Does Geography Determine National Sporting Success?

By

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DECLERATION

I declare that this dissertation has been composed by myself and that the work of which it is a record was performed by myself. The dissertation has not been admitted in any previous application for a degree at this or any other university. All sources of information have been specifically acknowledged.

Signed: 

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ABSTRACT

This study was an investigation into the influence of, and the potential for geographical variables, both human and physical to determine national sporting success through the use of results data from the Rio 2016 Olympic Games.

It must be noted that national sporting success is an extremely broad subject of investigation, so whilst geography may have influence and general determining factors, there are several micro and macro factors in each athlete's specific situation. Within the constraints of this study these cannot be tested and may impact overall trends. This study also was restricted in how much sporting data could be included, with selected events from five different sports there was a total of 40 competitions used to build the dataset. To give context, Athletics alone at the Rio Olympics had 47 competitions, had this study included every competition in its selected sports there would have been 132, and the total number of competitions at the games was 306. Additionally, the Rio 2016 Olympics had 207 nations competing (olympiandatabase.com n.d.), however with the sports and events included in this study, only 190 were analysed.

The results from this study are consistent with other literature on the subject, particularly in that GDP clearly stood out as the variable with the greatest level of influence on national sporting success. Similarly to other studies, other geographical factors such as average temperature appeared to suggest trends linked with the results data; however any statistical influence was significantly lesser than that of GDP and likely mere corelation rather than genuine sway.

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Introduction

This paper examined the determining influence of human and physical geographical factors on national sporting success. This was done by employing the 1956 Jokl method to convert the competition results of the 2016 Rio Olympics to a points-based ranking system. This ensured that results across different formats and different sports could be directly compared against each other and against external data. These results could then be compared against different variables to assess levels of influence using a multiple regression model.

On completion of the statistical analysis, it was found that GDP was clearly the most influential overall variable on national sporting success. After a significant gap, the next most influential variables were average temperature and total coastline length. The least influential variables were the Status of Women Index score and the Democracy Index score. It must be noted that these two least influential variables were also the least comprehensive data sets compared to other variables. Consequently it is possible that these results are inaccurate. It must also be noted that not every nation that competes in the Olympics is considered as a country in its own right outside of the Olympics, which in particular impacted results from island nations such as those which are a part of colonial territories.

Whilst GDP stood out as being the most influential variable overall, when individual sports were assessed there were two exceptions. Whilst GDP did remain the most influential variable for Cycling, all the variables had very similar β values and GDP did not stand out as with the overall rankings. The Cycling values also had only an R square value of 0.201 unlike the other sports (mean R square for the other four sports was 0.592), meaning the regression model only explained 20% of the values. By Contrast, the regression model explained the Shooting value by a much greater proportion (53%). In this case however, GDP was only the third most influential variable after average temperature and total population.

Much of the existing published literature covering the factors contributing to national sporting success include discussions of the impact of both private and national wealth, GDP having had such a strong influence on the Rio 2016 Olympic results is unsurprising. The literature generally considers physical geography factors such as climate to have minimal to no influence

on national sporting success. Where there appears statistical connection between these, the common answer is that; whilst there may be correlation between a physical geography factor and national sporting success, it is usually better explained by other variables. The results of this study indicate that physical geography factors such as temperature may influence national sporting success, however it is more likely that this is a symptom of global wealth distribution rather than genuine influence being attributed to the average temperature of a nation.

Background

National sporting success is a subject that is multidisciplinary in nature, and there are several factors involved. As such whilst we can study the potential determinative nature of geographical factors, it must be acknowledged that each individual athlete's success is determined on a case-by-case basis the details of which this study does not have the scope to investigate. Instead, this analysis should be considered as an introductory study to investigate the specific influence of geography in sport at a macro level, and to give direction for further studies on this matter.

One of the key methods used by this study is taken from Earnst Jokl's "Sports in the cultural pattern of the world: a study of the 1952 Olympic Games at Helsinki" where sporting results were converted into a points ranking system. This system standardised the values from the competition results and made the results from different types of events numerically comparable. Jokl's study, whilst problematic in some areas in respect to gender and racial equality is a good example of studying Olympic data from a Geographical perspective due to this vital ranking system. Jokl's study – whilst out of touch with today's standards – was progressive for his time, allowing the data to speak for him, which included contesting direct Environmental Deterministic perspectives of the time.

John Bale investigates Jokl's results further in his paper "Lassitude and Latitude – Observations on Sport and Environmental Determinism" where he also looks closer at the overall academic links between sport and Environmental Determinism. In this he concludes that "the reasons for cultural behaviour arise outside the area in which they are found". This study anticipated the same overall result however it also looked into human geography factors which, it was

expected, were more likely to have any influence in national sporting success. As mentioned previously, whilst it is possible for physical geography factors to corelate with national sporting success, it is possible for the "influence" in these factors to be explained through a wider lens.

Aims

This study aimed to evaluate if geographical influences are a determining factor in elite sporting success at a national Level. Furthering this, this study also aimed to assess to what extent physical geography has any determining influence in comparison with human geography.

These assessments looked at sporting success on a general scale by comparing the cumulative results data using the Jokl Ranking method for the five sports included in this study, as well as a more detailed analysis into groups of similar events within individual sports such as cycling and athletics.

Research Questions

What significance do physical geography factors have on elite sport in relation to other factors of success?

In comparison to related factors such as political systems and national prioritisation, what proportion of national wealth is an advantaging/limiting factor in elite national sporting success?

