The geography of Olympic combat sports – part two: boxing, fencing, modern pentathlon, wrestling

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A Study Design
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Abstract

Background and Study Aim:	This article continues the research line on the geography of Olympic combat sports. It is based on the perspective of their spatial differentiation and development. The aim of the paper was to reflect on the phenomenon of geography of Olympic combat sports, which have their roots in ancient times – boxing, fencing, modern pentathlon and wrestling.
Material and Methods:	The data for the analysis were the boxing, fencing, modern pentathlon and wrestling results from the Olympic Games available via the IOC website (the method of secondary source analysis). In order to relativize the data, two recently developed indicators were applied: the Olympic Games medal winning frequency index (M) and the Olympic Games points winning frequency index (P); the results were presented in the form of maps and tables. A cartographic method – choropleth map and proportional symbol map, including the natural interval method to determine class intervals – was applied to illustrate the findings.
Results:	The United States dominates boxing and wrestling in terms of the number and weight of medals won. With regard to fencing, France dominates in terms of the number of medals won, while Italy dominates in terms of the weight of medals won. And in modern pentathlon, Hungary dominates both in terms of the number and weight of medals won.
Conclusions:	Boxing, fencing, modern pentathlon and wrestling are dominated by the countries in which the respective combat sports were most popular at the time of their introduction to the modern Olympic Games program.
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Boxing – a combat sport in which two competitors fight each other using only their fists above the waist – originally without gloves and, from the early 20th century, with gloves. Olympic boxing competition is held under the rules of the International Boxing Association (IBA) [55].

Fencing – a combat sport based on the practice of handling cold weapons. Olympic fencing competition takes place in the disciplines of sabre, epee and foil, according to the rules of the International Fencing Federation (FIE) [56].

Modern pentathlon – a defensive sport in which victory is determined by the sum of points scored by an athlete in the following competitions: fencing (one-touch épée), freestyle swimming, equestrian show jumping, pistol shooting, and cross country running. Olympic competition in modern pentathlon follows the rules of the Union Internationale de Pentathlon Moderne (UIMP) [57].

Wrestling – a combat sport consisting of a direct clash between two competitors through the use of grips and throws. Olympic wrestling competition takes place in the following disciplines (styles): classical (holds are only allowed above the waist) and free (leg holds are additionally allowed), according to United World Wrestling (UWW) rules [58].

INTRODUCTION

Sports geography [1] can be placed in the discipline of physical culture sciences [2]. This science studies the distribution of various components within sport and the influence of geography on sports [3-6]. The geography of Olympic combat sports, meanwhile, is a new line of research that penetrates as yet undescribed areas of sport geography. This line of research should be understood as the science that examines the distribution of various components within combat sports and the influence of geography on combat sports [7]. Modern Olympic combat sports include boxing [8], fencing [9], judo [10], karate [11], modern pentathlon [12], taekwondo [13] and wrestling [14]. The first stage of the research describes the geography of Olympic combat sports from the Far East [15]: judo, karate, and taekwondo, and the current second stage of research examines the geography of Olympic combat sports with roots in ancient times [16]: boxing, fencing, modern pentathlon and wrestling.

We know from the long history of combat sports that boxing is one of the oldest sports in the world. This method of combat was known in ancient Sumeria, Egypt, and Crete [17]. Around 1400 BC, sporting varieties of fist fighting spread throughout Greece, and as a discipline in the Olympic Games, boxing first appeared in 688 BC [18]. After the collapse of the ancient Olympic Games, modern boxing was revived in England [19]. It was not until 1904 that boxing was introduced into the program of the modern Olympic Games in Saint Louis, and since then the sport has only ever been absent from the Games in 1912 due to a ban on practicing the sport in Sweden [20].

Modern sport fencing, in turn, derives from the traditional art of using cold weapons. In various historical periods, the fighting styles and ways of teaching fencing were suitable for cold weapons in use. In antiquity, these included backswords, swords and shields. In the Middle Ages, swords, shields and lances [21]. In 16th-century Spain and Italy, the rapier developed from the sword, which a century later in France gave rise to the court sword [22]. In contrast, the sabre developed in eastern Europe [23]. The following century saw the introduction of the foil and dueling masks, which significantly contributed to the development of sport fencing [24]. The culmination of the sporting transformation of cold weapons was that fencing appeared on the program of the first modern Olympic Games in Athens in 1896 [25].

Moreover, from the 1912 Olympic Games in Stockholm, the modern pentathlon has been competed, which now includes: fencing with epee, freestyle swimming, bonus round of fencing with epee, equestrianism, cross-country running with shooting [26]. Modern pentathlon was developed on the basis of the ancient pentathlon by the founder of the modern Olympic movement, Pierre de Coubertin. It was intended to be a combination of essential soldier skills with the idea that sport was the basis for military training [27]. The adjective 'modern' was added to emphasize that although the modern pentathlon refers to the ancient one, it is significantly different from it [28]. Fencing with epee [29] and other competitions of this defensive sport, due to the all-round skills that define warriors, fully relate to the desired physical fitness of combat sports athletes (fighters) [30]. Therefore, modern pentathlon has been fully incorporated into the geography of Olympic combat sports.

The origins of wrestling also date back to ancient times. At that time, it was one of the most popular combat sports [31]. From 708 BC, wrestling was also one of the most important disciplines played at the ancient Olympic Games and was part of the ancient pentathlon [32]. It is significant that wrestling has not lost its appeal over the centuries and has become so widespread that it currently has many counterparts that are specific to different cultures and nationalities [33]. Competition in wrestling, like fencing, has been featured since the first modern Olympic Games in Athens in 1896. But only once in the history of modern Games has wrestling not been held, and that was in 1900 in Paris [34].

The popularity of the above-described combat sports, their widespread training throughout the world and their accreditation by the International Olympic Committee allowed the introduction of these disciplines into the program of the modern Olympic Games. Therefore, for this study, the concept of spatial differentiation and the evolution of Olympic combat sports originating from antiquity (boxing, fencing, partly modern pentathlon and wrestling) was adopted.

The aim of the paper was to reflect on the phenomenon of geography of Olympic combat sports,

which have their roots in ancient times – boxing, fencing, modern pentathlon and wrestling.

