



MEN'S WRESTLING AT THE OLYMPIC GAMES, 1896–2024: A QUANTITATIVE ANALYSIS OF MEDAL DISTRIBUTION, COMPETITIVE CONCENTRATION, AND HISTORICAL TRANSFORMATION

Mehmet Yıldızⁱ

Gazi University,
Turkey

Abstract:

The aim of this study was to examine the historical development of men's Greco-Roman and freestyle wrestling competitions from the 1896 Athens Olympic Games to the 2024 Paris Olympic Games, the medal performances of Olympic delegations, and changes in the concentration of medal success over time. The study was designed as descriptive research based on the historical research method and secondary data analysis. Data on Olympic wrestling competitions were compiled from historical results published by United World Wrestling (UWW). Results from men's Greco-Roman and freestyle wrestling competitions were evaluated by Olympic year, wrestling style, and Olympic delegation. Historical performance rankings were determined primarily according to the number of gold medals, followed by silver and bronze medals. The Herfindahl–Hirschman Index (HHI), normalized HHI, Four-Delegation Concentration Ratio (CR4), and Gini coefficient were used to assess concentration and inequality in medal distribution. The main quantitative analyses were restricted to official editions of the Olympic Games; the 1906 Athens Intercalated Games were excluded from the primary analyses. The findings indicate that medal success in men's Olympic wrestling was concentrated among a limited number of delegations during the early periods, whereas competition gradually expanded to a broader international base as the number of medal-winning countries increased over time. In the historical ranking based on gold medals, the Soviet Union ranked first, while the United States recorded the highest total number of medals. Türkiye also ranked among the leading delegations in terms of historical gold-medal success. Long-term changes in the HHI, normalized HHI, and CR4 indicate that medal concentration, particularly in the modern period, declined compared with the early Olympic Games. Nevertheless, periodic fluctuations demonstrate that the transformation of the competitive structure was not linear. In conclusion, medal success in men's Olympic wrestling became distributed across a broader group of countries over approximately 130 years, while certain countries maintained their historical prominence.

ⁱ Correspondence: email mehmetyildiz@gazi.edu.tr

By evaluating the history of Olympic wrestling through the combined use of long-term medal data and competitive concentration indicators, this study is expected to contribute to the literature on sport history and sport management.

Keywords: Olympic wrestling, Greco-Roman wrestling, freestyle wrestling, Olympic Games, medal distribution, competitive concentration

1. Introduction

The modern Olympic Games constitute one of the most important institutional structures of the international sport movement that emerged in the late nineteenth century. The formation of the modern Olympic Movement was closely associated with the initiatives of Pierre de Coubertin and with the international sport and physical education movements of the period. The development of Coubertin's Olympic ideals and the establishment of the modern Olympic Games are regarded as major transformations in the history of modern sport (MacAloon, 2008; Young, 1996). With the development of the modern Olympics, the Olympic Games evolved beyond organizations devoted solely to athletic performance and became international sporting events with social, cultural, economic, and political dimensions (Guttmann, 2002; Roche, 2000).

Wrestling is a combat sport with a history extending back to antiquity. Wrestling occupied an important place in ancient Greek sporting culture and was introduced into the program of the Ancient Olympic Games in 708 BCE, subsequently becoming one of the principal athletic contests of the period (Miller, 2004; Poliakoff, 1987). This historical background provided an important context for the inclusion of wrestling among the sports contested during the formative period of the modern Olympic Games.

Wrestling first appeared in the modern Olympic Games at Athens in 1896. Only Greco-Roman wrestling competitions were held at the inaugural Games, whereas freestyle wrestling was added to the Olympic program at the 1904 St. Louis Games. As both styles developed within the modern Olympic program, Greco-Roman and freestyle wrestling became the two principal disciplines of men's Olympic wrestling. The scope of Olympic wrestling was subsequently expanded with the inclusion of women's wrestling at the 2004 Athens Olympic Games. Nevertheless, to ensure long-term comparability, the present study was restricted to men's Greco-Roman and freestyle wrestling competitions. Throughout the historical development of men's Olympic wrestling, substantial changes have occurred in the numbers of participating countries and athletes, weight-class structures, competition systems, and patterns of international representation. The cancellation of certain Olympic Games because of the World Wars, Olympic boycotts during different historical periods, and changes in the political structures of states created important historical disruptions in participation and competition patterns in Olympic wrestling, as they did in international sport more broadly. Consequently, long-term Olympic performance should be evaluated not only through aggregate medal totals but also by considering the historical and institutional characteristics of different periods.

The international sport system that emerged after the Second World War is particularly important in this regard. The Soviet Union became one of the major powers in international sport during the post-war period, and sport assumed a significant position within the Soviet social and institutional system. Riordan (1977) provides a detailed account of the institutionalization of Soviet sport, particularly after the Second World War, and of the importance attributed to international sporting success in enhancing the state's external prestige. Nevertheless, in the present study, the magnitude of the Soviet Union's performance in Olympic wrestling is examined directly through medal data, independently of historical interpretations concerning the characteristics of the Soviet sport system.

The dissolution of the Soviet Union and the subsequent emergence of new national delegations within the international sport system also represented an important historical transformation for Olympic wrestling. Athletes who had previously competed under a single Soviet Olympic delegation subsequently represented different national delegations, making it necessary to define historical units of representation explicitly when evaluating long-term medal distributions. Accordingly, the Soviet Union (USSR), the 1992 Unified Team (EUN), the Russian Federation, and other historical Olympic delegations were treated as separate units based on the official representative structures under which they competed during their respective periods.

When the historical development of Olympic wrestling is assessed solely through countries' total medal counts, it is difficult to capture the full extent of changes in the structure of international competition. When medals awarded at a particular Olympic Games are won by only a few countries, this indicates a highly concentrated competitive structure, whereas the distribution of medals among a larger number of countries reflects a lower level of concentration. Therefore, evaluating long-term Olympic competition requires an examination not only of medal totals but also of how those medals are distributed among countries.

For this purpose, quantitative indicators commonly used to measure distribution and concentration in different fields can also be applied to sporting achievement data. The Herfindahl–Hirschman Index (HHI) measures the concentration of shares within a distribution, while concentration ratios indicate the proportion of the total accounted for by a specified number of units with the largest shares (Herfindahl, 1950; Hirschman, 1964; Bain, 1951). The Gini coefficient provides a quantitative measure of inequality within a distribution (Gini, 1912; Cowell, 2011). Although these indicators have different conceptual properties, their combined use enables medal concentration across countries and its evolution over time to be assessed from complementary perspectives.

A substantial proportion of academic research on wrestling has focused on topics such as athletes' physiological characteristics, performance requirements, weight loss, and the effects of competition conditions on athletic performance. Horswill (1992) provided a comprehensive evaluation of the physiological demands of amateur wrestling, while Kraemer et al. (2001) examined physiological and performance responses under tournament wrestling conditions. Although these studies have made

important contributions to the performance-science dimension of the wrestling literature, evaluating the long-term historical competitive structure of Olympic wrestling requires a different research approach.

In the long-term examination of Olympic wrestling history, it is important not only to identify which countries have been the most successful but also to determine how the distribution of success has changed over time. Particularly when changes in the number of participating countries, structures of Olympic representation, and the international competitive environment between the early and contemporary Olympic Games are considered, comparative evaluation of medal distributions across different periods may contribute to a better understanding of the internationalization of Olympic wrestling.

The aim of this study was therefore to examine the historical development of men's Greco-Roman and freestyle wrestling competitions from the 1896 Athens Olympic Games to the 2024 Paris Olympic Games, identify the medal performances of Olympic delegations, and determine changes in the concentration of medal success over time using quantitative indicators. Accordingly, historical medal performances, the number of medal-winning countries, the Herfindahl–Hirschman Index, normalized HHI, Four-Delegation Concentration Ratio (CR4), and Gini coefficient were evaluated together.

In this respect, the study examines approximately 130 years of development in men's Olympic wrestling by integrating historical results with quantitative concentration analysis within a single research framework. Rather than approaching Olympic wrestling history merely through a chronological ranking of countries according to aggregate success, the study seeks to evaluate changes over time in the distribution of medal success among countries and in the structure of international competition.

2. Material and Methods

2.1. Research Design

This study was designed as descriptive research based on a historical research approach and secondary data analysis to examine the historical development of men's Greco-Roman and freestyle wrestling competitions held between the 1896 Athens Olympic Games and the 2024 Paris Olympic Games, the medal performances of Olympic delegations, and changes in the concentration of medal success over time.

The historical development of men's Olympic wrestling was examined using official competition results, and Olympic year, wrestling style, participation structure, and medal distributions were comparatively evaluated. In the quantitative component of the study, the distribution of medal success among Olympic delegations and changes in this distribution over time were analyzed using concentration and inequality indicators. The primary unit of analysis consisted of men's Greco-Roman and men's freestyle wrestling competitions held at each official edition of the Summer Olympic Games. Each Olympic year and wrestling style was treated as a separate observation. Women's wrestling was excluded from the study because it was introduced into the Olympic

program at the 2004 Athens Olympic Games and therefore does not have the same historical observation period as men's Greco-Roman and freestyle wrestling.

