Original Article

Before the Rio Games: A retrospective evaluation of the effects of the population size, GDP and national temperature on winning medals at the 2012 London Olympic Games

ISTVÁN SOÓS[1], JOSÉ CARLOS FLORES MARTÍNEZ[2], ATTILA SZABO[3]

[1] *Faculty of Health Sciences and WellBeing, University of Sunderland, Sunderland, United Kingdom*

[2] *Department of Psychology, University of Almería, Almería, Spain*

[3] *Institute of Health Promotion and Sport Sciences, ELTE Eötvös Loránd University, Budapest, Hungary*

ABSTRACT

Just weeks before the Rio 2016 Olympic Games, this work examined the connection between winning Olympic medals at the London 2012 Games and the participating nations' population size, Gross Domestic Product Per Capita (GDP-PC), and average annual temperature as based on the 'demographic-', 'economic-', and 'geographical' hypotheses (Hoffmann et al., 2002). The three dependent measures jointly accounted for 45% of the variance in winning Olympic medals ($p < .001$; effect size = 0.82). The contribution of the GDP-PC was relatively moderate (11%). The largest proportion of the variance in winning Olympic medals was explained by the nations' population size (27%). The average national temperature has accounted for a small portion of the variance (7%). Accordingly, the average temperature and GDP-PC had statistically significant, but modest roles in winning medals during the London Games, while the influence of the nations' population size was high. The three measures examined have explained nearly half of the total variance accounting in winning Olympic medals in London. **Key words:** ATHLETE, CORRELATION, CULTURE, DEMOGRAPHIC, NATION

Cite this article as:
Soós, I., Flores Martínez, J.C., & Szabo, A. (2017). Before the Rio Games: A retrospective evaluation of the effects of the population size, GDP and national temperature on winning medals at the 2012 London Olympic Games. *Journal of Human Sport and Exercise, 12*(1), 246-250. doi:10.14198/jhse.2017.121.20

Corresponding author. *Institute of Health Promotion and Sport Sciences, Eötvös Loránd University, 1117-Budapest, Bogdánfy u. 10, Hungary.*
E-mail: szabo.attila@ppk.elte.hu
Submitted for publication June 2016
Accepted for publication May 2017
JOURNAL OF HUMAN SPORT & EXERCISE ISSN 1988-5202

doi:10.14198/jhse.2017.121.20

INTRODUCTION

Numerous studies have investigated the various determinants of the Olympic success. Their results and predictions have linked population size and Gross Domestic Product (GDP) to the winning of Olympic medals (Berdahl, Uhlmann, & Bai, 2015; Bernard & Busse, 2004; De Bosscher, Knop, Heyndels, 2003; Hoffmann, Ging, & Ramasamy, 2002; Morton, 2002). Further, the climatic factors, including average national temperatures, may also play a role in the preparation and success of the athletes. For example, Hoffmann et al. (2002) showed that during the 2000 Games in Sydney an average yearly temperature of 15 degrees Celsius was the optimal in that it was associated with winning a near average of 15 Olympic medals. The authors suggested that athletes in nations with temperate climates could win an extra 14 to 20 medals. In spite of this report, the national temperature, alongside the national population size and GDP, has received virtually no attention with regard to its possible moderating role in the winning of Olympic medals.

In this brief content analysis, we retrospectively examined the relationship between the Olympic medals won (the total of gold, silver, and bronze) in the 2012 London Olympic Games and the participant nations' population size, GDP Per Capita (GDP-PC), and the national average temperature (degrees Celsius C°) on the grounds of the earlier proposed 'demographic-', 'economic-', and 'geographical' hypotheses (Hoffmann et al., 2002). We did not attempt to make any predictions, but simply tried to uncover earlier factual relationships.

METHODS

This content analysis was based on objective, publicly available data sets. National population sizes and GDP-PC were obtained from the published World Bank online sources (The World Bank, 2015). The Olympic medals data were obtained from the BBC SPORT (BBC, 2015) and the average national temperatures were obtained from a weather data source (CantyMedia, 2015).