The following hypothesis was established: the countries in which the respective combat sports were born dominate the Olympic competition in these disciplines.

MATERIAL AND METHODS

At first the secondary source analysis method was applied for retrieving boxing, fencing, modern pentathlon and wrestling results from the Olympic Games IOC website [35]. The spatial scope of the study included all countries of the world. The time span of the study included the whole history of modern Olympic Games until present times. Due to the COVID-19 pandemic, the most recent Tokyo 2020 Olympic Games were in fact played one year later [36-38]. Therefore, the time range for boxing was 1904-2021, for fencing 1896-2021, for modern pentathlon 1912-2021 and for wrestling 1896-2021. The total number of medals won by a given country and their weight were evaluated according to a weighted point system: gold (5 points); silver (3 points); bronze (1 point). The medal classifications of the studied countries were correlated to the modern-day geopolitical world division, therefore some adjustments had to be made. Medals awarded for Czechoslovakia, Yugoslavia, the USSR and the CIS were allocated to individual countries by taking the nationality of the medal-winning athlete into account, regardless of their place of residence or training. For the teams, the medals were distributed according to the nationality of the players proportionally to their country of origin. However, East Germany and West Germany medals were added up as medals for Germany.

Secondly, the following indicators were used again:

- the Olympic Games medal winning frequency index (M) = (number of gold medals + number of silver medals + number of bronze medals) / number of Olympic Games when the given competition was held;

- the Olympic Games points winning frequency index (P) = (number of gold medals x 5 points + number of silver medals x 3 points + number of bronze medals x 1 point) / number of Olympic Games when the given competition was held.

In the third step, two cartographic methods – proportional symbol map and choropleth map – were applied to illustrate the spatial distribution of the examined traits. Proportional symbol map was used to illustrate the total number and the distinct colors of the medals, and the choropleth map was used to illustrate the Olympic Games points winning frequency index; QGIS 3.28 GIS software was used to generate the maps. A proportional symbol map is a quantitative method that is used to show the spatial distribution of specific values of a phenomenon by means of diagrams varying in size, while a choropleth map shows the intensity of that phenomenon in specific reference fields, in this case countries. The proportional symbol map is a quantitative method for showing absolute data, while the choropleth map is a method for showing relative data [39, 40].

For the points winning frequency index (P), five classes were determined for all disciplines (including one 'zero' class). The authors used the natural interval method (Jenks' method) to determine the class intervals while constructing the choropleth maps. This is a commonly used method that involves clustering similar values so that class boundaries are shared by dissimilar values. In QGis, class determination is based on suitable algorithms that analyze the value chart and indicate the 'natural gaps' in which the class boundaries are present. Optimization in this method is based on finding the largest possible gaps and groups of values as close to each other as possible [39, 40]. The 'Cultural' cartographic base 1:10 000 000 map available in the public domain was used to generate the maps [41].

RESULTS

Boxing
Representatives of as many as 77 countries have won medals throughout the history of boxing during the modern Olympic Games, but the discipline has long been dominated by the USA (Figure 1). Other countries that scored medals most frequently (M index of 1 and up) were Cuba, Russia, Great Britain, Italy, Germany, and Poland (Table 1) – countries with long-standing traditions of fist fighting; it is also easily discernible in terms of points won (Table 2).

Fencing
Fencing has traditionally been a playground of France and Italy throughout the modern Olympic

Table 1. Medals won in boxing.

No.	Country	Gold	silver	bronze	Total number of medals	M index
1	United States	50	26	39	115	4.42
2	Cuba	38	19	15	72	2.77
3	Russia[A]	21	18	29	68	2.62
4	Great Britain	19	14	26	59	2.27
5	Italy	15	15	18	48	1.85
6	Germany	11	14	22	47	1.81
7	Poland	8	9	26	43	1.65
8	Romania	1	9	15	25	0.96
9	Argentina	7	7	10	24	0.92
10	Kazakhstan[B]	6	7	9	22	0.85
11	South Korea	3	7	10	20	0.77
12	Hungary	10	2	8	20	0.77
13	Bulgaria	5	5	9	19	0.73
14	France	4	7	8	19	0.73
15	South Africa	6	4	9	19	0.73
16	Ukraine[C]	4	7	8	19	0.73
17	Ireland	3	5	10	18	0.69
18	Canada	3	7	7	17	0.65
19	Finland	2	1	12	15	0.58
20	Thailand	4	4	7	15	0.58
21	Denmark	1	5	6	12	0.46
22	Mexico	2	3	7	12	0.46
23	Sweden	0	5	6	11	0.42
24	China	3	4	3	10	0.38
25	Uzbekistan[D]	2	1	6	9	0.35
26	Philippines	0	4	4	8	0.31
27	Japan	3	0	5	8	0.31
28	North Korea	2	3	3	8	0.31
29	Austria	0	3	4	7	0.27
30	Australia	0	3	4	7	0.27
31	Azerbaijan	0	0	7	7	0.27
32	Brazil	1	2	4	7	0.27
33	Netherlands	1	1	5	7	0.27
34	Kenya	1	1	5	7	0.27
35	Turkey	1	3	3	7	0.27
36	Algeria	1	0	5	6	0.23
37	Nigeria	0	3	3	6	0.23
38	Puerto Rico	0	1	5	6	0.23
39	Lithuania[E]	1	2	2	5	0.19
40	Mongolia	1	2	2	5	0.19
41	Norway	1	2	2	5	0.19

Table 2. Points won by in boxing.