2.2. Data Sources

The primary data source for this study was the historical Olympic results published by United World Wrestling (UWW) (United World Wrestling [UWW], n.d.-a). Results from men's Greco-Roman and freestyle wrestling competitions held between the 1896 Athens Olympic Games and the 2024 Paris Olympic Games were systematically compiled from UWW's historical results records.

For each Olympic edition and wrestling style, UWW records provide the numbers of participating athletes and countries, as well as countries' gold, silver, bronze, and other placing results. In the present study, only gold, silver, and bronze medal results and participation indicators were used. Non-medal placings, such as fourth, fifth, and sixth places, were excluded from the competitive concentration calculations.

During data compilation, the Olympic year, host city, wrestling style, number of athletes, number of participating countries, and medal-winning Olympic delegations were recorded for each Olympic edition. Accordingly, a separate data structure representing the distribution of total podium medals among delegations was created for each Olympic year and wrestling style.

2.3. Classification of Historical Olympic Delegations

Because the study covers the long historical period from 1896 to 2024, substantial changes occurred in the political structures of states, country names, and forms of Olympic representation. Consequently, directly matching historical medal results with present-day state structures may create methodological problems.

In the UWW historical results database, some early-period countries and delegations are presented using contemporary or database-specific standardized labels. For example, labels such as "Russian Federation," "Germany (until 1945)," "CSSR," "Federal Republic of Germany," and "German Democratic Republic" are used for certain historical results. Therefore, the country label provided in the UWW database was not considered, on its own, to represent the definitive historical description of the political or Olympic representation structure of the respective period (UWW, n.d.-a).

UWW historical results were used as the primary data source for the numbers of athletes and countries and for medal results, whereas the classification of delegations was based on preserving the representative structure applicable during the respective Olympic period. Thus, historical results were not retrospectively merged according to present-day national boundaries.

Accordingly, historical Olympic representative entities such as the Soviet Union (USSR), Unified Team (EUN), Russian Federation, Federal Republic of Germany (FRG), German Democratic Republic (GDR), and similar historical Olympic delegations were treated as separate units of analysis according to the Olympic identities under which they competed during their respective periods. Similarly, medals won by historical

delegations were not retrospectively reassigned to states that emerged later or currently exist.

This approach is particularly important for historical medal rankings and concentration analyses. It preserves the Olympic representation structure that existed when the sporting success was achieved and prevents historical political transformations from producing artificial aggregation in medal totals.

2.4. Scope of the Study and Data Collection Process

The study covered men's Greco-Roman and freestyle wrestling competitions held at official Summer Olympic Games between 1896 and 2024.

No observations were created for the 1916, 1940, and 1944 Olympic Games, which were not held because of the World Wars. The Olympic Games originally scheduled to be held in Tokyo in 2020 but postponed until 2021 because of the COVID-19 pandemic were recorded in the dataset as 2021, the year in which the competitions actually took place.

The 1906 Intercalated Games held in Athens are included in UWW's historical results records. Although UWW data contain athlete, country, and medal results for the 1906 Athens Greco-Roman competitions, this event was treated as being outside the official Olympic series used in the present study. Consequently, the 1906 Athens Intercalated Games were excluded from the historical medal rankings, HHI, normalized HHI, CR4 and Gini calculations, and period averages.

During the data collection process, men's Greco-Roman and freestyle results for each official Olympic edition were examined separately. First, the number of athletes and participating countries was recorded for each Olympic year and wrestling style. The Olympic delegations winning gold, silver, and bronze medals were then identified.

The numbers of gold, silver, and bronze medals won by each delegation in each Olympic Games/style observation were recorded as separate variables, after which the total number of podium medals was calculated. Before analysis, the dataset was checked according to Olympic year, wrestling style, delegation, and medal type.

2.6. Data Analysis

The study data were analyzed using descriptive statistics and measures of concentration and inequality. First, the number of athletes, number of participating countries, number of medal-winning delegations, and total numbers of gold, silver, and bronze medals won by delegations were determined by Olympic year and wrestling style.

2.7. Historical Medal Ranking

Historical performance rankings of Olympic delegations were determined primarily according to the number of gold medals won. In cases of equal numbers of gold medals, silver and then bronze medal counts were used as successive tie-breaking criteria. The historical ranking included only medals obtained in men's Greco-Roman and freestyle competitions within the scope of the study. Women's wrestling and the 1906 Athens

Intercalated Games were excluded from the ranking. Therefore, the rankings do not represent performance across “all Olympic wrestling” but specifically reflect performance in men’s Greco-Roman and freestyle Olympic wrestling between 1896 and 2024.

2.8. Herfindahl–Hirschman Index

The Herfindahl–Hirschman Index (HHI) was used to determine the extent to which medal distribution was concentrated among delegations. The HHI is calculated as the sum of the squared shares of each unit within the overall distribution. The index was calculated as follows:

$$HHI = \sum s_i^2$$

where s_i represents the proportion of total podium medals won by delegation i relative to the total number of podium medals awarded in the corresponding Olympic year and wrestling style. A higher HHI indicates that medal success was concentrated among a smaller number of delegations, whereas a lower HHI indicates that medals were distributed among a broader group of delegations.

2.9. Normalized Herfindahl–Hirschman Index

Because the number of medal-winning delegations varies across Olympic editions, direct comparisons of raw HHI values may be problematic. Therefore, a normalized HHI was also calculated using the following formula:

$$\text{Normalized HHI} = (HHI - 1/N) / (1 - 1/N)$$

where N represents the number of delegations that won at least one podium medal in the corresponding Olympic year and wrestling style. A normalized HHI approaching 0 indicates a more balanced medal distribution among medal-winning delegations, whereas a value approaching 1 indicates a higher concentration of medal success. The primary purpose of using the normalized HHI was to reduce comparability problems arising from differences in the number of medal-winning delegations across Olympic editions.

2.10. Four-Delegation Concentration Ratio (CR4)

The Four-Delegation Concentration Ratio (CR4) was calculated to determine the collective share of the leading delegations in the overall medal distribution. CR4 was calculated as follows:

$$CR4 = \sum_{(i=1)}^4 s_i \times 100$$

where s_i represents the individual share of total medals accounted for by each of the four delegations with the highest number of total podium medals. A higher CR4 indicates that a large proportion of total podium medals was won by the four leading delegations, whereas lower values indicate that medals were distributed among a broader group of delegations. In Olympic Games/style observations with fewer than four medal-winning delegations, all existing medal-winning delegations were included in the calculation. Consequently, the CR4 may equal 100% in such observations.

2.11. Gini Coefficient

The Gini coefficient was used to assess inequality in medal distribution among medal-winning delegations. For each Olympic year and wrestling style, the total number of podium medals won by medal-winning delegations was arranged in ascending order:

$$x_1 \leq x_2 \leq \dots \leq x_n$$

The Gini coefficient was then calculated using the following formula:

$$G = [2\sum_{i=1}^n(i \times x_i)] / [n\sum_{i=1}^n x_i] - (n + 1)/n$$

where x_i represents the total number of podium medals won by delegation i , and n represents the number of delegations that won at least one medal in the corresponding Olympic year and wrestling style. A Gini coefficient approaching 0 indicates a more equal distribution among medal-winning delegations, whereas a higher coefficient indicates greater inequality in medal distribution. The Gini coefficient was calculated only for delegations that won at least one podium medal. Participating delegations that did not win a medal in the corresponding Olympic Games/style observation were excluded from the Gini calculation.

2.12. Joint Evaluation of the Indicators

The HHI, normalized HHI, CR4, and Gini coefficient were not treated as interchangeable indicators but as complementary measures reflecting different characteristics of medal distribution. The HHI represents the overall concentration of total medal distribution; the normalized HHI improves comparability across Olympic editions with different numbers of medal-winning delegations; the CR4 represents the collective share of the four most successful delegations in the overall medal distribution; and the Gini coefficient measures inequality in medal distribution among the medal-winning delegations themselves. Accordingly, conclusions concerning the competitive structure were not based on a single index; all four indicators were interpreted jointly.

2.13. Period Analysis

To comparatively evaluate long-term changes in the competitive structure of men's Olympic wrestling, the study period was divided into four historical periods:

- 1896–1936: Establishment and early development of Olympic wrestling,
- 1948–1988: Post-Second World War and Cold War period,
- 1992–2000: Transitional period following the dissolution of the Soviet Union and the emergence of new structures of Olympic representation,
- 2004–2024: Contemporary Olympic competition in the twenty-first century.

For each period and wrestling style, the mean number of medal-winning delegations, mean normalized HHI, mean CR4, and mean Gini coefficient were calculated. Period values were calculated as the arithmetic means of the values obtained from official Olympic Games/style observations within the respective date ranges. The 1906 Athens Intercalated Games were excluded from these period calculations. The periodization was not used as a causal historical model but rather as an analytical classification enabling comparison of long-term competitive indicators across different historical periods.

2.14. Limitations of the Study

The findings of this study should be interpreted in light of several limitations.

First, the study covers only men's Greco-Roman and freestyle Olympic wrestling competitions. Because women's wrestling was not included, the findings should not be interpreted as representing the historical performance of all Olympic wrestling competitions.