To what extent does population size dictate elite national sporting success, particularly as countries build more strategic sporting systems.

Hypothesis

It was expected that geographical factors influence national sporting success but do not determine it. Furthermore, it was anticipated that human geography factors are more likely to have an impact than physical geography factors. The analysis of national sporting success

is a broad subject, and with so many different factors at play, it is unlikely that one area such as geography can be proved as deterministic.

The factors analysed in this study were total coastline length, average temperature, GDP, average elevation, Status of Women Index score, Democracy Index score, and population. It was expected that total coastline length is unlikely to determine national sporting success. Average temperature was expected to be unlikely to determine national sporting success, but to potentially influence national sporting success. GDP was expected to have the highest likelihood of determining sporting success for nations, and the highest likelihood of influencing the success. It was anticipated that average elevation may influence national sporting success, but that it would be unlikely to determine the success. The Status of Women Index score was expected to influence national sporting success and to have the potential to determine success. Democracy Index score was anticipated to influence national sporting success, but it was not expected to determine national success. Finally, total population of a nation was expected to both have a high probability of determining national success, and to influence national success.

Literature Review

The 'modern' Olympics was established in 1896 and since then the prestige associated with competitive sport at elite international levels have been an essential source of national pride and inspiration. In the midst of this, one might wonder what determines and influences elite sporting success for a nation. Indeed, many scholars, among which include Jokl and Bale, have considered Olympic success from a geographical perspective, questioning the factors required to reach such a standard.

Initially, elite national sporting success was considered through the lens of Environmental Determinism – a geographical paradigm which considers physical nature and biological makeup to be determined by the environment in which you are from. This problematic theory is considered as an excuse to justify racism and colonialist thinking and has often been proved wrong. Despite this it is clear that athletes and coaches value having access to specific types of environments to train and compete in, including those of a different average temperature

to normal training set ups, and specific altitudes which are favoured by some sports for their difference in wind resistance. These common sporting practices suggest that benefits can be obtained from access to certain environments, and that some environments may even provide optimum conditions for record breaking performances, which generates a question of exactly what impacts different environments and their access have on sport. Taking this further invites one to consider the significance of these impacts to elite national success in comparison to other geographical factors such as wealth or population.

The goal of this investigation is to review the impact of geographical factors on elite national sporting success by way of comparing the datasets of different potential factors such as population, wealth, and climate, with results from a number of events from the Rio 2016 Olympic Games. With such a broad potential topic of investigation, it would be impractical to assess every potential influencer fully within the constraints of a small geographical investigation.

The issue regarding the vast nature of this subject emerged a number of times in existing literature, and for this reason all of them narrowed their field of investigation as a result. This meant acknowledging but not examining factors with minimal data and focusing on a small selection of sports or events – in some cases grouping them into categories of similarities. Similarly, in this study, sports included in the assessment will be narrowed down to events that regularly appear in the Summer Olympic Programme, and events in which all participants can be ranked against each other coherently such as excluding events only available for male or female athletes.

Themes

Wealth

Wealth on both a micro and macro scale was the most frequently addressed factor of elite national sporting success in the existing literature. It has impacts on the access and quality of coaches, facilities, and equipment. Another key feature to a successful national performance sport programme which wealth influences is the ability for athletes/teams to travel for competition and training, particularly in regards to international trips. This impact on

globalisation may then further affect the influence of other variables such as those of differing environmental conditions. David's and Baker (2007) acknowledge that 'essential resources' such as income and coaching can have a fundamental impact in training engagement which further impacts success.

Constraints such as athlete poverty and social immobility were considered by Vagenas and Palaiothodorou (2019) when investigating climactic origin in comparison to national success at the Olympics. They highlighted that an athlete who is not supported by a national sporting system, could suffer serious financial strain from training and competing at an elite level, consequences of which include an athlete's drive to continue their career. It was further noted that in the case of aquatic sports, success was noticeably more significant in wealthy countries regardless of climate category and, similarly, countries who had been able to invest in the appropriate infrastructure for martial arts dominated in those fields.

It is clear from these studies that wealth is an essential factor to include in any analysis of sporting success. Nevertheless, whilst it is a somewhat obvious answer when considering what influences a nation to be successful in a sporting context, there is less clarity on whether wealth specifically determines this success. Schadenfreude (the act of rooting for an underdog (Goldschmied 2007)) has a popularity stemming from the belief that it is possible to beat the odds if one is courageous enough. Whilst often the result of fiction, the belief is reinforced by real occurrences which call into question the possibility for any variable, even one as prominent as wealth to be a truly determining factor.

Politics

Political influence spans a vast number of national sporting success factors including specific sports policies, prioritisation of investment and infrastructure, sporting significance to culture, and willingness to succeed at all costs – even if that involves morally wrong activities such as doping. In an analysis of sporting policy and the influence it has on national athletic success, Veerle De Bosscher (et al. 2006) drew attention to the use of Olympic medal tables as a measure of international superiority beyond sport by politicians and the media. It is thought that as a result of this, the competitiveness of international sport has now escalated to

propagandic competition between differing political systems. A direct misuse of the Olympic medal table according to the International Olympic Committee [IOC].

During the Cold War, the Olympics were seen to be some of the closest and most antagonistic opportunities for nationalist engagement (Wagg, S., and Andrews, D.L. (2007). Consumed by patriotism, the resulting 'mob' was particularly susceptible to propagandic efforts benefiting "governing elites" and providing strong incentive to substantially invest in sport. Former communist states of eastern Europe have had significant levels of international success as a result of this sporting investment priority (Veerle De Bosscher et al. 2006).