No.	Country	Total number of points	P index
1	United States	367	14.12
2	Cuba	262	10.08
3	Russia	188	7.23
4	Great Britain	163	6.27
5	Italy	138	5.31
6	Germany	119	4.58
7	Poland	93	3.58
8	Argentina	66	2.54
9	Hungary	64	2.46
10	Kazakhstan	60	2.31
11	South Africa	51	1.96
12	Bulgaria	49	1.88
13	France	49	1.88
14	Ukraine	49	1.88
15	Romania	47	1.81
16	South Korea	46	1.77
17	Canada	43	1.65
18	Ireland	40	1.54
19	Thailand	39	1.50
20	China	30	1.15
21	Denmark	26	1.00
22	Mexico	26	1.00
23	Finland	25	0.96
24	North Korea	22	0.85
25	Sweden	21	0.81
26	Japan	20	0.77
27	Uzbekistan	19	0.73
28	Turkey	17	0.65
29	Philippines	16	0.62
30	Brazil	15	0.58
31	Austria	13	0.50
32	Australia	13	0.50
33	Netherlands	13	0.50
34	Kenya	13	0.50
35	Lithuania	13	0.50
36	Mongolia	13	0.50
37	Norway	13	0.50
38	Venezuela	13	0.50
39	Nigeria	12	0.46
40	Czech Republic	12	0.46
41	Serbia	11	0.42

No.	Country	Gold	silver	bronze	Total number of medals	M index	No.	Country	Total number of points	P index
42	Serbia[F]	1	1	3	5	0.19	42	Belarus	11	0.42
43	Venezuela	1	2	2	5	0.19	43	Croatia	11	0.42
44	Armenia[G]	1	0	3	4	0.15	44	Slovakia	11	0.42
45	Belgium	1	1	2	4	0.15	45	Algeria	10	0.38
46	Czech Republic[H]	1	2	1	4	0.15	46	Belgium	10	0.38
47	Egypt	0	1	3	4	0.15	47	New Zealand	10	0.38
48	Ghana	0	1	3	4	0.15	48	Uganda	10	0.38
49	Spain	0	2	2	4	0.15	49	Puerto Rico	8	0.31
50	New Zealand	1	1	2	4	0.15	50	Armenia	8	0.31
51	Uganda	0	3	1	4	0.15	51	Spain	8	0.31
52	Belarus[I]	1	2	0	3	0.12	52	Azerbaijan	7	0.27
53	Chile	0	1	2	3	0.12	53	Egypt	6	0.23
54	Croatia[J]	2	0	1	3	0.12	54	Ghana	6	0.23
55	India	0	0	3	3	0.12	55	Dominican Republic	6	0.23
56	Columbia	0	0	3	3	0.12	56	Chile	5	0.19
57	Morocco	0	0	3	3	0.12	57	Cameroon	4	0.15
58	Moldova[K]	0	0	3	3	0.12	58	Macedonia	4	0.15
59	Slovakia[L]	2	0	1	3	0.12	59	India	3	0.12
60	Dominican Republic	1	0	1	2	0.08	60	Columbia	3	0.12
61	Georgia[M]	0	0	2	2	0.08	61	Morocco	3	0.12
62	Cameroon	0	1	1	2	0.08	62	Moldova	3	0.12
63	Macedonia[N]	0	1	1	2	0.08	63	Estonia	3	0.12
64	Tunisia	0	0	2	2	0.08	64	Tonga	3	0.12
65	Bermudas	0	0	1	1	0.04	65	Georgia	2	0.08
66	Chinese Taipei	0	0	1	1	0.04	66	Tunisia	2	0.08
67	Estonia	0	1	0	1	0.04	67	Bermudas	1	0.04
68	Guiana	0	0	1	1	0.04	68	Chinese Taipei	1	0.04
69	Kosovo[O]	0	0	1	1	0.04	69	Guiana	1	0.04
70	Mauritius	0	0	1	1	0.04	70	Kosovo	1	0.04
71	Niger	0	0	1	1	0.04	71	Mauritius	1	0.04
72	Pakistan	0	0	1	1	0.04	72	Niger	1	0.04
73	Syria	0	0	1	1	0.04	73	Pakistan	1	0.04
74	Tajikistan	0	0	1	1	0.04	74	Syria	1	0.04
75	Tonga	0	1	0	1	0.04	75	Tajikistan	1	0.04
76	Uruguay	0	0	1	1	0.04	76	Uruguay	1	0.04
77	Zambia	0	0	1	1	0.04	77	Zambia	1	0.04

A Russia: as USSR: (1952) 2 silver, 4 bronze; (1956) 2-1-1; (1960) 1-2-2; (1964) 3-3-2; (1968) 2-1-1; (1972) 2 gold; (1976) 2 bronze; (1980): 1-2-1; (1988): 1 silver; B Kazakhstan as USSR: 2 silver (1980), 1 bronze (1988); C Ukraine as CIS: 1 silver (1992); as USSR: 2 silver (1980), 1 bronze (1976); D Uzbekistan as USSR: 1 silver (1976); E Lithuania as USSR: 1 gold (1968), 2 silver (1964, 1968), 1 bronze (1956); F Serbia as Yugoslavia: 1 gold (1980), 1 silver (1976), 3 bronze (1968, 1972, 1984); G Armenia as USSR: 1 gold (1956), 1 bronze (1976); H Czech Republic as Czechoslovakia: 1 gold (1960), 1 silver (1928), 1 bronze (1960); I Belarus as USSR: 1 gold (1988); J Croatia as Yugoslavia: 2 gold (1972, 1984), 1 bronze (1988); K Moldova as USSR: 1 bronze (1988); L Slovakia as Czechoslovakia: 2 gold (1948, 1952), 1 bronze (1980); M Georgia as CIS: 1 bronze (1992); N Macedonia as Yugoslavia: 1 silver (1984), 1 bronze (1976); O Kosovo as Yugoslavia: 1 bronze (1984).
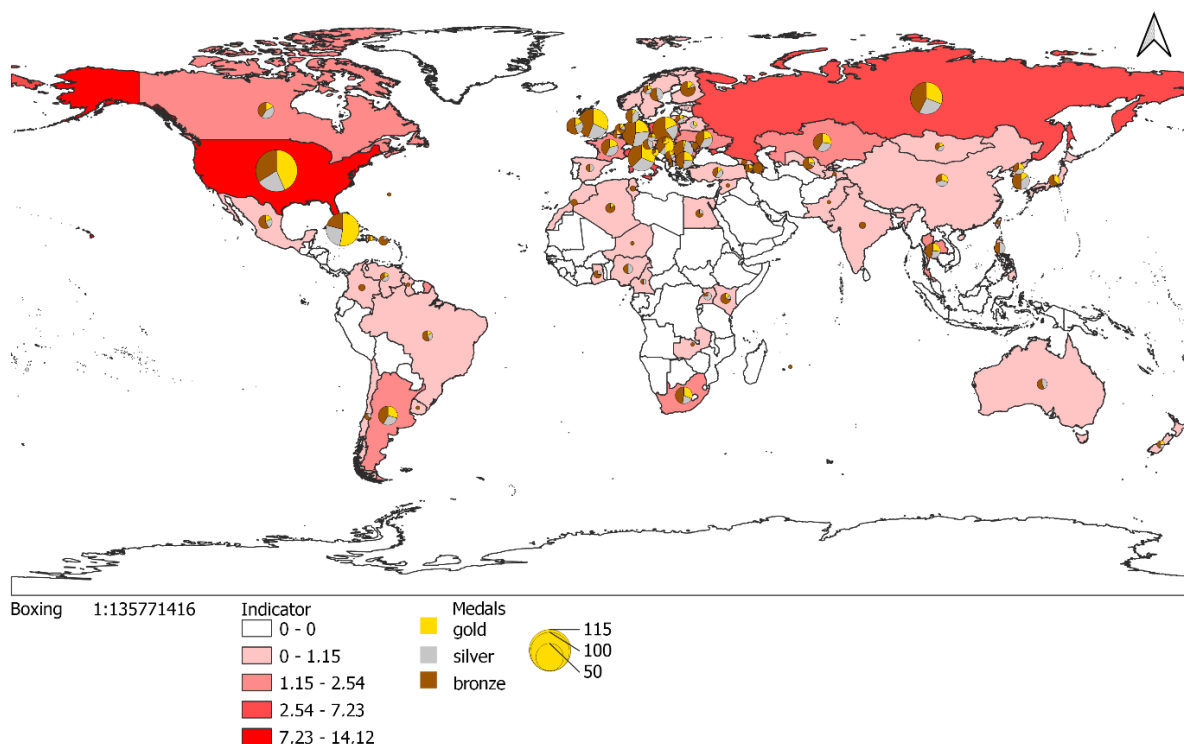
Figure 1. Medals in boxing and the index of point winning frequency (P) during the Olympic Games.

