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PARTICIPANT ADJUSTED MEDAL COUNTS: A NOTE ON EQUITY AND INCLUSIVENESS APPROACH TO TOKYO OLYMPIC

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Abstract

A lack of standard reporting systems on Olympic medal counts and subsequent rankings raises confusion among spectators. Ranking, based on inconsistent measures by IOC and other reporting organizations, has hampered scholarly investigations in search for objective, fair and inclusive ranking system based on the IOC spirit. This paper attempts to incorporate two additional variables into ranking system, size of participants and wealth of nations. When these two variables are incorporated into the statistical models, different outcomes emerged from what IOC and other organizations reported. Small countries like Bermuda and Kyrgyzstan emerged as strong contenders in the Olympic Games. This approach appears to have addressed fairness and inclusive issues in Olympic Games.

Keywords: IOC, Inclusiveness, Equity, Fibonacci system, adjusted medal counts, Weighed total medals, adjusted medal counts, Friedman's rank order test.

Introduction

The Olympic Games are the most watched and the expensive events on earth. Half the world's population watched coverage of the Tokyo Olympics. It was reported that the Tokyo Olympic cost between US$12 billion and US$28 billion (Wade and Yamaguchi et al, 2021).

Readers of the 2020 Tokyo Olympic were left confused with the rankings reported by various news media outlets. The International Olympic Committee (IOC) reported rankings by gold medals only while others use rankings based on total medals. The issue became more confusing when different outlets publish ranking depending on medals favorable to their countries. For example, in 2020 Tokyo Olympic, the Korean news outlets reported its standing as 13th based on total medal counts whereas reports from western countries put Korea to 16th based on gold medals. Search for comprehensive and fair reporting methods has been elusive (Putt, 2013).

The IOC reports only gold medal counts and ignore other important variables such as number of participants and wealth of participating countries. Such practice highlights achievements of the wealthy nations and ignores "extraordinary" achievements by smaller counties. Borrowing Putt's words, "While the IOC table ranking can be indicative of relative comparative achievement between two countries of similar population size, it is nevertheless useless for indicating the relative quality of performance for those countries that differ in population size by factors of a thousand like Bahamas and the USA"(p. 74). The IOC practice is allegedly based on its charter stating:"The Olympic Games are competitions between athletes in individual or team events and not between countries." Yet, it is reasonable and to some extent logical to assume that more athletes' one country sends to the Game, the better chance of winning gold medals. In other words, "the size matters". Current practice on medal counts raises an important moral question: does current practice violet in spirit of the principle of equality and inclusiveness that IOC was founded?

Literature Review

There have been not many discussions in academic literature on what would be a fair and inclusive way in ranking the achievements of a nation in the Olympics competitions. One recent study addresses only sustainability of Olympic Games. Muller et al (2021) evaluates the sustainability of the Olympic Games in a systematic longitudinal study and conclude that the overall sustainability of the Olympic Games is medium and that it has declined over time.

Existing literature, although sparse, addresses several areas in assessing the national rankings; number of gold medals only, total medals, population size, country that hosts the event (Bernard and Busse, 2004), economic of countries and political factors (Grimes *et al.,* 1974), and quality of medals using Fibonacci system (2013). Among several studies, Bernard and Busse, 2004) study is the most comprehensive report using such predictive variables as, population, per capita gross domestic product (GDP), host effect (whether a country is a host country or not), type of political-economic systems such as managed economy like planned, Soviet-bloc system, and history of Summer Olympic performance. Since Bernard and Busse's study in 2004, there has been no major research on medal counts and subsequent rankings until the Putt's 2013comprehensive analytical study. Using multivariate statistical model, Putt used quantifiable achievement in terms of the type and number of medals won by a country's entire Olympic team. He employed respective national populations and appropriately weighted medal tallies (gold, silver and bronze) to develop an empirical power law refinement technique that determines the criterion for elite performance. He claims that power law refining (PLR) method "fills a void by projecting small countries like New Zealand, Jamaica and at times sub-million population NOCs country like Bahamas into the limelight of Olympiads at which they excel." (p.87).

We argue, however, that it is not the size of population and wealth of countries that determine the outcomes. Rather it is how many athletes from a country participate in the Olympics. We further argue that total medals earned by each participating country should be adjusted by the number of athletes competing in the Olympics. When the medal counts are adjusted by the number of participating athletes, the results would be fair and inclusive for small and developing countries.