Another way for political systems to gain dominance through international sport is to win hosting rights for principal events such as a world championships or an Olympics. The host status becoming a symbol of greatness bestowed upon the host country and it brings tangible benefits including increased participation quotas for athletes of that nation in the event which directly increases opportunity for success. The host status grants attention to the nation, often resulting in tourism booms during and following the year it takes place (Li, S., Blake, A. and Cooper, C. 2011).

This increased interest also takes its toll on nations – particularly those perceived to have immoral behaviours. In September 2020 Iran executed Navid Afkari a national boxing star after obtaining a confession though torture for murdering a security guard during the 2018 Iranian peaceful protests – a crime which was never proven (Seifkaran 2020). This generated resounding condemnation from around the world (Amnesty International 2020) including several Iranian officials being blacklisted by the US for gross violations of human rights (Reuters 2020). Despite this, in October 2020 Iran was awarded the men's under 19 volleyball world championships, sparking global outcry which, after another athlete execution in January 2021 remains ongoing (Weinthal 2021). Furthermore, global audiences have questioned Iran's approach to women's rights issues particularly as women were only legally allowed to attend volleyball matches in 2016, and access continues to be heavily restricted.

The host factor in itself was considered as a separate factor by some of the existing literature, however it has proven to be difficult to quantify in terms of elite national sporting success.

Regardless, it is very likely that the politics surrounding the host factor will cause reverberations in national success.

Sports Policies

The political system of a country directly affects national sports policy, however evidence demonstrating specifically how policy affects sporting success at an international level is unclear (Veerle De Bosscher et al. 2006). Determinants relevant to a nations sporting success range from meso-level factors (which can be influenced by policy) to macro-level with more than 50% being the latter. These factors are explained by population and the Gross National Product (GNP) and are out with political control.

In the Literature reviewed by Veerle De Bosscher (et al. 2006) there were seven key factors (Table 1) which were regularly mentioned.

Table 1 Table Showing Common characteristics of elite sport systems (Veerle De Bosscher et al. 2006).

	Characteristics
1	Recognition of physical education and sport within constitutional law
2	Early talent spotting through schools
3	High training frequency embedded in the school system
4	Training and qualification systems of professional coaches
5	Financial support programmes
6	High priority of applied scientific research
7	A network of sports medicine

These have gradually been adopted by several nations however it was acknowledged that ultimately each event (let alone each sport) is often so different that no model ever could be completely accurate. Ultimately policy for sporting success will only be as effective as it is deemed to be a priority by governing systems.

Culture

Certain sports are ingrained in national culture and thus are given more significance in these countries. An example of this is the Olympic Sport of Judo which originated in Japan in 1882 and is regarded as a modern adaption to the ancient art of Jujitsu (Shohei, S. 2013). Its first appearance at an Olympic Games was in Tokyo in 1964, 82 years after its origins. Of those 82 years it had been a part of the Japanese education system for 53 (introduced in 1911). With such respect and inclusion given by the country it is of little surprise that Japan sits on top of the all-time Olympic Medal Table in this sport (Sportencyclo n.d.). This supports Vagenas and Palaiothodorou's (2019) statement that the development of sporting talent is entrenched in culture, education, and athletic tradition.

Cultural impacts may also have negative influence on national sporting success; when sports are linked to cultural tradition, they can trigger stereotypes about that region's prowess in those sports. These stereotypes can affect an athlete's psychological state, both building pressure and confidence in athletes who are stereotypically expected to achieve, whilst also eroding confidence in athletes which are not. "Stereotype Threat" is not something which can be researched within the scope of this analysis however the evidence provided by Barker and Horton (2003) indicates that this factor has the potential to influence the success of a national sport team.

Doping

Whilst it would be unrealistic to attempt to include data on doping due to the sheer lack of it, a study which did not acknowledge its prominence and implications to elite sport would be naïve. The use of performance enhancing drugs does have a clear impact on sporting success on the international stage, the likes of which can frequently be seen particularly in certain publicly popular sports and events such as the Tour de France where it its often privately an expected requirement of success to dope (Halter 1998). Furthermore, nations who systematically use doping as a part of their performance sport programmes without being caught do improve their sporting standing, even though the act is morally wrong. Admittedly not a specifically geographical variable, there are human geography components which shape

the extent to which doping behaviour is undertaken. These include wealth, development and, by extension, political regimes.

Doping scandals frequently occur in sport and have been ongoing for as long as clean sport has been treated as a priority. As such it is key to acknowledge the potential for doping athletes and teams to alter the accuracy of a statistical analysis in sporting success.

Globalisation

When considering globalisation, it can be defined in terms of both reach and response. Reach ranging from minor matters such as sportswear trends to major issues for instance deep seated controversial cultural views such was women competing in sport. Tan and Houlihan (2012) judge response to be viewed as a spectrum ranging from passive to conflicting. Elsewhere globalisation can be defined as entities operating on an international scale.

Globalisation in general can have significant impacts outside of Olympic competition, many professional sports teams employ players from other nationalities – something which cannot be done in the Olympics. This is significant as this study only uses data from Olympic events and is restricted in its accuracy of evaluating national sporting success as a result. Alternatively, sourcing talent from other nations could be considered an advantage, symptomatic of significant spending powers belonging to the importing country.

Whilst this often ensures an increased short-term chance of success it can be damaging to local athletes who lose out on opportunities to develop through the support of their own country's national programmes (Giulianotti 1995).