Games – with both countries being neck in neck in the medal (Table 3) and points classification (Table 4). And even though it has been present in the OG program since their beginning, representatives of only 32 countries have won medals, marking clearly the unique spatial concentration of this sport and its dominance in Europe (and Russia with its European and Asian part) in this discipline (70% medallists, Figure 2). Poland's 6th place in fencing in points classification is also worth mentioning; it is a reflection of long traditions of Polish school of fencing. The only three other countries outside Europe with noteworthy (10 medals and up) medal winnings are the USA, Cuba and China. Notably, there is not even a single African, south-East Asian, Oceania, Indian subcontinent or Middle East country with a fencing medal, and the only South American country to have won a medal is Argentina.

Modern pentathlon
The list of medal-winning countries in modern pentathlon is even shorter than fencing, with clear dominance of Hungary, Sweden and Russia (Table 5) – and these three countries clearly dominate

the points classification (Table 6). This varied and challenging sport discipline is a bit more diversified in terms of its spatial distribution than fencing, but still the European countries (and Russia with its European and Asian part) predominate the sport (2/3 medal-winning countries, Figure 3). Again, the African, Southeast Asian, Middle East, Oceania and South American countries are largely under-represented in the medal statistics.

Wrestling
Wrestling is popular predominantly in North America, Europe and Asia, with athletes from 59 countries holding the wrestling medals (Table 7). The struggle between the USA and Russia for the medal supremacy (also in the point classification against the background of other countries; Table 8) is even more visible here than in the case of boxing. Notably, in contrast to other discussed combat sports, Asian (Japan, South Korea), Middle East countries (Turkey, Iran) and Caucasian countries (Georgia, Azerbaijan, Armenia) with their native wrestling traditions are also visible on the medal map (Figure 4). Again, African, South American, South-East Asian and Oceania countries are largely under-represented.

Table 3. Medals won in fencing.

No.	Country	Gold	silver	bronze	Total number of medals	M index
1	France	43	42	35	120	4.29
2	Italy	45	41	33	119	4.25
3	Hungary	35	23	27	85	3.04
4	Russia	28.6	20	20	68.6	2.45
5	Germany	13	17	12	42	1.50
6	United States	3.33	7	12	22.33	0.80
7	Poland	4	9	9	22	0.79
8	Cuba	5.66	5	6	16.66	0.60
9	Romania	3	5	7	15	0.54
10	Belgium	3	3	4	10	0.36
11	China	3	6	1	10	0.36
12	Great Britain	1	8	0	9	0.32
13	Switzerland	1	4	3	8	0.29
14	South Korea	2	2	4	8	0.29
15	Ukraine	2.4	2.8	2.4	7.6	0.27
16	Sweden	2	3	2	7	0.25
17	Austria	1	1	5	7	0.25
18	Denmark	1	2	3	6	0.21
19	Netherlands	0	0	5	5	0.18
20	Greece	2	1	1	4	0.14
21	Japan	1	1	0	2	0.07
22	Estonia	1	0	1	2	0.07
23	Czech Republic	0	0	2	2	0.07
24	Belarus	0.6	0	1.2	1.8	0.06
25	Georgia	0.4	0	1.2	1.6	0.06
26	Latvia	0	0	1.2	1.2	0.04
27	Mexico	0	1	0	1	0.04
28	Argentina	0	0	1	1	0.04
29	Spain	0	0	1	1	0.04
30	Portugal	0	0	1	1	0.04
31	Hong Kong	1	0	0	1	0.04
32	Armenia	0	0.2	0	0.2	0.01

Table 4. Points won in fencing.