We propose, therefore, to test the hypothesis that *adjusted* medal count is "fair" and "inclusive."

Methodology

Sample space: 2020 Tokyo Olympic Games
Sample size: 93 countries with 11,552 participants
Data sources: IOC

Variables: medals by class (gold, silver and bronze), total medals (gold+silver+ bronze), weighted total medals using Fibonacci system (gold=3, silver=2 and bronze=1) and number of athletes from a country competing in the Olympics. We assume in this paper that number of athletes attending the Olympic Games reflects the nation's wealth. We elected to use the Fibonacci system over exponential sequencing method as this method is straightforward (Klein, 2008).

Although nation's GDP and population size could be significant factors in determining number of medals counts, we argue that it is not the size of GDP and population. Rather it is willingness of a country to spend some portion of GDP on sports in general and on Olympic competition in particular. For example, China with $14.72 trillion GDP (www.statista.com) and 1.44 billion populations (www.worldpmrters.ino) sent 448 athletes to the 2020 Tokyo Olympic while Australia with GDP of $1.36 trillion and 24.8 million populations sent 501 athletes. In order to normalize data skewed by the size of GDP and population, we calculated numbers of athletes per medal won in three categories; gold, total, and weighted total medal. This approach should address concern raised by Forrest et al, 2015 that some countries maximize their resources by concentrating on a few sports such as Judo, sailing, Tae Kwon-Do etc., where they have better chance to win medals.

Unit of measurement: Some variables cited above are converted into ordinal scale (ranks) to avoid scale bias.

Statistical methods: The large sample size (94 countries with 11,552 participants) allows us to perform statistical tests with sufficient statistical power (e.g., Tabachnick and Fidell, 2012).Initially we computed descriptive statistics on interval scale variable (gold medals, total medals, weighted total medals and number of participants in the Olympics)to assess overall landscape of participants and medals

counts (Table 1). Information in Table1 should reveal the nature of distribution of variables in our study.

It would also be interesting to investigate whether there is any relationship among variables including new created variable (number of participants per medal won). Correlation matrix is created to measure the extent of such relationships among variables (Table 2). If information from interval scale variables is statistically different from that with participant adjusted variables (new variable), we assume that the adjusted variables behave differently from the original variables. Statistically significant differences between these two groups of variables may raise a politically sensitive question whether the current ranking system is fair and inclusive for small and developing countries. We highlighted top 10 countries within two groups (rankings on medal count only and on medal count adjusted by number of participants) to compare and contrast the results from these two groups of countries (Table 3). Finally, Friedman rank order test was performed on all rank variables to investigate whether rank orders are statistically different from each other (Table 4). A statistically significant difference in rank order test may imply that one or one group of variables (e.g., gold medal) may not be indicative of overall performance for countries.

Results

Table 1 shows descriptive statistics on interval variables that might have impacted the standings at the Tokyo Olympic. There seems to be a wide difference in numbers of participants ranging from 1 (Kyrgyzstan) to 1,033 (USA) with median of 67 participants. Total medal count shows from 1 medal (12different countries) to 113 medals (USA) with median of 4 indicating highly skewed distribution. As to gold medals, the range is also wide from 0 gold medals (28 countries) to 39 gold medals (USA) with median of 1 gold medal. Weighted total medal shows from 1weighted value (8 counties) to 232 weighted values (USA) with median of 9 weighted values. When medals are adjusted by the number of participants, different results emerged. The adjusted gold medals reveal in average 48 athletes per gold medal with median of 35 participants. As to the total medals, almost 16 athletes per total medals with median of 11 athletes considerably narrower range than outcomes based on unadjusted medal counts. Athletes per weighted total medal indicate almost 9 athletes per weighted total medals with median value of 6.11. The ratio of mean to median values would indicate the degree of disparity between these two indicators. The lower the ratio, the two group of indicators carry the similar information. As shown, the ratios are much lower when the medals are adjusted by the number of athletes participated in the Olympics; 2.9 vs.1.42 for total medals, 3.66 vs. 1.42 for gold medals, and 2.46 vs. 1.47 for weighted total medals. This implies that the number of participants become more relevant and fairer factor in determining the outcomes.