Globalisation is also influential to individual athletes – enabling international travel for training and competition in different environments which has a range of benefits such as acclimatisation, major competition experience and access to higher standards of athletes to push against.

Population

Population size is generally considered to be a significant factor in elite national sporting success as a large population gives national performance sport programmes large pools of potential athletes to identify talent from. This endless availability of choice additionally allows the national programme to clinical and ruthless about which athletes remain supported, which could be an advantage over smaller nations.

Despite this potential advantage, countries of smaller populations don't necessarily perform less well as strategic planning can be used to produce more success than population. A good example of this from the existing literature is the historical performances of Australia which have been consistently good in the summer Olympics between 1996 and the present despite a relatively small population size (Veerle De Bosscher et al. 2006). As other countries follow suit, population is becoming a gradually less accurate predictor of sporting success which will be keeping eyes on in present and future studies.

Land Mass

Although often acknowledged as a factor in sporting success in the existing literature, there are few consensuses on the exact influence of land mass (Veerle De Bosscher et al. 2006). It has been suggested that there is a need to identify a model of the determinants of sporting success that applies to every country without reference to traditional factors such as land mass or wealth (Chelladurai and Robinson 2012). One of the interesting things about this factor is how hard it is to find any information. There are plenty of sources who quote or cite Veerle De Bosscher (et al. 2006), but few elaborate beyond stating that there is little consensus on the subject. This may be to do with its positive yet weak statistical significance (Pearson's corelation co-efficient of 0.46) when comparing the all-time medal table [presently existing countries only] and land area.

Environmental Determinism

Environmental Determinism, once a popular geographical paradigm, is now considered to be an outdated geographical concept. It argues that the environment in which one comes from

determines the physical nature and behaviour of a person. At the time it was popular it was often used to justify aggressive colonialist behaviours, this paired with lack of definitive scientific support is why it is now widely considered as racist. One of the best-known thinkers on Environmental Determinism described men with iron legs living on mountains, whilst those who did not live on as harsh terrain were “weak and flabby” (Semple 1911).

Despite this, Environment is a recurring theme in sporting analysis, likely due to perceived short term environmental impacts that athletes experience during training and competition. Many athletes for example partake in altitude training, and whilst much research has been inconclusive, certain papers suggest it has benefits to cardiovascular ability (Girard et al. 2013). With this in mind it would not be a huge stretch to assume athletes brought up and living at higher altitudes might have developed stronger cardiovascular systems that others, creating an advantage. If this were correct statistical analysis might display a relationship between national success and altitude. It is clear however that in regard to Environmental Determinism itself there is minimal evidence to support its impact on sport.

Climate

Another traditionally explored factor for sporting success in existing literature has been climate. Temperature acclimatisation training is often considered a critical element of preparation before a major competition by athletes and coaches. In wealthy national sporting programmes, it is common for athletes preparing for major events to attend training camps and smaller competitions in environments that mimic that of the event they are preparing for.

However climactic origin of the athlete has no solid evidence supporting any influence in Olympic Performance (Vagenas and Palaiothodorou 2019). Whilst there is the occasional correlation between climate and performance, the sporting result can often be better explained with deeper analysis into each country. Vagenas and Palaiothodorou (2019)’s study had a few exceptions for example it was noted that countries in the Warm-Humid Climate appeared to have superiority over countries in the Cool-Humid climate in aquatic sports. However, it was considered that national wealth was more likely to be the cause.

Genetics

Although not specifically geographical, genetics is another factor linked to sporting success which should not be neglected when exploring the determining factors of elite sport. Alongside national talent, genetics is a depiction of the age old 'nature vs nurture' debate, and as such influences from either can usually be taken with a pinch of salt (Davids and Baker 2007). In the recent past genetics been so strongly considered that attempts to identify runners as sprinters or endurance have been made based on a single gene. Similarly, in 2000 there was predictions that "gene-transfer technology" could be used similarly to doping in future Olympic Games. Davids and Barker (2007) highlight the eccentricities of this thinking before recommending the approach be discarded in preference of the study of human behaviour. Whilst genetics will have an effect on many of the physiological factors that make someone a successful athlete, there is no single gene that controls these attributes. It is better to have a good coach who can adapt the learning environment to specifically suit the needs of the athlete.

Methodological Approaches

When investigating national Olympic success in relation to climate, Vagenas and Palaiothodorou (2019) took a sample of nations that had won a minimum of one medal at the Olympic Games between 1996 and 2016 (six games in total). The nations were categorised by political systems, as well as split into different groups based on climate using the Köppen–Geiger–Trewartha (KGT) system. Olympic sports were put into groups based on similar events such as combat sports. A Tobit Model was then used for statistical analysis of comparative advantage, it was considered a good fit as both the medal table and comparative advantage datasets contained many zeros and -1s meaning that the data was naturally censored. In all twelve models a final model fit was not determined suggesting the maximation algorithm was unlikely to converge. These issues resulted in a use of the Tobit Model in both comparative advantage and medal table analysis.

Vagenas and Palaiothodorou (2019) describe six drawbacks to their study; the sample did not include nations who had not achieved a medal, medals were not weighted based on colour,

the six Olympic Games looked at were not investigated in isolation, geographically large countries such as Russia do not fit neatly into one climate category, the factor of a home games was not explored, and finally, many athletes train and compete in test events in Olympic facilities before the games (giving them a chance to get used to the climate and environment) and this could not be analysed within the study.