No.	Country	Total number of points	P index
1	Italy	381	13.61
2	France	376	13.43
3	Hungary	271	9.68
4	Russia	223	7.96
5	Germany	128	4.57
6	Poland	56	2.00
7	United States	49.65	1.77
8	Cuba	49.3	1.76
9	Romania	37	1.32
10	China	34	1.21
11	Great Britain	29	1.04
12	Belgium	28	1.00
13	Ukraine	22.8	0.81
14	Sweden	21	0.75
15	Switzerland	20	0.71
16	South Korea	20	0.71
17	Denmark	14	0.50
18	Greece	14	0.50
19	Austria	13	0.46
20	Japan	8	0.29
21	Estonia	6	0.21
22	Netherlands	5	0.18
23	Hong Kong	5	0.18
24	Belarus	4.2	0.15
25	Georgia	3.2	0.11
26	Mexico	3	0.11
27	Czech Republic	2	0.07
28	Latvia	1.2	0.04
29	Argentina	1	0.04
30	Spain	1	0.04
31	Portugal	1	0.04
32	Armenia	0.6	0.02

Russia as USSR: 2 bronze (1956); 3-2-0.6 (1960); 1.8-1-1 (1964); 2.8 gold, 2.6 silver(1968); 1.8-1.8-2.8 (1972); 2.8-2-1(1976); 3-2.8-1.8 (1980); 0.8-0.8-3 (1988), as CIS 0.6-1-1.8 (1992); USA as mixed team: 0.33 gold (1904); Cuba as mixed team: 0.66 gold (1904); Ukraine as USSR: 1 gold (1964); 1.4 silver (1968); 0.2 silver, 0.2 bronze (1972); 0.2 silver (1988); as CIS 0.4 gold, 1 silver, 0.2 bronze (1992); Belarus as USSR: 0.2 gold (1968), 0.2 gold (1972), 0.2 gold 1 bronze (1976), 0.2 bronze (1980); Georgia as USSR: 0.2 bronze (1960), 0.2 gold, 1 bronze (1964), 0.2 gold (1988); Latvia as USSR: 1.2 bronze (1960); Armenia as USSR 0.2 silver (1980).
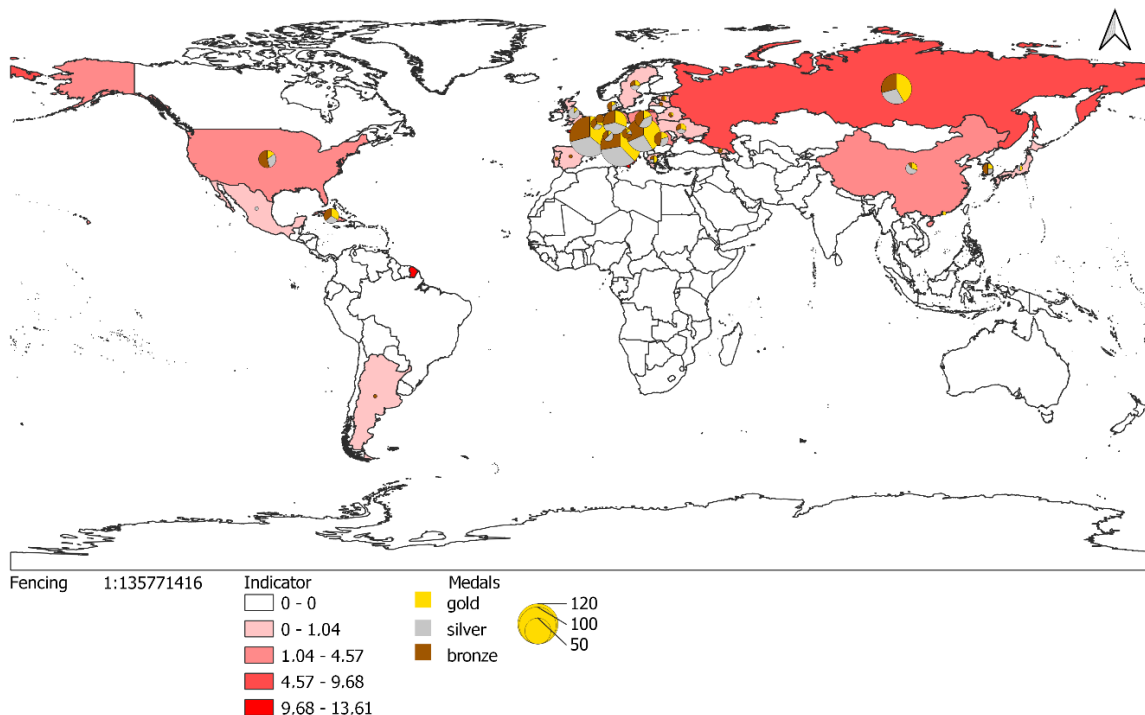
Figure 2. Medals in fencing and the index of point winning frequency (P) during the Olympic Games.

Table 5. Medals won in modern pentathlon.

No.	Country	gold	silver	bronze	Total number of medals	M index
1	Hungary	9	8	6	23	0.92
2	Sweden	9	7	5	21	0.84
3	Russia	8.66	4.99	5	18.65	0.75
4	Great Britain	4	2	3	9	0.36
5	United States	0	6	3	9	0.36
6	Italy	2	2	3	7	0.28
7	Lithuania	1	3.33	1	5.33	0.21
8	Finland	0	1	4	5	0.20
9	Poland	3	0	1	4	0.16
10	Czech Republic	1	1	2	4	0.16
11	Germany	2	0	1	3	0.12
12	France	0	1	2	3	0.12
13	Ukraine	0.33	2.33	0	2.66	0.11
14	Belarus	0	0	2	2	0.08
15	Georgia	0	0	1	1	0.04
16	Australia	1	0	0	1	0.04
17	Kazakhstan	1	0	0	1	0.04
18	China	0	1	0	1	0.04
19	Latvia	0	1	0	1	0.04

Table 6. Points won in modern pentathlon.

No.	Country	Total number of points	P index
1	Hungary	75	3.00
2	Sweden	71	2.84
3	Russia	63.27	2.53
4	Great Britain	29	1.16
5	United States	21	0.84
6	Italy	19	0.76
7	Poland	16	0.64
8	Lithuania	15.99	0.64
9	Germany	11	0.44
10	Czech Republic	10	0.40
11	Ukraine	8.64	0.35
12	Finland	7	0.28
13	France	5	0.20
14	Australia	5	0.20
15	Kazakhstan	5	0.20
16	China	3	0.12
17	Latvia	3	0.12
18	Egypt	3	0.12
19	Belarus	2	0.08

No.	Country	gold	silver	bronze	Total number of medals	M index		No.	Country	Total number of points	P index
20	Brazil	0	0	1	1	0.04		20	Georgia	1	0.04
21	Mexico	0	0	1	1	0.04		21	Brazil	1	0.04
22	Egypt	0	1	0	1	0.04		22	Mexico	1	0.04
23	South Korea	0	0	1	1	0.04		23	South Korea	1	0.04
24	Estonia	0	0.33	0	0.33	0.01		24	Estonia	0.99	0.04