Second, the number of weight classes, competition formats, and medal structures in Olympic wrestling changed over the historical period. Therefore, the total number of medals awarded and the competition conditions were not identical across Olympic periods.

Third, in the UWW historical results database, some early-period state and delegation names may be presented using contemporary or database-specific standardized labels. Therefore, UWW records were used as the primary source for medal results, while historical delegations were standardized in a manner intended to preserve the representation structure applicable during the corresponding Olympic period.

Fourth, the World Wars, Olympic boycotts, and changes in the political structures of states affected the international participation structure of certain Olympic Games. Consequently, increases or decreases in concentration during particular periods should not be interpreted solely as reflecting changes in the level of sporting competition.

Finally, the HHI, normalized HHI, CR4, and Gini coefficient are not causal indicators that explain why countries or delegations achieve sporting success. These measures describe only the distribution, concentration, and inequality of medal success among delegations. Therefore, no direct causal relationship between economic resources, population, government policies, athlete development systems, or political structures and success in Olympic wrestling was inferred from the findings of this study.

3. Results

3.1. Historical Development of Men's Olympic Wrestling Competitions (1896–2024)

To examine the historical development of men's Olympic wrestling, official men's Greco-Roman and freestyle wrestling competitions held from the 1896 Athens Olympic Games to the 2024 Paris Olympic Games were analyzed. Each wrestling style was treated as a separate observation within the Olympic edition in which it was contested, and Olympic year, host city, number of athletes, and number of participating countries were considered the primary indicators.

Although the 1906 Athens Intercalated Games are included in historical results records, they were excluded from the main analyses of this study. Accordingly, Table 1 includes only those events considered part of the official Olympic series within the scope of the study.

Table 1: Historical Overview of Men's Olympic Wrestling Competitions (1896–2024)

Year	Host City	Style	No. of Athletes	No. of Countries
1896	Athens	Greco-Roman	5	4
1904	St. Louis	Freestyle	48	4
1908	London	Greco-Roman	74	13
1908	London	Freestyle	61	6
1912	Stockholm	Greco-Roman	172	19
1920	Antwerp	Greco-Roman	105	17
1920	Antwerp	Freestyle	61	13
1924	Paris	Greco-Roman	125	22
1924	Paris	Freestyle	100	14
1928	Amsterdam	Greco-Roman	107	24
1928	Amsterdam	Freestyle	62	16
1932	Los Angeles	Greco-Roman	41	13
1932	Los Angeles	Freestyle	49	15
1936	Berlin	Greco-Roman	110	23
1936	Berlin	Freestyle	100	20
1948	London	Greco-Roman	54	17
1948	London	Freestyle	50	17
1952	Helsinki	Greco-Roman	53	15
1952	Helsinki	Freestyle	52	16
1956	Melbourne	Greco-Roman	48	14
1956	Melbourne	Freestyle	50	20
1960	Rome	Greco-Roman	52	19
1960	Rome	Freestyle	50	17
1964	Tokyo	Greco-Roman	53	19
1964	Tokyo	Freestyle	50	17
1968	Mexico City	Greco-Roman	50	17
1968	Mexico City	Freestyle	48	16
1972	Munich	Greco-Roman	61	18
1972	Munich	Freestyle	61	18
1976	Montreal	Greco-Roman	60	16

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1976	Montreal	Freestyle	60	17
1980	Moscow	Greco-Roman	60	16
1980	Moscow	Freestyle	60	16
1984	Los Angeles	Greco-Roman	61	20
1984	Los Angeles	Freestyle	61	22
1988	Seoul	Greco-Roman	61	23
1988	Seoul	Freestyle	61	17
1992	Barcelona	Greco-Roman	187	46
1992	Barcelona	Freestyle	184	45
1996	Atlanta	Greco-Roman	201	57
1996	Atlanta	Freestyle	201	57
2000	Sydney	Greco-Roman	159	42
2000	Sydney	Freestyle	155	40
2004	Athens	Greco-Roman	146	46
2004	Athens	Freestyle	146	44
2008	Beijing	Greco-Roman	139	41
2008	Beijing	Freestyle	139	45
2012	London	Greco-Roman	135	44
2012	London	Freestyle	132	42
2016	Rio de Janeiro	Greco-Roman	116	41
2016	Rio de Janeiro	Freestyle	119	41
2021	Tokyo	Greco-Roman	96	39
2021	Tokyo	Freestyle	95	41
2024	Paris	Greco-Roman	96	38
2024	Paris	Freestyle	96	43

Note: The 1906 Athens Intercalated Games were excluded from the main analyses of the study.

As shown in Table 1, men's Olympic wrestling initially had a limited participation structure but gradually developed into a competition with broader international representation. At the 1896 Athens Olympic Games, only Greco-Roman wrestling was contested, with five athletes from four countries participating. Freestyle wrestling was introduced at the 1904 St. Louis Olympic Games, and from the 1908 London Olympic Games onward, both Greco-Roman and freestyle wrestling were included in the same Olympic edition.

Participation indicators fluctuated considerably during the early period. In Greco-Roman wrestling, the number of athletes increased from five in 1896 to 172 at the 1912 Stockholm Olympic Games, while the number of participating countries increased from four to 19 over the same comparison. The 1924 Paris and 1928 Amsterdam Olympic Games also featured relatively broad international participation in both styles, whereas at the 1932 Los Angeles Olympic Games the number of athletes declined to 41 in Greco-Roman and 49 in freestyle wrestling.

Between 1948 and 1988, athlete participation was more stable than in the preceding period. During this period, the number of athletes per style generally ranged from 48 to 61, while the number of participating countries generally ranged from 14 to 23.

The most pronounced increase in participation occurred during the 1990s. At the 1992 Barcelona Olympic Games, Greco-Roman wrestling included 187 athletes from 46 countries, while freestyle wrestling included 184 athletes from 45 countries. At the 1996 Atlanta Olympic Games, participation reached its highest level within the period examined, with 201 athletes from 57 countries in each style.

Although the number of athletes gradually declined from the 2000 Sydney Olympic Games onward, the number of participating countries remained relatively high. At the 2024 Paris Olympic Games, 96 athletes competed in each style, representing 38 countries in Greco-Roman and 43 countries in freestyle wrestling. Overall, the number of countries participating in men's Olympic wrestling increased substantially compared with the early Olympic period. However, growth in the number of participating countries does not in itself indicate that medal success became equally distributed among countries. Therefore, subsequent analyses separately examined the medal performances of Olympic delegations and the concentration of medal distribution.

3.2. Historical Performance Based on Medal Success in Men's Olympic Wrestling

In the second stage of the study, the historical performances of Olympic delegations that won medals in men's Greco-Roman and freestyle Olympic wrestling competitions between 1896 and 2024 were examined. To preserve differences in historical representation structures, the Soviet Union (USSR), Unified Team (EUN), Russian Federation, and other historical Olympic delegations were treated as separate units of analysis according to the forms of representation under which they competed. The performance ranking was determined primarily according to the number of gold medals won; in cases of a tie, silver and then bronze medal counts were used as successive tie-breaking criteria.

Table 2: Most Successful Olympic Delegations by Number of Gold Medals
in Men's Greco-Roman and Freestyle Olympic Wrestling (1896–2024)

Rank	Olympic Delegation	Gold	Silver	Bronze	Total
1	Soviet Union (USSR)	62	31	23	116
2	United States	55	44	36	135
3	Russian Federation	30	10	12	52
4	Türkiye	29	18	19	66
5	Sweden	28	27	29	84
6	Finland	26	28	30	84
7	Japan	26	20	15	61
8	Hungary	20	17	19	56
9	Bulgaria	18	30	20	68
10	Iran	13	19	23	55
11	Cuba	12	6	12	30
12	South Korea	11	11	14	36
13	Romania	7	8	19	34
14	Italy	7	4	11	22
15	Unified Team (EUN)	6	5	5	16

Note: The table includes only men's Greco-Roman and freestyle Olympic wrestling competitions. Women's wrestling and the 1906 Athens Intercalated Games were excluded. Historical Olympic delegations were treated separately according to the forms of representation under which they competed.

According to Table 2, the Soviet Union was the most successful delegation in the history of men's Greco-Roman and freestyle Olympic wrestling in terms of gold medals, winning 62 gold, 31 silver, and 23 bronze medals, for a total of 116 medals. Although the United States ranked second with 55 gold medals, it recorded 135 medals overall, the highest total medal count among the delegations presented in the table. This finding demonstrates that championship success and overall podium performance represent distinct dimensions of sporting achievement. The Russian Federation ranked third with 30 gold medals, followed by Türkiye in fourth place with 29 gold medals. Türkiye also won 18 silver and 19 bronze medals, resulting in a total of 66 podium medals. Sweden ranked fifth with 28 gold medals, while Finland and Japan each won 26 gold medals. Finland ranked above Japan because it had a higher number of silver medals. In terms of total medal count, Sweden and Finland each won 84 medals, followed by Bulgaria with 68, Türkiye with 66, and Japan with 61. These findings demonstrate that rankings based on gold medals do not necessarily correspond to rankings based on total podium performance.