In an analysis of sports policies, Veerle De Bosscher (et al. 2006) explains that whilst looking at sporting success, inputs and outputs can be measured with relative ease however throughputs require more indirect methods. As a result, some of these may not progress beyond descriptive analysis, which can cause a lot of constraints when assessing links between policy and success. She then goes on to state that the link between policy and sporting success will always have a level of uncertainty, and that it is not possible to create a one size fits all model for sporting policy as each country has unique characteristics that will either have complimentary or abrasive effects which will influence the effectiveness of the policy.

Many studies of this subject used multiple regression analysis as a primary method. This is a natural choice given the ability to determine relative influence and outliers of different factors in sporting success, provided one does not get caught out by the assumptions of linear regression.

Implications for Research

It is clear that there are an extensive number of factors which can impact elite national sporting success. One of the clear limits for this research will be narrowing down which factors are most worthy of exploration with the resources and time available. Geography is in itself a broad subject so questioning if it in any way determines sporting success is equally as broad. These limitations are echoed in the literature, for example Vagenas and Palaiothodorou (2019) suggest exploring the impact if education, gender and exploring the needs of each Olympic event in more specific detail.

Dividing countries by factors that are not naturally measurable, such as politics or culture will likely generate inaccuracies in any study. Be that as it may, by avoiding investigation into these factors one would are also put their research at risk of error. Likewise, whilst it is natural to

compare sporting performance by country, it is not a standardised unit of measurement, which means it is possible that they are not the most appropriate units to assess this subject (Veerle De Bosscher et al. 2006).

A common issue to arise in many of the studies is based around countries who have not achieved any Olympic medals. Statistically it may make sense to leave them out, however this may also cause inaccuracies in results. Most of the literature appeared to not include these countries in their statistical analysis but make a point of explaining the issue in their discussion of limitations with their research. It is for this reason that the Jokl method will be employed in this analysis as it awards points based on placings in relation to total number of participants and thus removes the zero values which would otherwise be given to these nations.

Methods

Data Types

Data from five different sports were selected based on the types of events they contained and both the men's competition and the women's competition in each event was included.

The First Sport selected was Athletics as it is a staple of the Olympics and could be considered the most accessible sport as participation can take place despite a lack of specific equipment or facilities. The events included from Athletics in the study were the marathon, 100m, 400m, 10000m and high jump. Cycling is also considered a core sport to the Olympics, so it was also included with four events: velodrome sprint, road race, mountain biking, and the omnium. Gymnastics is another well-known staple of the Olympics, so it was included in the study. Only three events (floor, vault, and trampoline) have both male and female participants, so only these events were included. Target Shooting has a straightforward format and less obvious patterns of success than other sports. It also requires a lot of equipment and very costly and niche infrastructure so to draw contrast to the accessibility of athletics it was included. The events selected for inclusion were 50m three positions rifle, 10m air rifle, 10m air pistol and Olympic trap. The last sport to be included was swimming due to its station as a core sport and its duality of accessibility in which individual athletes require relatively little equipment,

but infrastructure is costly. The events from swimming included in the study were 50m freestyle, 100m freestyle, 400m freestyle and the marathon (10km).

Seven different geographical factors were identified as a result from prior literary analysis on this subject. Physical factors included Total coastline length (km), Average Annual Temperature (Degrees Celsius), and Average elevation (Feet). Human Factors included GDP ($US Billion), Status of Women Index score, Political System (by way of the Democracy Index), and Population. Full details of all data can be found in Appendix 1.

Data Locations

The Olympic medal results used in this study came from a database known as "Olympian database.com" which is constructed using official reports written after each Olympic Games and contains the complete results of every historical event starting from the first modern Olympics in 1896. These sporting results were then analysed against number of different geographical factors, the data of which came from different sources, with some being notable to mention. All sources for data can be found in the references section.

The World Bank provided data on climate and average temperature and was used for the majority of countries which participated in the specific sporting events being tested. However, they did not have data for some of the smaller nations which compete at the Olympics including the following: Aruba, Bermuda, British Virgin Islands, Cayman Islands, Chinese TP (Taiwan), Cook Islands, Guam, Hong Kong, Kosovo, Montenegro, and Palestine. As such, the data for these specific countries comes from "weatherspark.com" which is a database allowing one to gather data from individual weather stations in specific locations. This does mean that there will likely be an inconsistency between these listed countries and others in the statistical analysis.

The "Status of Women Index score" factor data came from the "Women, Peace, and Security Index" by the Georgetown University's Institute for Women, Peace, and Security. This data assesses women's equality and wellbeing and provides a score and a ranking for each country. However, it only includes 167 countries so 23 of the participation nations in the sporting events analysed by this study will be left out.

The “Political System Factor” was measured using data which came from the 2019 Democracy Index score by The Economist.

Sporting Data Collection Notes

In gymnastics only two athletes per country may advance to the final regardless of performance compared to athletes from other nations, so first to eighth place e have been determined by the Olympic final whilst placings from nine onwards are athletes who did not qualify in the Olympic final but place in 1st to 8th place in the qualification match in order the remaining athletes are then ranked in order as normal.

In events using heat formats, such as swimming and short distance running, places one to eight were determined by a final, places nine through 16 were allocated athletes who competed in the semi-finals but did not compete in the finals with the times ranked and places 17 to the end were all athletes ranked by time who did not qualify for the semi-final. Athletes with the code DNS (did not start), DNF (did not finish) and DQ (disqualified) were not included in the rankings. Similarly, long distance events and events without finals had athletes right in order as the list suggested but did not include athletes with the pre-mentioned athlete codes.