Russia as USSR: 1 gold (1956), 0.66 silver (1960), 1-1-1 (1964), 0.33 silver, 1 bronze (1968), 0.66 gold, 1 bronze (1972), 1 silver (1976), 2 gold, 1 bronze (1980); as CIS 1 silver, 1 bronze (1992); Lithuania as USSR: 0.33 silver (1968); Czech Republic as Czechoslovakia: 1 silver, 1 bronze (1976); Ukraine as USSR: 0.33 (1968); 0.33 gold, 1 silver (1972); Georgia as USSR: 1 bronze (1988); Estonia as USSR: 0.33 silver (1960).
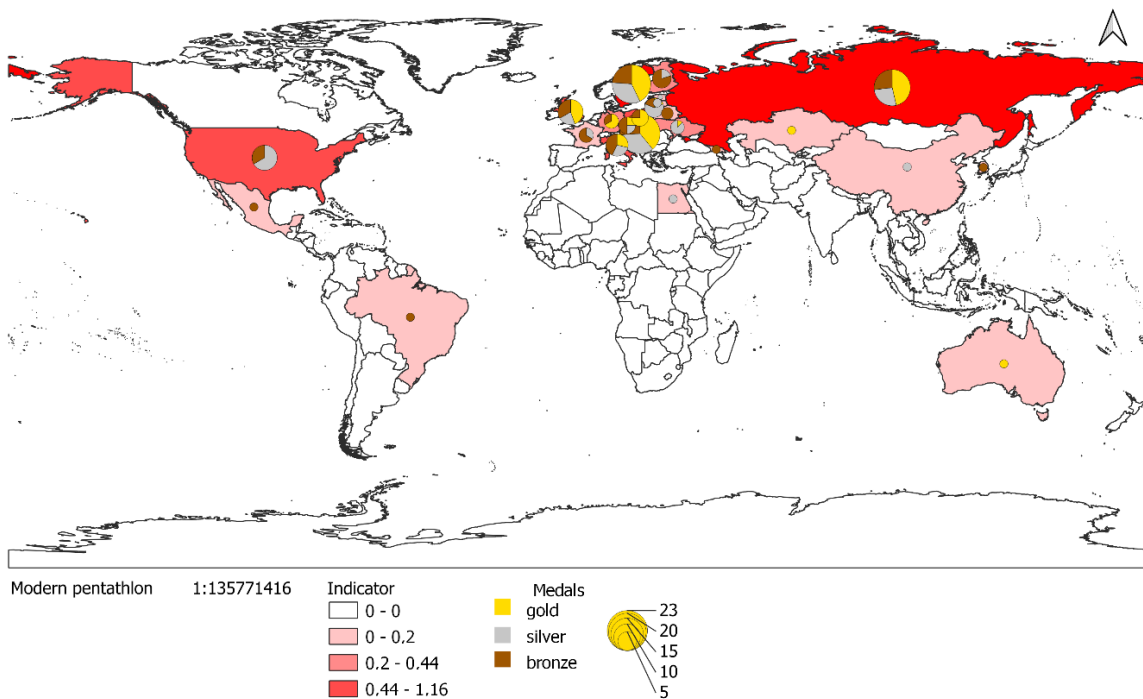
Figure 3. Medals in modern pentathlon and the index of point winning frequency (P) during the Olympic Games.

DISCUSSION

The geography of Olympic combat sports originating in antiquity presents the dominance of specific countries in boxing, fencing, modern pentathlon and wrestling throughout the history of the modern Olympic Games as well as the spatial distribution of the countries in which these disciplines are popular enough to result in Olympic medals. This is a continuation of research in a new field at the intersection of physical culture sciences, socio-economic geography and spatial management. It indicates the influence of geography on sport [42]. The analyses carried out provided interesting data from a cognitive perspective.

Boxing is essentially dominated by the United States in terms of the number and weight of medals won. This is probably due to the popularity of boxing in the United States, which introduced this combat sport to the program of the modern Olympic Games. Many professional world champions from the United States had previously been Olympic champions. Yet, the first rules of athletic competition in boxing were established in 1867 in the UK as the Queensberry Rules [43]. Therefore, it should be considered that boxing is the domain of the Anglo-Saxon countries that were once British colonies and this explains the high medal position of Great Britain. The high medal position of the Cubans is also significant in boxing. History shows

Table 7. Medals won in wrestling.

No.	Country	Gold	silver	bronze	Total number of medals	M index
1	United States	52	42	39	133	4.93
2	Russia	59	33	29	121	4.48
3	Japan	37	21	18	76	2.81
4	Sweden	22	26	28	76	2.81
5	Finland	24	25	26	75	2.78
6	Bulgaria	16	32	23	71	2.63
7	Turkey	29	18	19	66	2.44
8	Hungary	20	15	18	53	1.96
9	Germany	8	23	19	50	1.85
10	Iran	11	15	21	47	1.74
11	Georgia	14	11	19	44	1.63
12	South Korea	11	11	14	36	1.33
13	Romania	7	8	18	33	1.22
14	Azerbaijan	4	11	15	30	1.11
15	Ukraine	11	9	10	30	1.11
16	Poland	5	9	13	27	1.00
17	Cuba	11	6	9	26	0.96
18	Kazakhstan	3	7	14	24	0.89
19	Belarus	4	8	10	22	0.81
20	Great Britain	3	4	10	17	0.63
21	Italy	6	3	8	17	0.63
22	Canada	3	6	7	16	0.59
23	Armenia	6	6	3	15	0.56
24	France	3	4	8	15	0.56
25	Switzerland	4	4	7	15	0.56
26	China	2	5	7	14	0.52
27	Uzbekistan	7	3	4	14	0.52
28	Estonia	6	2	4	12	0.44
29	Serbia	3	4	4	11	0.41
30	Greece	1	3	6	10	0.37
31	North Korea	3	2	5	10	0.37
32	Mongolia	0	4	6	10	0.37
33	Czech Republic	1	5	3	9	0.33
34	Denmark	0	2	6	8	0.30
35	Egypt	2	3	3	8	0.30
36	Norway	4	2	2	8	0.30
37	India	0	2	5	7	0.26
38	Slovakia	0	1	5	6	0.22
39	Kyrgyzstan	0	3	2	5	0.19
40	Belgium	0	3	0	3	0.11
41	Croatia	1	1	1	3	0.11
42	Lebanon	0	1	2	3	0.11

Table 8. Points won in wrestling.