3.3. Historical Changes in Competitive Concentration in Men's Olympic Wrestling

Although aggregate medal counts identify the delegations that have historically achieved the greatest success, they are insufficient to explain the extent to which medals were concentrated among delegations. Therefore, historical changes in medal distribution in men's Olympic wrestling were assessed using the HHI, normalized HHI, CR4, and Gini coefficient.

Table 3: Competitive Concentration Indicators by Wrestling
Style and Olympic Year in Men's Olympic Wrestling

Year	City	Style	Medal-Winning Delegations	HHI	Normalized HHI	CR4 (%)	Gini
1896	Athens	Greco-Roman	2	0.556	0.111	100.0	0.167
1904	St. Louis	Freestyle	2	0.909	0.819	100.0	0.452
1908	London	Freestyle	5	0.500	0.375	93.8	0.525
1908	London	Greco-Roman	6	0.194	0.033	83.3	0.222
1912	Stockholm	Greco-Roman	6	0.307	0.168	86.7	0.433
1920	Antwerp	Greco-Roman	4	0.422	0.230	100.0	0.417
1920	Antwerp	Freestyle	5	0.242	0.053	87.5	0.225
1924	Paris	Greco-Roman	5	0.364	0.205	94.4	0.422
1924	Paris	Freestyle	7	0.229	0.101	85.7	0.395

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1928	Amsterdam	Greco-Roman	8	0.154	0.034	66.7	0.250
1928	Amsterdam	Freestyle	9	0.143	0.036	66.7	0.286
1932	Los Angeles	Greco-Roman	8	0.175	0.057	81.0	0.327
1932	Los Angeles	Freestyle	8	0.179	0.062	81.0	0.351
1936	Berlin	Greco-Roman	8	0.175	0.057	76.2	0.339
1936	Berlin	Freestyle	10	0.125	0.027	61.9	0.271
1948	London	Greco-Roman	8	0.177	0.060	75.0	0.344
1948	London	Freestyle	8	0.181	0.063	79.2	0.365
1952	Helsinki	Greco-Roman	8	0.174	0.056	75.0	0.333
1952	Helsinki	Freestyle	9	0.142	0.035	66.7	0.296
1956	Melbourne	Greco-Roman	9	0.160	0.055	66.7	0.324
1956	Melbourne	Freestyle	8	0.156	0.036	70.8	0.271
1960	Rome	Greco-Roman	13	0.111	0.037	58.3	0.321
1960	Rome	Freestyle	10	0.153	0.059	70.8	0.375
1964	Tokyo	Greco-Roman	11	0.115	0.026	54.2	0.258
1964	Tokyo	Freestyle	8	0.170	0.052	79.2	0.323
1968	Mexico City	Greco-Roman	10	0.132	0.035	58.3	0.267
1968	Mexico City	Freestyle	10	0.122	0.024	58.3	0.258
1972	Munich	Greco-Roman	15	0.104	0.040	53.3	0.351
1972	Munich	Freestyle	12	0.149	0.072	66.7	0.422
1976	Montreal	Greco-Roman	11	0.178	0.096	73.3	0.455
1976	Montreal	Freestyle	11	0.158	0.074	70.0	0.424
1980	Moscow	Greco-Roman	9	0.160	0.055	70.0	0.356
1980	Moscow	Freestyle	11	0.162	0.078	66.7	0.412
1984	Los Angeles	Greco-Roman	12	0.104	0.023	53.3	0.278
1984	Los Angeles	Freestyle	11	0.173	0.091	73.3	0.455
1988	Seoul	Greco-Roman	13	0.122	0.049	63.3	0.385
1988	Seoul	Freestyle	11	0.162	0.078	70.0	0.430
1992	Barcelona	Greco-Roman	13	0.136	0.064	53.3	0.333
1992	Barcelona	Freestyle	11	0.136	0.049	63.3	0.352

1996	Atlanta	Greco-Roman	16	0.084	0.023	46.7	0.296
1996	Atlanta	Freestyle	17	0.087	0.030	50.0	0.322
2000	Sydney	Greco-Roman	15	0.090	0.025	50.0	0.278
2000	Sydney	Freestyle	15	0.104	0.040	54.2	0.306
2004	Athens	Greco-Roman	16	0.084	0.023	42.9	0.205
2004	Athens	Freestyle	10	0.134	0.038	61.9	0.300
2008	Beijing	Greco-Roman	20	0.062	0.012	37.0	0.206
2008	Beijing	Freestyle	17	0.092	0.035	46.4	0.303
2012	London	Greco-Roman	17	0.082	0.024	42.9	0.277
2012	London	Freestyle	13	0.097	0.022	50.0	0.280
2016	Rio de Janeiro	Greco-Roman	16	0.076	0.015	41.7	0.229
2016	Rio de Janeiro	Freestyle	11	0.118	0.030	58.3	0.288
2021	Tokyo	Greco-Roman	16	0.073	0.011	37.5	0.203
2021	Tokyo	Freestyle	14	0.118	0.050	58.3	0.333
2024	Paris	Greco-Roman	13	0.097	0.022	50.0	0.269
2024	Paris	Freestyle	13	0.097	0.022	50.0	0.269

Note: HHI and CR4 were calculated from the distribution of total podium medals among Olympic delegations. The normalized HHI was used to account for variation in the number of medal-winning delegations. The Gini coefficient was calculated only for delegations that won at least one podium medal. The 1906 Athens Intercalated Games were excluded from the analysis.

As shown in Table 3, medal concentration in men's Olympic wrestling was high during the early Olympic period and generally declined in subsequent periods. In freestyle wrestling, the highest concentration was observed at the 1904 St. Louis Olympic Games. The HHI was 0.909, the normalized HHI was 0.819, and the CR4 was 100%. The fact that only two delegations won medals indicates that freestyle wrestling had an extremely concentrated medal distribution during this period. One example of high concentration in early Greco-Roman wrestling was the 1920 Antwerp Olympic Games, where the HHI was 0.422, the normalized HHI was 0.230, and the CR4 was 100%. After 1928, both HHI and CR4 generally declined in both styles. However, year-to-year changes were not linear, and concentration indicators increased again at certain Olympic Games. From the 1996 Atlanta Olympic Games onward, low concentration values became more frequent, particularly in Greco-Roman wrestling. At the 2008 Beijing Olympic Games, 20 different delegations won medals in Greco-Roman wrestling; the HHI was 0.062, the normalized HHI was 0.012, and the CR4 was 37.0%. These values represent one of the lowest levels of concentration observed in Greco-Roman wrestling during the study period. At Tokyo 2021, the normalized HHI for Greco-Roman wrestling declined to 0.011.

At the same Games, the CR4 was 37.5% and the Gini coefficient was 0.203. At the 2024 Paris Olympic Games, 13 delegations won medals in each style. The HHI was 0.097, normalized HHI was 0.022, CR4 was 50.0%, and Gini coefficient was 0.269 in both styles. These findings indicate that, compared with the early Olympic Games, medal success in the contemporary period has been distributed among a broader group of Olympic delegations.

3.4. Historical Change in the Normalized HHI in Men's Olympic Wrestling

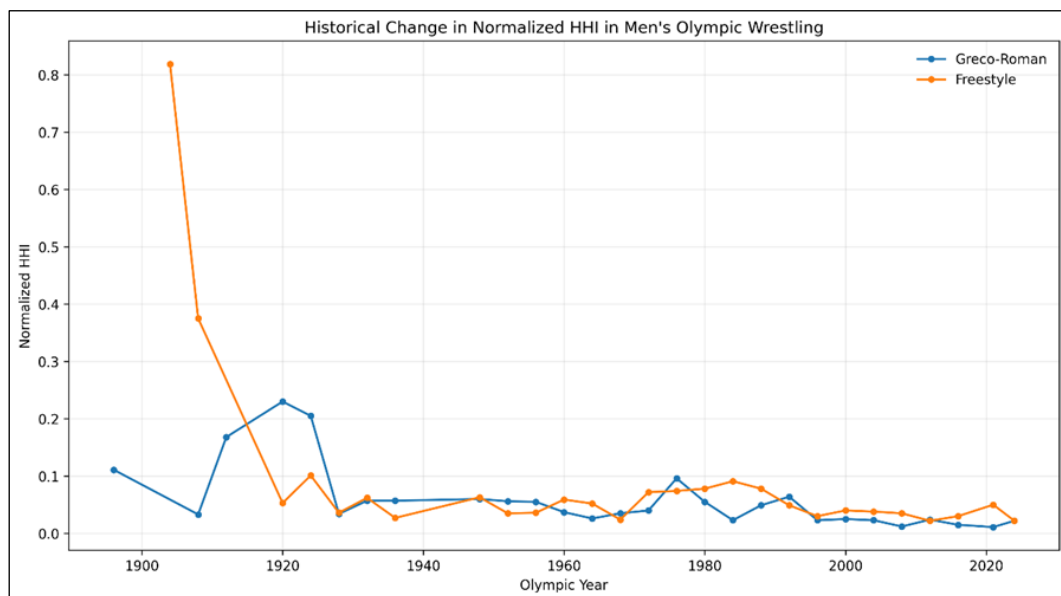


Figure 1: Historical Change in the Normalized HHI in Men's Olympic Wrestling

An examination of the historical trajectory of normalized HHI values in Figure 1 indicates a general long-term trend toward decreasing concentration in both wrestling styles. In freestyle wrestling, the value of 0.819 at the 1904 St. Louis Olympic Games represents the highest normalized HHI in the entire series. The marked decline in subsequent Olympic Games indicates that freestyle medal success became distributed among a larger number of delegations. In Greco-Roman wrestling, one of the highest early-period values was 0.230 at Antwerp 1920. After 1996, normalized HHI values in Greco-Roman wrestling generally remained at very low levels, reaching 0.011 at Tokyo 2021, one of the lowest values in the series examined. At Paris 2024, the normalized HHI was 0.022 in both styles, indicating that Greco-Roman and freestyle wrestling reached similar levels of concentration at the same Olympic Games.