Table 1: Descriptive Statistics

	N	Minimum	Maximum	Mean	Median	Ratio (Mean to Median)
No of Participants	93	1	1033	124.22	67	1.85
Total Medals (Gold +Silver +Bronze)	93	1	113	11.61	4	2.90
Total Gold Medals	93	0	39	3.66	1	3.66
Weighted Total Medals (Gold=3, Silver=2, Bronze=1)	93	1	232	22.18	9	2.46
Athletes/ Gold Medals	65	2	229	47.56	35	1.36
Athletes/ Total Medals	93	.33	76.33	15.55	10.9	1.42
Athletes/ Weighted Total Medals	93	.20	40.75	8.99	6.11	1.47

Table 2 illustrates correlation matrix on variables with interval scale. Information in Table 2 reveals the extent of relationship among variables. It appears that there is a strong relationship ($p < 0.01$) between interval scale variables as expected. However, when the variables are adjusted by the number of participants, the results are quite different. None of the adjusted variables show a significant relationship with the number of participants. This result seems to support Putt's (2013) argument that "this table ('list of gold medals by country') highlights achievement of the 'superpower' countries but obscures extraordinary achievement by smaller countries" (p.74). A statistically significant relationship shown by "superpowers" disappeared when medals are normalized by the number of athletes participated in the Olympic. Smaller countries appear to have found "voice" in the Olympics.

Table 2: Correlation matrix based on ranks

	Participants	Total Gold Medals	Total Medals	Weighted Total Medals	Athletes/ Total Gold Medals	Athletes/ Total Medals	Athletes/ Weighted Total Medals
Participants	1	0.662**	0.701**	0.693**	-0.057	-0.066	0.0162
Total Gold Medals		1	0.874**	0.946**	0.316*	0.189	0.394
Total Medals			1	0.969**	0.046	0.209*	0.303**
Weighted Total Medals				1	0.088	0.196	0360**
Athletes/ Total Gold Medals					1	0.579*	0.699**
Athletes/ Total Medals						1	0.915**
Athletes/ Weighted Total Medals							1

**p<0.01, *p<0.05

In order to check the "super power" vs. "smaller countries" argument (Putt, 2013), top 10 countries in each category (variable) are listed in Table 3. The "super power" countries dominated top ten lists in the categories of number of participants, gold medals, total medals and weighted total medals. Except China and Russia, every country in this category is a member of OECD block and many with European Union. The number of participants between USA and even "wealthy" countries is noticeably wide (1,033 for USA and 630 for Japan, the second highest participant country).Statistics show that many countries sent few athletes to the Olympics. For example, 11 countries sent 10 or fewer athletes; Kyrgyzstan (1), Bermuda (2), San Marino (5), Grenada (6), Syrian (6), Dominican Republic (7), Burkina Faso (7), North Macedonia (9), Turkmenistan (9), Ireland and Kuwait (10). As shown in Table 1, the mean number is 124.22 athletes whereas the median is 67, a wide range of participants in the game.

A very different picture emerges when each variable is adjusted by the number of participants. "Super Power" countries are no longer listed in the top 10 ranking. Instead, small and developing countries dominate the list. For example, while it took 26.5 athletes to earn 1 gold medal for U.S.A, 11.8 athletes for China and 23.3 athletes for Japan, it takes only 2 athletes to earn a gold medal for Bermuda and 0.3 athletes to earn total medal for Kyrgyzstan as shown in Table 3. Smaller countries appear to have achieved very efficient "production frontier" in winning medals.

Another interesting result in Table 3 is that most countries in top 10 athletes per medal count are from former Soviet Union block. These countries usually concentrate in few areas in the Olympics where they have a better chance to win medals, which confirms the study by Bernard and Busse (2004). Nevertheless, these small counties have never been in forefront in news. If the spirit of Olympic Games "… is competitions between athletes in individual or team events and not between countries," then, the number of athletes who represent their countries should be recognized to keep the spirit of the Olympic Games.