No.	Country	Total number of points	P index
1	United States	425	15.74
2	Russia	423	15.67
3	Japan	266	9.85
4	Finland	221	8.19
5	Turkey	218	8.07
6	Sweden	216	8.00
7	Bulgaria	199	7.37
8	Hungary	163	6.04
9	Germany	128	4.74
10	Georgia	122	4.52
11	Iran	121	4.48
12	South Korea	102	3.78
13	Ukraine	92	3.41
14	Cuba	82	3.04
15	Romania	77	2.85
16	Azerbaijan	68	2.52
17	Poland	65	2.41
18	Belarus	54	2.00
19	Armenia	51	1.89
20	Kazakhstan	50	1.85
21	Uzbekistan	48	1.78
22	Italy	47	1.74
23	Canada	40	1.48
24	Estonia	40	1.48
25	Switzerland	39	1.44
26	Great Britain	37	1.37
27	France	35	1.30
28	China	32	1.19
29	Serbia	31	1.15
30	Norway	28	1.04
31	North Korea	26	0.96
32	Czech Republic	23	0.85
33	Egypt	22	0.81
34	Greece	20	0.74
35	Mongolia	18	0.67
36	Denmark	12	0.44
37	India	11	0.41
38	Kyrgyzstan	11	0.41
39	Belgium	9	0.33
40	Croatia	9	0.33
41	Macedonia	9	0.33
42	Slovakia	8	0.30

No.	Country	Gold	silver	bronze	Total number of medals	M index		No.	Country	Total number of points	P index
43	Macedonia	1	1	1	3	0.11		43	Lebanon	5	0.19
44	Albania	0	0	2	2	0.07		44	Australia	4	0.15
45	Australia	0	1	1	2	0.07		45	Latvia	3	0.11
46	Columbia	0	0	2	2	0.07		46	Mexico	3	0.11
47	Lithuania	0	0	2	2	0.07		47	Nigeria	3	0.11
48	Spain	0	0	1	1	0.04		48	Puerto Rico	3	0.11
49	Latvia	0	1	0	1	0.04		49	Syria	3	0.11
50	Mexico	0	1	0	1	0.04		50	Tajikistan	3	0.11
51	Moldova	0	0	1	1	0.04		51	Albania	2	0.07
52	Nigeria	0	1	0	1	0.04		52	Columbia	2	0.07
53	Pakistan	0	0	1	1	0.04		53	Lithuania	2	0.07
54	Puerto Rico	0	1	0	1	0.04		54	Spain	1	0.04
55	San Marino	0	0	1	1	0.04		55	Moldova	1	0.04
56	Syria	0	1	0	1	0.04		56	Pakistan	1	0.04
57	Tajikistan	0	1	0	1	0.04		57	San Marino	1	0.04
58	Tunisia	0	0	1	1	0.04		58	Tunisia	1	0.04
59	Turkmenistan	0	0	1	1	0.04		59	Turkmenistan	1	0.04

Albania as Yugoslavia: 2 bronze (1980, 1984); Armenia as USSR: 3 gold (1976, 1980, 1988), 2 silver (1976, 1988); as CIS 1 gold (1992); Azerbaijan as USSR: 2 silver (1952, 1964) 1 bronze (1952), as CIS 1 silver (1992); Belarus as USSR: 4 gold (1960, 1964, 1968, 1988), 1 silver (1980); as CIS 1 silver, 2 bronze (1992); Croatia as Yugoslavia: 1 gold (1984), 1 silver, 1 bronze (1972); Czech Republic as Czechoslovakia: 1 gold (1972); 5 silver (1928, 1936, 1952, 1964, 1976); 3 bronze (1960, 1968 x 2); Estonia as USSR: 1 gold (1952); Georgia as USSR: 8 gold (1952 x 2, 1960, 1968, 1976, 1980, 1988 x 2), 6 silver (1952, 1960, 1964 x 2, 1968, 1988 1 silver), 3 bronze (1960, 1964 x 2), as CIS1 gold, 2 bronze (1992); Kazakhstan as USSR: 2 gold (1980), 1 silver (1988), as CIS 1 silver, 1 bronze (1992); Macedonia as Yugoslavia: 1 gold (1984), 1 silver (1988); Serbia as Yugoslavia: 2 gold (1964, 1976), 4 silver (1960, 1968, 1976, 1984), 3 bronze (1964, 1968, 1984); Slovakia as Czechoslovakia: 1 silver (1961); 4 bronze (1952, 1980 x 2, 1988); Russia as USSR: 21 gold (1952 x 2, 1964 x 2, 1976 x 9, 1980 x 6, 1988 x 2), 12 silver (1964, 1968 x 4, 1976 x 4, 1980 x 2, 1988), 10 bronze (1952, 1960 x 4, 1968, 1976, 1980, 1988 x 2), as CIS 1 gold 2 silver (1992); Turkmenistan as USSR: 1 bronze (1980); Ukraine as USSR: 6 gold (1952, 1960, 1968, 1976, 1980 x 2), 2 silver (1960, 1964), 1 bronze (1988), as CIS 1 gold (1992); Uzbekistan as USSR: 2 gold (1988); as CIS 2 gold (1992).

that boxing in Cuba is a popular sport among the lower classes analogous to the United States, where poor Irish, Italians, Jews, Poles and later African-Americans became champions [44]. But in Cuban boxing only the Olympic rules are in place: 3 rounds of 3 minutes each. This has a close connection with communism and Russian influence. During the Cold War, the opposing sides of the Iron Curtain competed against each other ideologically, militarily, and athletically in every area of social life. Therefore, the Olympic Games were the perfect opportunity to prove the superiority of Soviet training over Western training methods, which also explains Russia as a third force in boxing.