3.5. Historical Change in the CR4 Ratio in Men's Olympic Wrestling

Figure 2 illustrates changes over time in the proportion of total podium medals won by the four delegations with the highest medal totals. CR4 values were very high during the early Olympic period. The CR4 was 100% in Greco-Roman wrestling at Athens 1896, freestyle wrestling at St. Louis 1904, and Greco-Roman wrestling at Antwerp 1920. The

lowest CR4 in Greco-Roman wrestling was 37.0% at Beijing 2008. A similarly low value of 37.5% was observed at Tokyo 2021. In freestyle wrestling, the CR4 was 46.4% at Beijing 2008, increasing to 58.3% at both Rio de Janeiro 2016 and Tokyo 2021. At Paris 2024, the CR4 was 50% in both styles, indicating that the four most successful delegations won half of all podium medals.

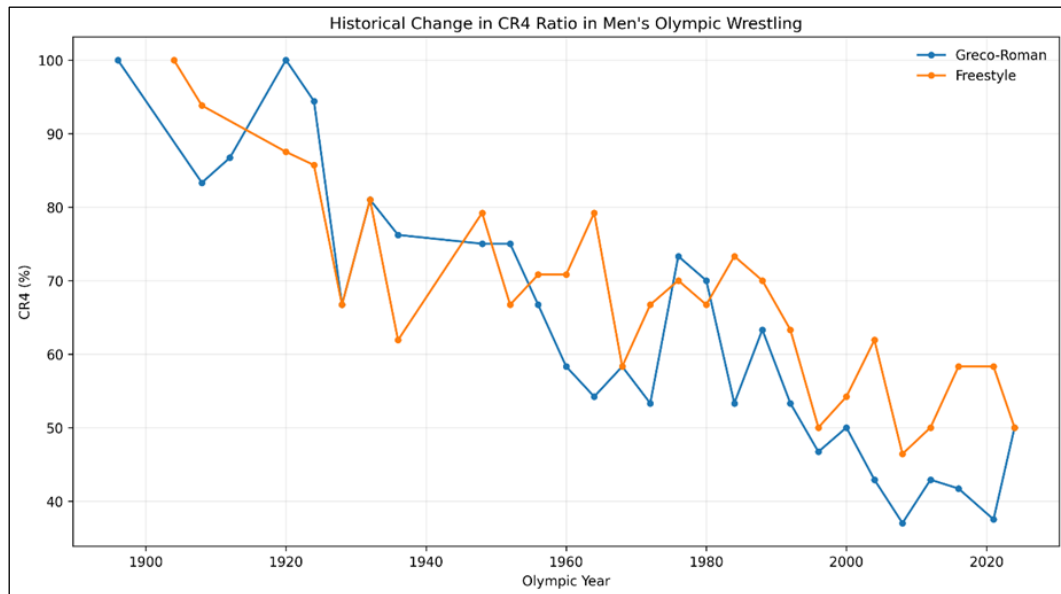


Figure 2: Historical Change in the CR4 Ratio in Men's Olympic Wrestling

3.6. Historical Change in the Gini Coefficient in Men's Olympic Wrestling

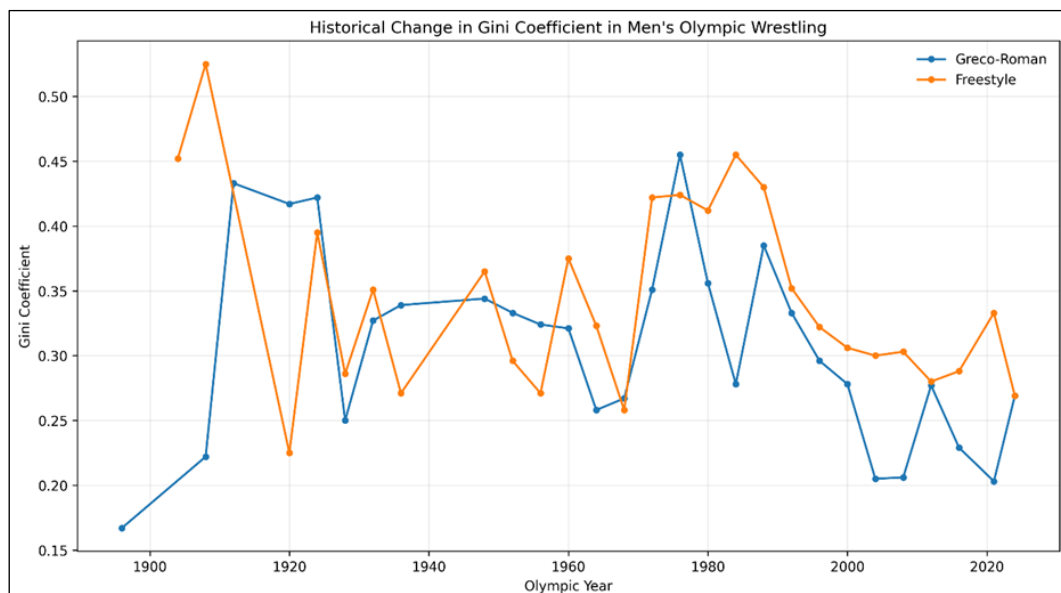


Figure 3: Historical Change in the Gini Coefficient in Men's Olympic Wrestling

Figure 3 shows that inequality in medal distribution among medal-winning delegations exhibited a more fluctuating pattern over time. In freestyle wrestling, the

highest Gini coefficient was 0.525 at the 1908 London Olympic Games. In Greco-Roman wrestling, the highest value was 0.455 at Montreal 1976. The Gini coefficient of 0.225 for freestyle wrestling at Antwerp 1920 indicates a relatively balanced distribution of medals among medal-winning delegations. By contrast, the high CR4 at the same Games demonstrates that the Gini coefficient and CR4 capture different dimensions of medal distribution. In the more recent period, relatively low Gini values were observed in Greco-Roman wrestling, including 0.205 at Athens 2004 and 0.203 at Tokyo 2021. At Paris 2024, the Gini coefficient was 0.269 in both styles. When considered together with the HHI and CR4 findings, this result indicates that medal success in contemporary Olympic wrestling is distributed among a broader group of delegations than during the early Olympic period.

3.7. Periodic Changes in Competitive Concentration in Men's Olympic Wrestling

To assess long-term changes more clearly alongside annual fluctuations, the study period was divided into four historical periods: 1896–1936, 1948–1988, 1992–2000, and 2004–2024. The 1906 Athens Intercalated Games were excluded from the period calculations.

Table 4: Mean Competitive Concentration Indicators
by Period and Style in Men's Olympic Wrestling

Period	Style	No. of Olympic Editions	Mean No. of Medal-Winning Delegations	Mean Normalized HHI	Mean CR4 (%)	Mean Gini
1896–1936	Greco-Roman	8	5.88	0.112	86.0	0.322
1896–1936	Freestyle	7	6.57	0.210	82.4	0.358
1948–1988	Greco-Roman	11	10.82	0.048	63.7	0.334
1948–1988	Freestyle	11	9.91	0.060	70.2	0.366
1992–2000	Greco-Roman	3	14.67	0.037	50.0	0.302
1992–2000	Freestyle	3	14.33	0.040	55.8	0.326
2004–2024	Greco-Roman	6	16.33	0.018	42.0	0.232
2004–2024	Freestyle	6	13.00	0.033	54.2	0.296

Note: Period values are arithmetic means of the official Olympic Games/style observations included in each respective period. The 1906 Athens Intercalated Games were excluded from the calculations.

According to Table 4, medal success in men's Olympic wrestling became distributed among a broader group of delegations over time. In Greco-Roman wrestling, the mean number of medal-winning delegations increased from 5.88 in 1896–1936 to 10.82 in 1948–1988, 14.67 in 1992–2000, and 16.33 in 2004–2024. Across the same periods, the mean

normalized HHI for Greco-Roman wrestling declined from 0.112 to 0.018, while the mean CR4 declined from 86.0% to 42.0%. These changes indicate that Greco-Roman medals became increasingly distributed among a broader group of delegations over the long term. A similar general trend was observed in freestyle wrestling. Whereas an average of 6.57 delegations won medals in the first period, this figure increased to 13.00 during 2004–2024. The mean normalized HHI declined from 0.210 to 0.033, while the mean CR4 declined from 82.4% to 54.2%. During 1992–2000, the mean number of medal-winning delegations exceeded 14 in both styles. In this period, the mean normalized HHI was 0.037 in Greco-Roman wrestling and 0.040 in freestyle wrestling.