RESULTS

Due to skewed raw data, $\log_e$ transformations were performed. A multiple regression was conducted to test if population size, GDP-PC, and annual national temperature accounted for the number of Olympic medals won at the London 2012 Games. Initially, the test of the standardized residuals was carried out, which showed that the data contained no outliers (Std. Residual Min = -1.96, Std. Residual Max = 2.53). Further tests performed to determine if the transformed data met the assumption of collinearity, indicated that multicollinearity was not a concern (national population size, *tolerance* = .958, *VIF* = 1.044; GDP-PC, *tolerance* = .947, *VIF* = 1.056; average national temperature, *tolerance* = .965, *VIF* = 1.036). The Durbin-Watson statistic value was lower than 2 (.845), but that was expected due to the non-random and transformed data that, nevertheless, met the assumption of non-zero variances (national population sizes, variance (s^2) = 3.01, GDP-PC, s^2 = 1.51, and national temperatures, s^2 = 0.54). Using the enter-method, a statistically significant regression equation was found (F (3, 81) = 23.91, p < .001, R^2 = .47, $R^2_{adjusted}$ = .45, effect size (Cohen's f^2) = 0.82). In accounting for the total Olympic medals, it was shown that the size of the population in the participating nations (B = *.44,* $B_{standardized}$ = 0.62, t(81) =7.5, p < .001), the GDP-PC (B = *.33,* $B_{standardized}$ = 0.32, t(81) = 3.7, p < .001), as well as the national average temperature (B = *-.47,* $B_{standardized}$ = -0.28, t(81) = -3.3, p = .001) were all statistically significant factors (Table 1). A stepwise multiple regression was also performed to see the contribution of each of the dependent measures to the regression equation. This analysis revealed that population size accounted for 27% ($R^2_{adjusted}$ = .269) of the variance, which was increased to 38% ($R^2_{adjusted}$ = .383) when adding GDP-PC, and to 45% ($R^2_{adjusted}$ = .450) when further adding

the national average temperature. Individual nonparametric correlations (due to the skewed data), between the Olympic medals won and the three dependent measures examined in the current analysis, were also calculated to estimate the linear relationship between them. These correlations are illustrated in Table 2.

Table 1. Model Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients			95% Confidence interval for β	
	β	Standard error	Beta	t	Significance	Lower bound	Upper bound
Constant	-1.424	.957		-1.487	.141	-3.330	.483
Population	.442	.060	.621	7.364	.001	.323	.562
GDP-PC	.322	.085	.320	3.776	.001	.152	.491
Temperature	-.470	.142	-.278	-3.312	.001	-.752	-.187

Table 2. Correlations (Spearman's rho **ρ**), probability levels, and the proportion of shared variance (in the ranked variables, i.e. **ρ²**) between the total Olympic medals won and three dependent measures.

Correlations between:	***ρ, p***	***ρ²***
Total Olympic medals and national population size	.486 < .001	.236
Total Olympic medals and GDP per capita	.217 = .051	.047
Total Olympic medals and average national temperature	-.414 < .001	.171

DISCUSSION AND CONCLUSSIONS

The results of this brief content analysis of the London 2012 Olympic Games appear to strengthen previous reports (Bernard & Busse, 2004; De Bosscher, et al., 2003; Hoffmann, et al., 2002; Morton, 2002) claiming that the population size of the participating nations, GDP per capita, and their average annual temperatures

are related to Olympic success. However, the findings regarding the connection between GDP-PC and the total Olympic medals won during the London 2012 Games emerged to be not very robust. They were comparable to the contribution of the national temperature of the participating nations, which alone has revealed a stronger direct correlation (a closer linear relationship) with Olympic medals won than the GDP-PC (see Table 2). Population size surfaced as the most robust indicator, out of the three measures examined, in accounting for the won medals.

