Handball 2 (1975,1980) |
| KUNGLER Frank                | USA   | 4            | Tug of War 1 (1904), Weightlifting 2 (1904), Wrestling 1 (1904) |
| LYDON Joseph                 | USA   | 2            | Boxing 1 (1904), Football 1 (1904) |
| MERZ William                 | USA   | 5            | Athletics 4 (1904), Athletics 1 (1904) |
| MONTGOMERY John Carter       | USA   | 2            | Equestrian 1 (1912), Polo 1 (1920) |
| NIELSEN Holger               | DEN   | 3            | Fencing 1 (1896), Shooting 2 (1896) |
| NIEMINEN Veli Heikki         | FIN   | 2            | Gymnastics 1 (1908), Shooting 1 (1920) |
| NORLING Lars Daniel          | SWE   | 3            | Equestrian 1 (1920), Gymnastics 2 (1908,1912) |
| ROMERO Rebecca               | GBR   | 2            | Cycling 1 (2008), Rowing 1 (2004) |
| SARRADE Emile                | FRA   | 2            | Rugby 1 (1900), Tug of War 1 (1900) |
| SCHUMANN Carl                | GER   | 4            | Gymnastics 3 (1896), Wrestling 1 (1896) |
| THOFELT Sven                  | SWE   | 3            | Fencing 2 (1936,1948), Modern Pentathlon 1 (1928) |
| UGGLA Bertil                 | SWE   | 2            | Athletics 1 (1912), Modern Pentathlon 1 (1924) |
| VERSIS Sotrios               | GRE   | 2            | Athletics 1 (1896), Weightlifting 1 (1896) |
| WEGELIUS Karl Magnus         | FIN   | 5            | Gymnastics 1 (1908), Shooting 4 (1920,1924) |
Games until 1924. Obtaining medals in several sports is currently nearly impossible. Competition in individual disciplines is very big, and this forces athletes toward a clear specialization (Feeley et al., 2016). Very interesting from this point of view is the fact that since 1924, only 3 athletes (Conrad Francis Findlay, Roswitha Krause, Rebecca Romero) have succeeded. Another characteristic monitored was the number of countries that won at least one medal in a given sport (Figure 3).

Athletics is the only sport in which more than 100 countries have won medals (101). Given the ability to perform this sport even in limited conditions, this is not very surprising. Likewise, the natural physical predisposition of black athletes to dominate in long distance runs is well-known and supported by many scientific studies (Onywera et al., 2006; Saltin et al., 1995; Weston et al., 1999). This fact is also observable on the main map. A colour background is set on this map for each country according to the sport in which that country won the highest number of medals (of any value). Some countries have not yet won a gold medal, or have one, which may be more a matter of chance than the dominance of the sport in this country. In most African countries that have won an Olympic medal, athletics dominate. In the top ten sports, power sports are dominant (2. Boxing (79), 4. Weightlifting (64), 5. Wrestling (62), 7. Judo (55)). Even in this case, these are sports in which there is not such a high financial demand for their realisation. In contrast, a cluster of success in martial arts is visible in the Middle East region. On the other hand, we have groups of sports in which the strong dominance of one country is well-known (Table Tennis – From totally 54 gold medallists, up to 49 are from China (90.7%), Fencing - long-term dominance of French and Italian athletes, Archery - South Korea etc.). In a more detailed assessment of countries’ successes in individual sports, it would be necessary to follow the relationship between sports policies in individual countries and the subsequent sports success (De Bosscher et al., 2009). This is a very complex issue, since the understanding of which is necessary for a more detailed evaluation of countries’ achievements in individual sports.

5. Conclusion

In this contribution, we have tried to focus on the historical statistics of awarding medals at the Summer Olympics through an individual approach. The evaluation of countries’ success is usually based on the official number of medals won and weighted by their value. We have abstracted from this approach. Our intention was not to create a methodology for evaluating the success of countries, but rather trying to highlight specific individuals – medallists who turned their years of hard training into an Olympic medal. The success of athletes has a wide social impact. Many of them are the faces of charitable campaigns, product promoters, and supporters of political programs and thus influence the decisions of other people in society. With our contribution and accompanying web page, we attempt to point out the specific names and persons of the medallists in the modern Summer Olympic Games. Athletes’ successes are often perceived intensely by the people of their countries, and thus fill them with a sense of pride and happiness (Hallmann et al., 2013). These stories have been documented in film many times (I Am Bolt (2016), Jappeloup (2013), Chariots of Fire (1981), etc.) and may be an inspiration for future generations, even becoming a part of similar research in a few years’ time. Positive inspiration is a very important moment in the development of individuals, but also for society as a whole. And it is exclusively the sporting achievements.

Figure 3. Number of countries that have won a medal in a given sport.
and knowledge of the life destinies of these actors that play an important role from this point of view. By creating this paper, the main problem was the absence of a complete dataset available that could be used for this type of research. Completion of the database itself represented a relatively large part of the research. In our database, we eventually identified 33152 medals in total that were awarded to 24287 athletes. Due to the problems with the creation of the database described in the previous part of the article, we are aware that these figures are not completely accurate, but we tried to get as close to reality as much as possible. The main map shows this state at the level of individual countries. In the context of the importance of specific athletes, an accompanying page was created (www.sodbtn.sk/olympics), which displays these details. It contains several graphic elements that are suitable for such statistical processing. We deliberately avoided a detailed evaluation of the most successful athletes. These statistics are available on many Internet portals. In terms of the previous ‘emotional’ approach, it is difficult to answer the question of whether the 23rd Gold Medal of Michael Phelps or the silver medals awarded to the Paraguayan football team at the 2004 Olympic Games in Athens is more important. The impact on the local community can be diametrically different, despite the value of the medal and the historical record. The further research of Olympic medallists can also go in several directions. In the qualitative approach, we can observe the impact of individual athletes on their surroundings (cities, communes, communities), or even how the support of sports by the authorities (local or state level) has changed after the success at the Olympic Games. At the quantitative level, many characteristics can be observed in relation to population, number of participants, level of GDP, etc. In conclusion, we would like to emphasize that one of the impulses for writing this paper arises from the extremely difficult situation in the world in 2020, when the Summer Olympic Games in Tokyo were cancelled for the first time in modern history for reasons other than a world military conflict. We strongly believe that in 2021, despite the ongoing unfavourable pandemic situation, a similar scenario will not be repeated, and the Tokyo Summer Olympic games will be enriched with other interesting performances, along with the associated stories and destinies of the athletes.

**Notes**

1. We are aware that this source is not widely accepted in scientific work, but due to the investigated characteristics, we consider the use of this source in data verification to be appropriate.
2. Database available at https://www.kaggle.com/heesoo37/120-years-of-olympic-history-athletes-and-results

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