The 2004–2024 period had the lowest mean concentration values among the periods examined for Greco-Roman wrestling. The mean normalized HHI was 0.018, the mean CR4 was 42.0%, and the mean Gini coefficient was 0.232. For freestyle wrestling during the same period, the mean normalized HHI was 0.033, the mean CR4 was 54.2%, and the mean Gini coefficient was 0.296. Thus, in the contemporary period, Greco-Roman wrestling exhibited lower levels of medal concentration and inequality than freestyle wrestling. When all four periods are considered together, the number of medal-winning delegations increased over the long term in both styles, while normalized HHI and CR4 values declined. The overall trend therefore indicates that medal success in men's Olympic wrestling became distributed across a broader base of international representation over time.

3.8. Geographical Distribution of Medal Success in Men's Olympic Wrestling (1896–2024)

To examine the geographical distribution of medal success in men's Olympic wrestling, the gold, silver, and bronze medals won by the Olympic delegations included in the study were evaluated according to continental groups.

Table 5: Medal Distribution by Continent in Men's Olympic Wrestling (1896–2024)

Continent	Gold	Silver	Bronze	Total	Total (%)
Europe	278	264	303	845	64.36
Asia	68	90	119	277	21.10
Americas	68	58	54	180	13.71
Africa	2	3	3	8	0.61
Oceania	0	1	2	3	0.23
Total	416	416	481	1,313	100.00

Note: The table includes only men's Greco-Roman and freestyle Olympic wrestling competitions. The 1906 Athens Intercalated Games were excluded from the calculations. Historical delegations were assigned to the relevant continental group according to the geographical classification used in this study.

According to Table 5, most of the historical medal accumulation in men's Olympic wrestling is attributable to delegations classified within the European group. Of the 1,313 podium medals won during the period examined, 845 were won by European delegations, representing 64.36% of all medals.

Europe also ranked first in all three medal categories, with 278 gold, 264 silver, and 303 bronze medals. Of the 416 gold medals awarded in total, 66.83% were won by delegations in the European group.

Asia ranked second with 277 medals and a 21.10% share of the total. Asian delegations won 68 gold, 90 silver, and 119 bronze medals. Asia's share of approximately one-fifth of all medals demonstrates its substantial contribution to podium success in men's Olympic wrestling.

The Americas won 180 medals, comprising 68 gold, 58 silver, and 54 bronze medals, and accounted for 13.71% of all medals.

African delegations won eight medals in total—two gold, three silver, and three bronze—representing 0.61% of the total medal count.

Oceania won three medals in total, comprising one silver and two bronze medals, accounting for 0.23% of all medals.

With respect to the geographical distribution of gold medals, 278 of the 416 gold medals were won by Europe (66.83%), 68 by Asia (16.35%), 68 by the Americas (16.35%), and two by Africa (0.48%).

Of the silver medals, 264 were won by Europe (63.46%), 90 by Asia (21.63%), 58 by the Americas (13.94%), three by Africa (0.72%), and one by Oceania (0.24%).

Of the bronze medals, 303 were won by Europe (62.99%), 119 by Asia (24.74%), 54 by the Americas (11.23%), three by Africa (0.62%), and two by Oceania (0.42%).

These findings demonstrate that although international participation and the number of medal-winning delegations in men's Olympic wrestling increased over time, the cumulative distribution of medals across continents remained unequal.

Europe and Asia together accounted for 85.46% of all podium medals, whereas the combined share of Africa and Oceania remained below 1%.

3.9. Medal Distribution by Continent in Men's Olympic Wrestling (1896–2024)

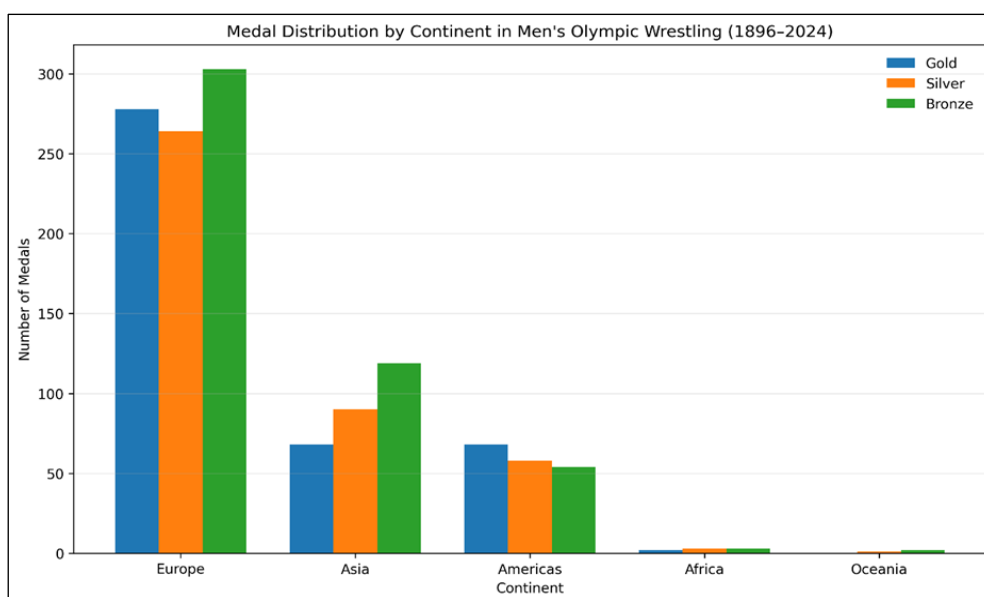


Figure 4: Medal Distribution by Continent in Men's Olympic Wrestling (1896–2024)

Figure 4 comparatively presents the continental distribution of gold, silver, and bronze medals. The European group clearly stands apart from the other geographical groups in all three medal categories.

Asia constituted the second-largest medal group, with 68 gold, 90 silver, and 119 bronze medals, while the Americas ranked third with 68 gold, 58 silver, and 54 bronze medals.

The corresponding values for Africa and Oceania were substantially lower than those of the other geographical groups.

When Table 5 and Figure 4 are considered together, the expansion of competition at the delegation level and the geographical balancing of cumulative medal success appear to represent distinct processes in men's Olympic wrestling. While the HHI, normalized HHI, and CR4 indicate that medals became distributed among an increasing number of delegations over time, the continental totals demonstrate that the majority of historical podium success remained concentrated in Europe, Asia, and the Americas.

Taken together, the findings for the 1896–2024 period indicate that the international competitive base of men's Olympic wrestling broadened over the long term, while the historical accumulation of medals continued to exhibit substantial geographical inequality.

4. Discussion

This study examined the historical development of men's Greco-Roman and freestyle wrestling competitions from the 1896 Athens Olympic Games to the 2024 Paris Olympic Games in terms of participation structure, medal performances of Olympic delegations, medal concentration, and geographical distribution. The main findings indicate that men's Olympic wrestling evolved from an early structure characterized by participation from a limited number of countries and medal success concentrated among relatively few delegations into a competitive environment marked by broader international representation and lower levels of medal concentration over the long term.

The first major finding of the study is the substantial expansion of international participation in men's Olympic wrestling over time. At the 1896 Athens Olympic Games, only five athletes from four countries competed in Greco-Roman wrestling, whereas particularly marked increases in both participating countries and athletes were observed during the 1990s. At the 1996 Atlanta Olympic Games, the highest participation levels in the study period were recorded, with 57 countries and 201 athletes in each style. Although the number of athletes declined after 2000, the number of participating countries remained high compared with the early Olympic period, indicating a broadening of the international representation base of men's Olympic wrestling.

This historical expansion should be considered alongside the development of wrestling within the modern Olympic program. Wrestling has been part of the Olympic program since the beginning of the modern Games; only Greco-Roman wrestling was contested at Athens 1896, whereas freestyle wrestling was introduced later. United World

Wrestling's historical records also confirm that wrestling was among the sports included in the 1896 modern Olympic program and that Greco-Roman was the only wrestling style contested at the inaugural Games (United World Wrestling [UWW], n.d.). Nevertheless, an increase in participation alone cannot be interpreted as evidence of greater competitive balance. For this reason, participation indicators were evaluated together with medal concentration measures in the present study.

The second major finding is that medal success in men's Olympic wrestling has historically accumulated to a considerable extent among particular delegations. In the ranking based on gold medals, the Soviet Union ranked first with 62 gold medals, followed by the United States with 55, the Russian Federation with 30, and Türkiye with 29. In terms of total podium medals, however, the United States ranked first with 135 medals. This difference demonstrates that rankings based solely on total medals or solely on championships reflect different dimensions of Olympic success.

The Soviet Union's position at the top of the gold-medal ranking is particularly notable within the historical context of the international sport system following the Second World War. Riordan (1977) examined in detail the institutional development of sport and physical education in the Soviet Union and the role of sport within the Soviet social system. However, the design of the present study does not test the causes underlying the Soviet Union's high medal performance in Olympic wrestling. Therefore, the structure of the Soviet sport system may be considered as historical context, but no causal conclusion that the observed medal success was directly produced by that system can be drawn from the findings of this study.