The findings are important, since they show that the widely hypothesized relationship between the winning of Olympic medals and GDP in reality was only modest in London. The outcome matches the results of another recent content analysis, which has revealed that the participating countries' GDP was a weak predictor of medals won in Athens 2004 and Beijing 2008, in which the physical size of the participating countries and their national health care expenditures were stronger indices of winning medals (Boudreau, Kepner & Rondone, 2014).

In the current investigation, the three measures examined accounted for 45% of the variance in the winning of medals. While this figure is relatively large, more than half of the factors associated with success at the London Olympic Games could not be explained by the participating nations' population size, GDP-PC, and the average national temperature. The direct correlation between GDP-PC and Olympic medals won during the London Games was barely statistically significant, but this factor boosted by 11% the total variance explained by three dependent measures. In spite of a stronger direct correlation that emerged between the Olympic medals and the average national temperatures, the latter only contributed 7% to the total variance explained by the three dependent measures examined in this work. The average national temperatures were negatively associated with winning medals, that is in accord with Hoffmann et al.'s (2002) results, which revealed that a cool temperate climate was optimal in securing medals at the Sydney (2000) Games.

The conclusions of this work, based on the London 2012 Olympics and supported by previous analyses of two other Olympic Games (Boudreau et al., 2014), is that the role of the GDP appears to be inflated in the scholastic effort to predict the winning of Olympic medals. The size of the population of the participating nations accounted for more than twice as much of the variance in the winning of Olympic medals than the GDP-PC, pointing to the fact the success at the Olympic Games is not as much dependent on the national share of wealth as it was presumed earlier in the literature. Indeed, the winning of medals at the Olympics may involve several other factors that, to date were not identified. These findings may deserve replication with data from future (i.e. Rio 2016) Olympics. In the interim, the message from this work is that, according to this analysis of the London Olympics, wealth may be a feeble factor that is comparable to the average national temperature, in the winning of medals at the Olympic Games.

REFERENCES

1. BBC SPORT (2015). SPORT, Olympics, Medals. Retrieved April 08, 2016 from: http://www.bbc.co.uk/sport/olympics/2012/medals/countries
2. Berdahl, J. L., Uhlmann, E. L., & Bai, F. (2015). Win–win: Female and male athletes from more gender equal nations perform better in international sports competitions. *Journal of Experimental Social Psychology, 56*, 1-3. doi:10.1016/j.jesp.2014.08.003
3. Bernard, A. B., & Busse, M. R. (2004). Who wins the Olympic Games: Economic resources and medal totals. *Review of Economics and Statistics, 86*(1), 413-417.

4. Boudreau, J., Kepner, J., & Rondone, J. (2014). *The Miracle on Thin Ice: How A Nation's GDP Affects its Olympic Performance.* Research Paper, Georgia Institute of Technology, School of Economics. Retrieved December 22, 2015 from: https://smartech.gatech.edu/handle/1853/51651
5. CantyMedia (2015). weatherbase.com. Accessed April 08, 2016 at: http://www.weatherbase.com/
6. De Bosscher, V., De Knop, P., & Heyndels, B. (2003). Comparing relative sporting success among countries: create equal opportunities in sport. *Journal for Comparative Physical Education and Sport, 3*(3), 109-120.
7. Hoffmann, R., Ging, L. C., & Ramasamy, B. (2002). Public policy and Olympic success. *Applied Economics Letters, 9*(8), 545-548.
8. Morton, R.H. (2002). Who won the Sydney 2000 Olympics? An allometric approach. *The Statistician, 51*, 147-155.
9. The World Bank (2015). *GDP per capita, 2012*. Retrieved April 12, 2016 from: http://data.worldbank.org/indicator/NY.GDP.PCAP.CD
10. The World Bank (2015). *World population data, 2012.* Retrieved April 12, 2016 from: http://data.worldbank.org/indicator/SP.POP.TOTL