In the shooting events three disciplines, air rifle, and air pistol at the same way of determining overall placings. Placings one to eight were determined by the Olympic final, and placings from nine onwards were determined by the qualification match. In Olympic Trap placings one and two are determined by the final placings, three and four are determined by the “B” final placings, five and six are determined by the semi-final, and placings seven to the end are determined by “round one”.

Jokl Method

In order to compare results from different sporting events, which have different measures of success and different numbers of entrants, this study employed the Jokl Ranking Method (Jokl 1956). This method allocates a number of points to each participant based on placing, with first place always receiving 100 points and last place receiving 0.

Figure 1 Jokl Ranking Method

$$P = 100 \times (\frac{1 - \log x}{\log n})$$

$P = x/n =$ probability of achieving a rank equal to or better than x

$n =$ Number of Competitors

$x =$ Rank (ordinal placing of competitor)

The use of this method allowed for a standardised system of comparison, and countries were statistically analysed through their total accumulation of Jokl Points overall, as well as in each sporting category.

Statistical Methods

Initially this study intended to use a tolbit regression model as its main form of statistical analysis as it would be appropriate given the nature of the Jokl Method's fixed start and end points. However, it was not possible to access the necessary toolkit in Microsoft Excel, and this form of regression is not supported by SPSS Statistics. Consequently, this study employed the use of Multiple Regression (Enter Method) through the SPSS Statistics programme. A model was run for Overall Jokl Rankings, as well as individual sporting categories – Athletics, Cycling, Gymnastics, Shooting and Swimming – for a closer look at different types of sports and potential requirements for success.

For further details about the data such as assessing independence of observations, the Durban Watson Statistic was used, as well as an ADNOVA test to assess the fit of the model to the data and a Multicollinearity test to rule out variables which might be correlated to one another.

Statistical Analysis Notes

Proceeding with the multiple regression model and associated statistical tests was smooth and there were no arising faults or issues during the analysis.

In re attempting this study with greater resources and more time, it would be worth going deeper with the dataset and analysing each individual event, particularly those of which have major differences such as Road Cycling and Mountain Biking or Air Rifle, Air Pistol, Trap (Shotgun) and Three Positions Shooting (.22 Rifle). One might also explore any differences between the male event data and the female event data, particularly in reference again to factors such as the Democracy Index score, GDP, and the Status of Women Index score.

Results

Overall Jokl Rankings

The multiple regression analysis began with the overall Jokl ranking points over the five sport types (40 events over athletics, cycling, gymnastics, shooting and swimming). The Durban Watson test had a result of 2.162 which is between the critical values of $1.5 < d < 2.5$ so it can be assumed that there is no first order auto correlation in this data.

The R Square value for the overall Jokl rankings against all the tested factors was 0.719 and the model had an adjusted R Square value of 0.705 meaning that the predictor variables tested explain 71.9% of the variance in the rankings assuming that every variable explains the dependent. The ADNOVA had an F value of 51.644 which was highly significant and a ρ value of 0.000 with the P Plot visually suggesting the data is normally distributed (Figure 2). Multicollinearity testing showed no significant issues (Table 2) as tolerance levels were greater than 0.1 and VIF values were less than 10 in each of the predictor variables.

Table 2 Multicollinearity Results for Overall Jokl Rankings

	Tolerance	*VIF*
Coastline	0.861	1.161
Temperature	0.489	2.046
GDP	0.608	1.664
Elevation	0.704	1.352
Status of Women Index score	0.330	3.028
Democracy Index score	0.450	2.222
Population	0.629	1.590

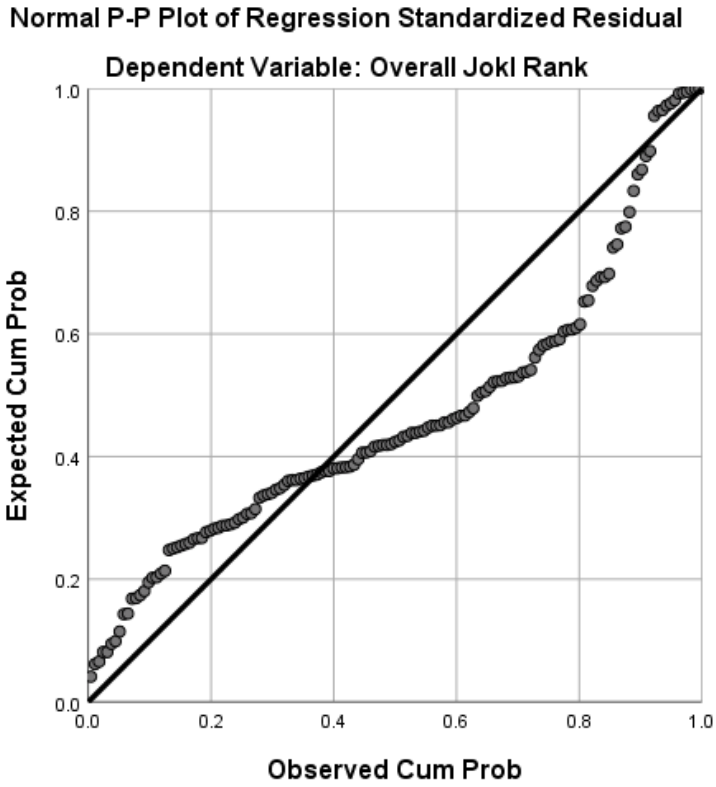

Figure 2 P Plot for Overall Jokl Rankings

The Standardised Coefficient values tell us that GDP stood out as having had the greatest impact on the overall Jokl rankings (β = 0.729, ρ = 0.000). The next most impactful variables were average temperature (β = -0.196, ρ = 0.003), average elevation (β = -0.129, ρ = 0.014) and total coastline length (β = 0.119, ρ = 0.015). The least impactful variables were the Status of Women Index score (β = 0.080, ρ = 0.304), population (β = -0.059, ρ = 0.300) and the Democracy Index score (β = 0.030, ρ = 0.651).