Similarly, Türkiye's fourth-place position in the historical ranking with 29 gold medals reflects a high level of long-term performance in men's Greco-Roman and freestyle Olympic wrestling. However, because variables that could explain sporting success, such as athlete development systems, coaching structures, economic resources, sport policies, or population size, were not analyzed in this study, direct causal explanations for the historical performances of Türkiye or other successful delegations cannot be made. The present findings identify only the relative positions of these delegations within long-term medal accumulation.

One of the most prominent findings of the study concerns the historical change in medal concentration. HHI, normalized HHI, and CR4 values, which were very high during the early Olympic periods, generally declined over time. In freestyle wrestling, the normalized HHI of 0.819 and CR4 of 100% at the 1904 St. Louis Olympic Games indicate that medal success was concentrated among an extremely limited group of delegations. By contrast, substantially lower concentration values were observed in the contemporary period, particularly in Greco-Roman wrestling. At Beijing 2008, the normalized HHI was 0.012 and the CR4 was 37.0%; at Tokyo 2021, the normalized HHI was 0.011 and the CR4 was 37.5%.

This finding demonstrates that the structure of international competition in men's Olympic wrestling changed considerably over time. Nevertheless, the change was not linear. The re-emergence of higher concentration values at certain Olympic Games

indicates that the long-term trend did not occur uniformly across all editions. Historical factors such as Olympic boycotts, the emergence of new Olympic delegations following the dissolution or unification of states, and changes in competition and weight-class structures should therefore be considered when interpreting results for particular years. The period-based analyses clearly support this long-term change in concentration. In Greco-Roman wrestling, the mean normalized HHI and CR4 were 0.112 and 86.0%, respectively, during 1896–1936, but declined to 0.018 and 42.0% during 2004–2024. Over the same comparison, the mean number of medal-winning delegations increased from 5.88 to 16.33. A similar pattern was observed in freestyle wrestling, where the normalized HHI declined from 0.210 to 0.033 and the CR4 from 82.4% to 54.2% between the earliest and contemporary periods.

Taken together, these results indicate that international competition in men's Olympic wrestling broadened over the long term. However, the meaning of “increased competition” in the context of this study must be clearly delimited. Competition was not measured through technical quality, performance differences between athletes, or uncertainty of match outcomes, but through the distribution of podium medals among Olympic delegations. Therefore, a low HHI or CR4 indicates that medal success was shared among more delegations; it does not directly demonstrate that individual matches were technically more competitive.

The comparison between the two wrestling styles also revealed an important finding. During 2004–2024, the mean normalized HHI, CR4, and Gini coefficient in Greco-Roman wrestling were 0.018, 42.0%, and 0.232, respectively, whereas the corresponding values for freestyle wrestling were 0.033, 54.2%, and 0.296. Thus, in the contemporary period, the distribution of podium medals among delegations was less concentrated and less unequal in Greco-Roman wrestling than in freestyle wrestling. However, this result should not be generalized to suggest that Greco-Roman wrestling is inherently “more competitive”; it should be interpreted only in relation to the medal-distribution indicators used in this study.

The findings concerning the Gini coefficient further demonstrate that medal concentration should not be evaluated using a single indicator. Whereas the HHI and CR4 showed a more pronounced long-term decline, the Gini coefficient followed a more fluctuating pattern. This is primarily because the indicators are sensitive to different characteristics of the distribution. The HHI measures the overall concentration of all medal shares, the CR4 measures the combined share of the four leading delegations, and the Gini coefficient measures inequality in medal distribution among delegations that succeeded in winning medals. Consequently, it is mathematically possible for a relatively high CR4 and a comparatively low Gini coefficient to occur within the same Olympic edition.

For example, in freestyle wrestling at Antwerp 1920, the CR4 was 87.5%, whereas the Gini coefficient was 0.225. The fact that the four leading delegations won a substantial proportion of the medals explains the high CR4, whereas the relatively balanced distribution of medals among all medal-winning delegations accounts for the lower Gini

coefficient. This finding demonstrates that the combined use of different concentration and inequality measures provides a more comprehensive picture than an assessment based on a single index.

Another finding of the study concerns the geographical distribution of medal success. Of the 1,313 podium medals included in the analysis, 845 (64.36%) were won by delegations classified within Europe, 277 (21.10%) by Asian delegations, and 180 (13.71%) by delegations from the Americas. Africa accounted for 0.61% of the total, while Oceania accounted for 0.23%. Thus, the historical accumulation of medals in men's Olympic wrestling has been distributed unevenly across continents.

Europe's share of approximately two-thirds of all medals demonstrates the historical weight of European delegations in men's Olympic wrestling. Asia formed the second-largest geographical medal group, followed by the Americas. However, this finding alone does not demonstrate how continental performance changed over time. Because the current continental analysis is based on cumulative totals for the entire 1896–2024 period, conclusions such as "Asia has risen over the last half-century" or "Europe's share declined during a particular period" cannot be drawn from this table alone. Such conclusions would require separate analyses of continental medal distributions by historical period or Olympic year.

When the geographical findings are considered together with the concentration indicators, an important distinction emerges. A decline in medal concentration at the country/delegation level does not necessarily imply a comparable balancing of medal success at the geographical level. While the HHI and CR4 indicate that medals were shared among a larger number of delegations in the contemporary period, the fact that 64.36% of the historical total is associated with Europe demonstrates that long-term medal accumulation remains substantially unequal across continents.

This finding suggests that the historical development of men's Olympic wrestling should be evaluated at two distinct levels. The first is the competitive structure among individual Olympic delegations. At this level, medal success became distributed among a broader set of delegations over the long term. The second is cumulative geographical distribution. At this level, Europe retained a dominant share of historical medal accumulation, while Asia and the Americas accounted for important but smaller shares, and Africa and Oceania remained comparatively limited.

The findings after 1992 should also be interpreted within the context of changes in historical Olympic representation structures. Following the dissolution of the Soviet Union, athletes who had previously competed under a single Olympic representation began participating under different national delegations. This change may have mechanically affected both the number of medal-winning delegations and the concentration indicators. Therefore, it would be inappropriate to explain all of the lower concentration values observed after the 1990s solely as evidence that sporting capacity spread to a larger number of countries. Changes in political borders and units of Olympic representation are also historical factors that may account for part of the observed distribution.

Nevertheless, the long-term pattern of the findings also indicates that the lower concentration observed after 1992 cannot be attributed exclusively to changes in representation. The persistence of low normalized HHI and CR4 values in Greco-Roman wrestling at the 2004, 2008, 2012, 2016, and 2021 Olympic Games suggests that the broadening of medal distribution was not merely a temporary phenomenon of the 1990s. However, because the present study did not test the institutional, economic, or sporting determinants underlying this change, explanations for the causes of this trend should be addressed in future research.

Another contribution of the study lies in its decision not to retrospectively merge historical Olympic representation structures into contemporary states. Treating the Soviet Union, Unified Team, Russian Federation, and other historical delegations separately according to their identities at the time of competition enables the historical context in which sporting success was achieved to be preserved in long-term rankings. At the same time, the use of contemporary or standardized labels for some historical country names in the UWW database highlights the need for careful verification of delegation names in long-term historical data analysis.

In conclusion, the findings demonstrate that over approximately 130 years of men's Greco-Roman and freestyle Olympic wrestling, international representation expanded, the concentration of podium medals among delegations generally declined, and medal distribution became broader in the contemporary period than in the early Olympic era. However, this transformation was not linear, and cumulative historical medal success remains unevenly distributed both among delegations and across geographical groups. Therefore, the historical development of men's Olympic wrestling should be evaluated not solely through rankings of successful countries but through a combined consideration of participation, historical representation structures, medal concentration, distributional inequality, and geographical accumulation.

5. Recommendations

Future studies may examine women's Olympic wrestling and period-based changes in continental medal distribution. Research incorporating economic, demographic, and sport-system factors may further explain differences in Olympic success. The concentration indicators used in this study may also be applied to other Olympic sports to enable comparative analyses of international competitive structures.

6. Conclusion

This study examined the historical development of men's Greco-Roman and freestyle wrestling competitions from the 1896 Athens Olympic Games to the 2024 Paris Olympic Games in terms of participation indicators, medal performances of Olympic delegations, medal concentration, distributional inequality, and geographical accumulation of medals. Covering a period of approximately 130 years, the findings demonstrate that

men's Olympic wrestling underwent a substantial transformation over time, both in terms of participation structure and the distribution of medal success among delegations. The first major conclusion is that the international representation base of men's Olympic wrestling expanded markedly over time. At the 1896 Athens Olympic Games, the first edition of the modern Olympics, only five athletes from four countries competed in Greco-Roman wrestling. Particularly from the 1990s onward, however, the number of participating countries increased substantially. At the 1996 Atlanta Olympic Games, the highest participation levels within the study period were reached, with 57 countries and 201 athletes in each wrestling style. Although athlete quotas declined at subsequent Olympic Games, the number of participating countries remained high compared with the early Olympic period, indicating that men's Olympic wrestling developed into a sport with broad international representation.