France dominates the fencing in terms of number of medals won, closely followed by Italy, which dominates in terms of medals won, but these differences are marginal. Hungary, on the other hand, ranked third in terms of the number and weight of medals won. The above data were linked to the popularity of honour fencing duels, which were popular between the 17th and 19th centuries in Europe, especially in France, Italy, Hungary, and Germany. These personal skirmishes with all their accompanying rituals are firmly rooted in the history and culture of the countries dominating in fencing through French traditions in the court sword, Italian traditions in the rapier, and Hungarian traditions in the sabre [45].

In modern pentathlon, Hungary dominates in terms of the number and weight of medals won, followed closely by Sweden and Russia. Hungary is a country rich in folklore traditions, the defensive motifs of which fit perfectly into the specifics of modern pentathlon [46]. Hungary has a strongly cultivated heritage in fencing, horse riding and shooting.
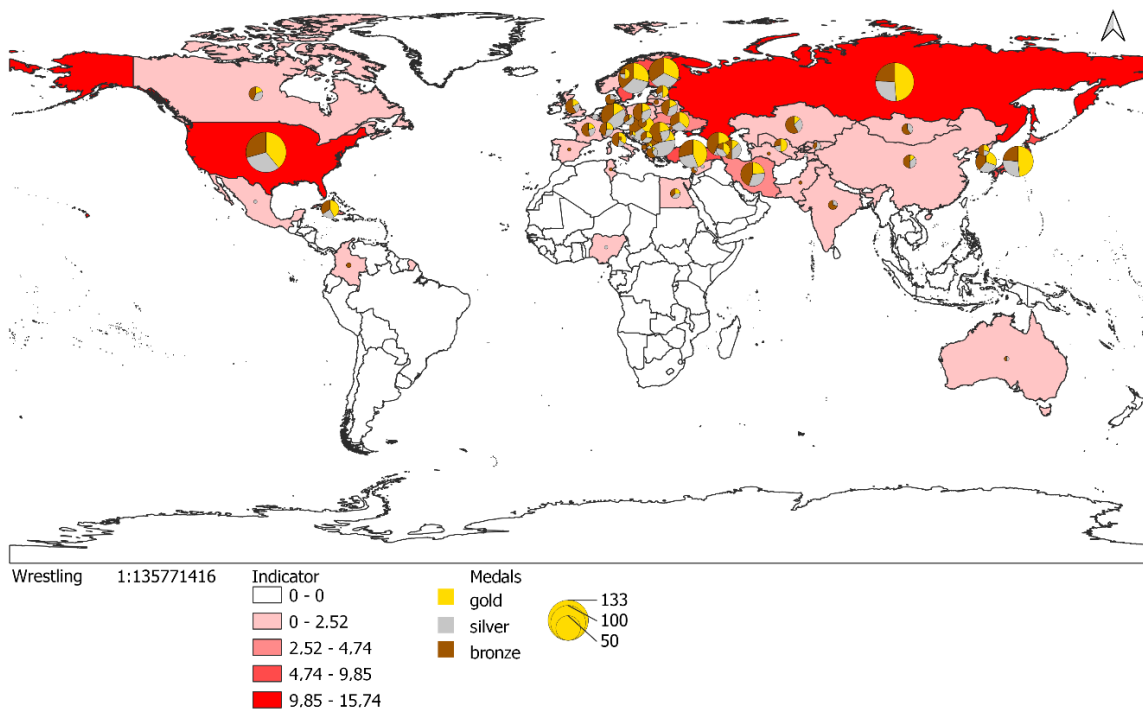
Figure 4. Medals in wrestling and the index of point winning frequency (P) during the Olympic Games.

Sweden, on the other hand, has always dominated the Olympic modern pentathlon competition. This is primarily due to the specificity of the running-shooting competition [47], which corresponds to Scandinavian traditions in biathlon and translates into the Swedes being well prepared. Russia, on the other hand (at various stages of its existence, including as the USSR or the CIS) pays great attention to military issues. Therefore, the all-round defensive preparation of the Russians is part of high-level combat sports and substantially translates into Olympic results in modern pentathlon.

In wrestling, in terms of number and weight of medals won, the United States, Russia and Japan successively dominate. Here the medal rivalry between the United States and Russia is particularly evident, being a historical reflection of the political systems and the Cold War. But it should be noted that it was the Americans who introduced freestyle, consequently called 'American', to wrestling [48]. Moreover, wrestling is on the school physical education curriculum in the United States, which shows how socially important this sport is for Americans [49]. The Russian school of wrestling, on the other hand, is linked to sambo traditions [50]. Japan's classification as a third force in wrestling, on the other hand, stems from the Japanese wrestling tradition of sumo [51].

Accordingly, it was found that the Olympic Games are not dominated by the countries where individual combat sports were born. Instead, they are dominated by the countries where particular combat sports disciplines were most popular at the time of their introduction to the modern Olympic Games program. In general, boxing in most varied in terms of spatial distribution of medal-winning countries, and fencing is most spatially concentrated.

Here, one should mention the educational value of the geography of Olympic combat sports: athletes learn geography while practicing combat sports. They discover the tradition, culture and history of the countries where combat sports originated, together with the sports techniques [52]. Moreover, the geography of Olympic combat sports fits in well with the health-promoting aim of sport [53] and opposes the neo-gladiatorism phenomenon [54].

CONCLUSIONS

The geography of Olympic combat sports: boxing, fencing, modern pentathlon and wrestling, is dominated by the countries where each combat sport was most popular at the time of its

introduction to the modern Olympic Games program. It clearly shows the dominance of certain world regions and countries (notably Europe, Asia, the USA) in all discussed combat sports and illustrates the different degrees of spatial diversity of medal-winning countries. Boxing is most spatially diversified while fencing is most coherent in terms of their spatial distribution. The above is the result of long sporting traditions, cultural and geopolitical features of countries representing the discussed disciplines in the modern Olympic Games.

The authors believe that in the future, an artificial intelligence (AI) algorithm could be developed to read the medal data automatically. However, one has to be careful of errors in the source data, e.g. the spread between the medal totals and the list of these medals. Besides, AI would have to distinguish automatically between the nationalities of athletes from the USSR, CIS, former Yugoslavia, Czechoslovakia and assign them to their countries of origin, which is not easy. AI would have to add up athletes from East Germany and West Germany and count medals and points from countries that do not exist (e.g. Persia's medals for Iran).

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