Athletics

After analysing the overall Jokl rankings, the first group of events to be analysed using the multiple regression model was athletics (ten events). The Durban Watson test had a result of 2.058 which is between the critical values of 1.5 < d < 2.5 so it can be assumed that there is no first order auto correlation in this data. The R Square value for athletics against all the tested factors was 0.483 and the model had an adjusted R Square value of 0.454 meaning that the predictor variables tested explain 48.3% of the variance in the rankings assuming

that every variable explains the dependent. The ADNOVA had an F value of 16.187 which was significant and a ρ value of 0.000 and the P Plot visually suggests the data is normally distributed (Figure 3), however less normally distributed than the overall Jokl rankings. Multicollinearity testing showed no significant issues (Table 3) as tolerance levels were greater than 0.1 and VIF values were less than 10 in each of the predictor variables.

Table 3 Multicollinearity Results for Athletics

	Tolerance	*VIF*
Coastline	0.868	1.152
Temperature	0.523	1.914
GDP	0.608	1.645
Elevation	0.762	1.312
Status of Women Index score	0.351	2.848
Democracy Index score	0.460	2.172
Population	0.624	1.603

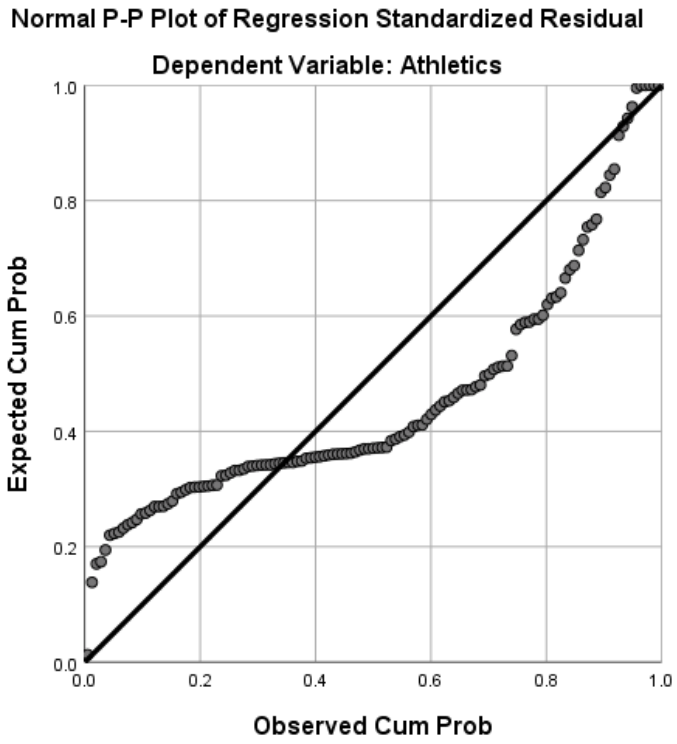

Figure 3 P Plot for Athletics

The standardised coefficient values tell us that as with the overall Jokl rankings, GDP stood out as having had the greatest impact on athletics (β = 0.729, ρ = 0.000). The next most impactful variables were population (β = -0.247, ρ = 0.003) and total coastline length (β =

0.145, ρ = 0.041). The least impactful variables were the Democracy Index score (β = 0.066, ρ = 0.496), the Status of Women Index score (β = 0.064, ρ = 0.564), average temperature (β = 0.050, ρ = 0.579), and average elevation (β = -0.014, ρ = 0.855).

Cycling

The next group of events to be analysed using the multiple regression model was cycling (eight events). The Durban Watson test had a result of 2.472 which is between the critical values of 1.5 < d < 2.5 so it can be assumed that there is no first order auto correlation in this data. The R Square value for cycling against all the tested factors was 0.201 and the model had an adjusted R Square value of 0.074 meaning that the predictor variables tested explain 20.1% of the variance in the rankings assuming that every variable explains the dependent. The ADNOVA had an F value of 1.582 which suggests the fit of the model was not significant in the case of cycling, and the ρ value of was 1.66, however the P Plot visually suggests the data is normally distributed (Figure 4), and comparatively, cycling appears to be the most normally distributed data out of all those which have been tested. Multicollinearity testing showed no significant issues (Table 4) as tolerance levels were greater than 0.1 and VIF values were less than 10 in each of the predictor variables.