The second major conclusion is that long-term medal success accumulated substantially among particular Olympic delegations. Within the men's Greco-Roman and freestyle wrestling competitions included in the study, the Soviet Union ranked first with 62 gold medals, followed by the United States with 55, the Russian Federation with 30, and Türkiye with 29. In terms of total podium medals, however, the United States ranked first with 135 medals. This finding demonstrates that championship success and total podium performance represent distinct but complementary dimensions of Olympic achievement.

One of the most important findings of the study concerns the long-term change in medal concentration. The general decline in HHI, normalized HHI, and CR4 values from the early Olympic period to the contemporary era indicates that podium medals became distributed among a broader group of Olympic delegations over time. In freestyle wrestling, the normalized HHI of 0.819 and CR4 of 100% at the 1904 St. Louis Olympic Games reflected an extremely high level of concentration. By contrast, in Greco-Roman wrestling, the normalized HHI was 0.012 and the CR4 was 37.0% at Beijing 2008, while the corresponding values at Tokyo 2021 were 0.011 and 37.5%. These changes indicate that medal success in contemporary men's Olympic wrestling is shared among a larger number of delegations than during the early Olympic era.

The period-based analyses further support this long-term trend. In Greco-Roman wrestling, the mean number of medal-winning delegations increased from 5.88 during 1896–1936 to 16.33 during 2004–2024. Over the same comparison, the normalized HHI declined from 0.112 to 0.018 and the CR4 from 86.0% to 42.0%. In freestyle wrestling, the mean number of medal-winning delegations increased from 6.57 to 13.00, while the normalized HHI declined from 0.210 to 0.033 and the CR4 from 82.4% to 54.2%. These results indicate that the general long-term tendency in both styles has been toward lower medal concentration.

Nevertheless, the findings also demonstrate that changes in the competitive structure were not linear. The re-emergence of higher concentration values at certain Olympic Games indicates that different historical periods did not develop uniformly. Historical circumstances such as the World Wars, Olympic boycotts, the dissolution or

unification of states, the emergence of new Olympic delegations, changes in the number of weight classes, and modifications to competition systems should therefore be taken into account when interpreting medal distributions at particular Olympic Games.

The emergence of new national delegations following the dissolution of the Soviet Union in the 1990s is particularly important when evaluating long-term concentration indicators. The distribution of sporting capacity that had previously been represented under a single Olympic delegation across multiple new delegations represents a structural change that may have contributed to an increase in the number of medal-winning countries and a decline in concentration indicators. Nevertheless, the persistence of relatively low concentration values during the 2000s indicates that the broadening of medal distribution was not limited solely to changes in political representation during the 1990s.

The study also identified differences between Greco-Roman and freestyle wrestling. During 2004–2024, the mean normalized HHI, CR4, and Gini coefficient in Greco-Roman wrestling were 0.018, 42.0%, and 0.232, respectively, whereas the corresponding values for freestyle wrestling were 0.033, 54.2%, and 0.296. Thus, in the contemporary period, podium medal distribution among delegations was less concentrated and less unequal in Greco-Roman wrestling than in freestyle wrestling. However, this finding should not be interpreted as indicating that Greco-Roman wrestling is inherently more competitive in technical or sporting terms; the phenomenon measured in the present study concerns only the distribution of podium medals among delegations.

The more fluctuating historical trajectory of the Gini coefficient compared with the HHI and CR4 also demonstrates that medal distribution cannot be adequately evaluated using a single concentration measure. The HHI reflects overall concentration, the CR4 represents the combined medal share of the four most successful delegations, and the Gini coefficient measures inequality in medal distribution among delegations that won medals. Therefore, evaluating these indicators together enables a more comprehensive interpretation of the competitive structure of men's Olympic wrestling.

The geographical distribution findings indicate that the historical accumulation of medals in men's Olympic wrestling has not been evenly distributed across continents. Of the 1,313 podium medals included in the study, 845 (64.36%) were won by delegations classified within Europe, 277 (21.10%) by Asian delegations, and 180 (13.71%) by delegations from the Americas. Africa accounted for 0.61% and Oceania for 0.23%. Thus, although medal concentration at the delegation level declined over time, long-term cumulative medal success remained substantially differentiated geographically.

This finding demonstrates that two distinct historical processes occurred simultaneously in men's Olympic wrestling. On the one hand, podium medals were increasingly shared among a larger number of Olympic delegations, reducing concentration at the delegation level. On the other hand, the majority of historical cumulative medal success remained concentrated among delegations from Europe, Asia, and the Americas. Accordingly, the broadening of the international competitive base

should not be considered equivalent to a geographical equalization of historical medal accumulation.

Overall, the findings demonstrate that over approximately 130 years, men's Greco-Roman and freestyle Olympic wrestling underwent a long-term transformation from an early structure in which a limited number of delegations accounted for a large share of medal success toward a multi-actor competitive structure in which podium success became distributed among a broader group of delegations. Nevertheless, historically successful delegations continue to occupy strong positions in cumulative medal totals. The historical transformation of Olympic wrestling should therefore not be interpreted as the complete disappearance of traditional centers of strength, but rather as the development of a competitive structure in which a growing number of delegations have been able to share podium success alongside these traditional powers.

The findings of this study also suggest several directions for future research. First, the Olympic dataset for women's wrestling, available since 2004, could be examined separately to compare gender-based differences in medal concentration and geographical distribution between men's and women's wrestling. Such an analysis could contribute to understanding the gendered competitive structure of Olympic wrestling.

Second, continental medal distribution should be examined not only through cumulative totals for 1896–2024 but also by historical period or Olympic year. This would make it possible to identify directly how the medal shares of Europe, Asia, the Americas, Africa, and Oceania changed over time. Such an analysis could provide historical evidence regarding the rise or decline of particular regions that cumulative totals alone cannot demonstrate.

Third, future studies seeking to explain differences in Olympic wrestling performance among countries could examine variables such as population, income per capita, investment in sport, athlete development systems, participation in international competitions, coaching structures, and sport policies alongside medal performance. The HHI, normalized HHI, CR4, and Gini measures used in this study describe the structure of the distribution but do not explain the causes underlying that distribution. Future multivariate analyses may therefore provide insight into these determinants.

Fourth, the effects of historical changes in weight-class structures on medal concentration could be examined separately. Changes in the number of weight classes across Olympic periods directly affect both the number of medals awarded and the maximum number of medals a delegation can potentially win at a single Olympic Games. Accordingly, the development of standardized performance indicators that account for the number of weight classes may improve the precision of long-term comparisons.

Fifth, the effects of Olympic boycotts and political disruptions could be evaluated through separate analyses. In particular, the 1980 Moscow and 1984 Los Angeles Olympic Games, together with the 1992 Barcelona Olympic Games following the dissolution of the Soviet Union, provide important historical comparison points for examining the relationship between political conditions, international participation, and medal distribution.

Finally, applying the concentration-based approach used in this study to Olympic sports other than wrestling could enable comparative evaluation of international competitive structures across disciplines. Applying the same indicators to sports such as athletics, judo, weightlifting, boxing, taekwondo, or gymnastics could reveal which sports exhibit broader international distribution of medal success and in which disciplines long-term concentration among particular countries remains stronger.

In conclusion, this study examined the historical development of men's Greco-Roman and freestyle Olympic wrestling from 1896 to 2024 not only through chronological medal totals but also through a quantitative perspective integrating participation structure, historical Olympic delegations, medal concentration, distributional inequality, and geographical accumulation. The findings indicate that international representation and podium success in men's Olympic wrestling broadened over the long term, while historical medal accumulation continued to display strong continuity among particular delegations and geographical groups.

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Conflict of Interest Statement

The author declares no conflicts of interest.

About the Author(s)

Assoc. Prof. Dr. Mehmet Yıldız is a faculty member at the Faculty of Sports Sciences, Department of Physical Education and Sports Education at Gazi University. He completed his undergraduate education at Hacettepe University, School of Sport Sciences and Technology, Department of Recreation, received his master's degree in Physical Education and Sports Education from Gazi University, and completed his doctoral studies at Gazi University Institute of Educational Sciences. His doctoral dissertation focused on the employment, studies, and impacts of foreign experts invited to Türkiye in

the field of physical education and sports during the Republican period (1923–1973). Dr. Yıldız's academic research primarily focuses on physical education and sports pedagogy, sports history, Turkish educational history, sports sociology, and the modernization of physical education in Türkiye. His studies particularly examine the historical development of physical education and sports institutions, foreign experts in Turkish sports history, educational reforms in sports sciences, and contemporary approaches in physical education teaching. He has published numerous academic articles, book chapters, and books on sports history, physical education teacher training, educational policies, artificial intelligence applications in sports sciences, and the historical development of Turkish sports institutions. Among his notable works are *Türkiye'ye Beden Eğitimi ve Spor Alanında Gelen Yabancı Uzmanlar (1923–1973)* and studies related to the history of wrestling and sports education in Türkiye. In addition to his academic studies, Dr. Yıldız has served in various academic and administrative positions, including Vice Dean, Deputy Head of Department, and Deputy Director at the Faculty of Sports Sciences, Gazi University. He continues to teach undergraduate courses related to physical education teaching methods, Turkish educational history, research methods, and sports sciences

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