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Table 3: Top 10 countries based on number of participants and number of athletes per medal*

	Top 10 "Super Power" countries based on Total number of participants				Top 10 countries based on Number of athletes per medal		
rank	No. of Participants	Total gold medals & no. of athletes per gold	Total medals & no. of athletes per total medal	Weighted total medals & No. of athletes per weighted medal	Total gold medals & No. of Athletes per gold medal	Total medals & No. of athletes per total medal	Total weighted Medals & No. of Athlete per weighted medal
1	USA (1033)	USA (39); 26.5	USA (113): 9.1	USA (232): 4.5	Bermuda (1): 2.0	Kyrgyzstan (3): 0.3	Kyrgyzstan (3): 0.2
2	Japan (630)	China (38): 11.8	China (88): 5.1	China (196): 2.3	Ireland (10); 5.0	Dominican Republic (5): 1.4	Bermuda (1): 0.7
3	Australia (501)	Japan (27): 23.3	Russia (71): 3.2	Russia (139): 1.6	Kosovo (11): 5.5	San Marino (3): 1.7	Dominican Republic: (6): 1.7
4	China (448)	Great Britain (22): 19.9	Great Britain (65): 6.1	Great Britain (130): 3.4	Qatar (16): 8.0	Bermuda (1): 2.0	Ireland (10): 1.3
5	Germany (440)	Russian (20): 11.3	Japan (58): 10.9	Japan (68): 5.8	Bahamas (16): 8.0	Ireland (4): 2.5	San Marino (1.3)
6	Great Britain (437)	Australia (17): 29.5	Australia (46): 10.9	Australia (87): 5.8	Cuba (70): 10.0	Russian (71): 11.3	Russian (71): 1.6
7	Italy (428)	Netherlands (10): 29.2	Italy (40): 10.7	Italy (70): 6.1	Russia (226): 11.3	Georgia (8): 4.5	Kosovo (11): 1.8
8	France (418)	France (10): 41.8	Germany (33): 11.9	Germany (68): 6.5	China:448 (11.8)	Cuba (70): 4.7	Georgia (8): 2.1
9	Canada (400)	Germany (10): 44	Netherlands (24): 8.1	Netherlands (68): 4.3	Bulgaria (43): 14.3	Philippines (4): 4.8	Cuba: (70): 2.2
10	Spain (345)	Italy (10): 42.8	France (33): 12.7	France (65): 6.4	Uganda (32): 16.1	China (88): 5.1	Qatar (16) and, China (448): 2.3

*Numbers in parentheses indicate number of participant

Olympic watchers pay a great deal of their attention to the rankings of each category of medals rather than numbers of medal that a country won. Ranking (ordinal scale) effectively removes medal counts (interval scale). Accordingly, it would be interesting to test the hypothesis whether ranking in each variable is related to other variables. If they are related, ranking on one variable may be indicative of those for other variables (dependence). The results are in Table 4.

Table 4: Mean Rank Order for Friedman Test

Variables	Mean
Rank by numbers of Participants	5.86
Rank by Gold Medals	3.11
Rank by Total Medals	3.6
Rank by Total Weighted Medals	3.08
Rank by Athletes/ Gold Medals	3.14
Rank by Athletes/ Total Medals	5.13
Rank by Athletes/ Total Weighted Medals	4.11

N=65, Chi-square=103.848 ($p < 0.001$)

As shown in Table 4, rank order difference for 7 variables is statistically significant at $p < 0.01$, indicating that each variable behaves independently from others. The results in Table 4 appear to support and understand why some countries use one category of achievement (e.g. gold, IOC standard) over others (e.g. total medal count, like Korea who uses total medal counts).

Discussion, Conclusion and Limitations

This study presents a different way of measuring Olympic performance. It is not our intention to challenge any existing way of ranking the Olympic outcomes. Each study has its own merits and contribution to the body of knowledge. To some extent, our study is an extension of the Putt's study from different perspective.

The main focus of our study is on inclusion of small countries who do not have resources to send a large contingency to the Olympic Games. Although IOC spirit is not on a nation but on athletes, the reality is that each athlete represents a country and therefore, it is unavoidable that we do judge performance by county. Accordingly, we argue that the size of athletes in the Games should be a part of equation. Our method, participant adjusted rankings, would give such platform ("voice") for small countries in Olympic stage.

Based on our analyses, our hypothesis (participant adjusted medal count is "fair" and "inclusive" for small countries) is supported.

This study used only one sample space, 2020 Tokyo Olympics. It would be interesting to repeat this approach to previous Olympics games and see whether similar conclusions can be observed. In addition, this study does not address other pertinent variables such as countries that host Olympics (Bernard and Busse, 2004), past performance, political factors (Ball, 1972; Grimes *et al.,* 1974; Johnson & Ali, 2000: Levine, 1972), etc. Outcomes may be different if these variables are included in the model.

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