Table 4 Multicollinearity Results for Cycling

	Tolerance	*VIF*
Coastline	0.735	1.361
Temperature	0.447	2.235
GDP	0.455	2.200
Elevation	0.678	1.475
Status of Women Index score	0.287	3.484
Democracy Index score	0.347	2.677
Population	0.342	2.923

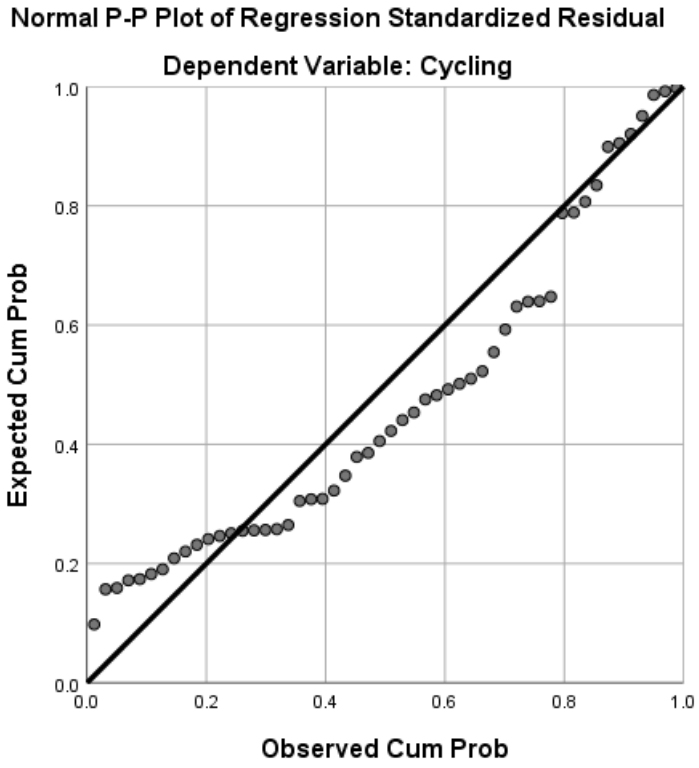

Figure 4 P Plot for Cycling

The Standardised Coefficient values tell us that the greatest variable impact on cycling was GDP (β = 0.345, ρ = 0.091) and the Status of Women Index score (β = 0.228, ρ = 0.370). The least impactful variables were population (β = -0.151, ρ = 0.516), average elevation (β = -0.097, ρ = 0.555), the Democracy Index score (β = 0.073, ρ = 0.743), total coastline length (β = 0.044, ρ = 0.780), and Average temperature (β = 0.027, ρ = 0.895).

Gymnastics

The next group of events to be analysed using the multiple regression model was gymnastics (six events). The Durban Watson test had a result of 2.094 which is between the critical values of 1.5 < d < 2.5 so it can be assumed that there is no first order auto correlation in this data. The R Square value for gymnastics against all the tested factors was 0.609 and the model had an adjusted R Square value of 0.552 meaning that the predictor variables tested explain 60.9% of the variance in the rankings assuming that every variable explains the dependent. The ADNOVA had an F value of 10.686 which suggests the fit of the model was significant, the ρ value of was 0.000 and the P Plot (Figure 5) visually suggests the data is normally distributed.

Multicollinearity testing showed no significant issues (Table 5) as tolerance levels were greater than 0.1 and VIF values were less than 10 in each of the predictor variables.

Table 5 Multicollinearity Results for Gymnastics

	Tolerance	*VIF*
Coastline	0.787	1.270
Temperature	0.460	2.173
GDP	0.613	1.631
Elevation	0.820	1.219
Status of Women Index score	0.235	4.261
Democracy Index score	0.381	2.262
Population	0.549	1.823

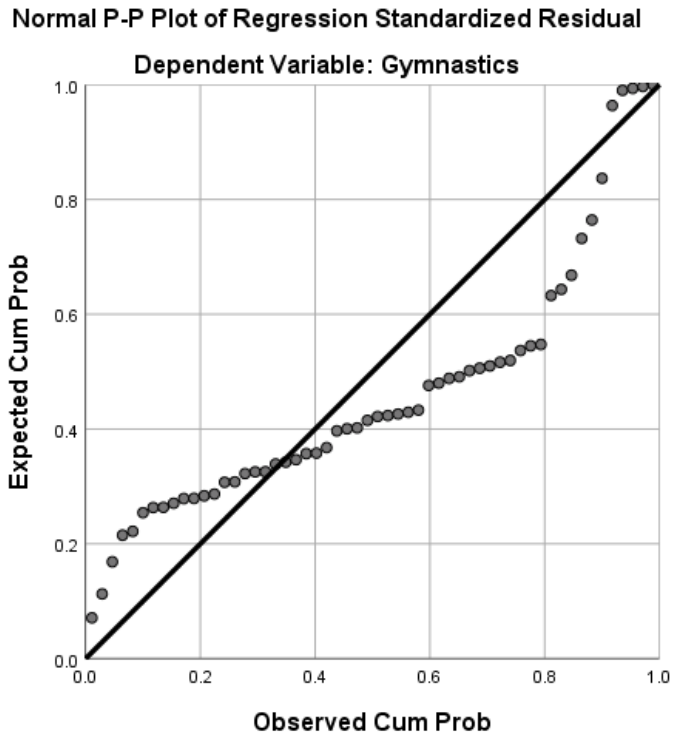

Figure 5 P Plot for Gymnastics

The standardised coefficient values tell us that the greatest variable impact on gymnastics stood out as GDP (β = 0.648, ρ = 0.000). The next most impactful variables were total coastline length (β = 0.188, ρ = 0.070), average temperature (β = -0.186, ρ = 0.168) and the Democracy Index score (β = 0.115, ρ = 0.435). The least impactful variables were Average elevation (β = -0.079, ρ = 0.432), the Status of Women Index score (β = 0.051, ρ = 0.787), and population (β = -0.030, ρ = 0.808).

Shooting

The penultimate group of events to be analysed using the multiple regression model was Shooting (eight events). The Durban Watson test had a result of 2.335 which is between the critical values of $1.5 < d < 2.5$ so it can be assumed that there is no first order auto correlation in this data. The R Square value for shooting against all the tested factors was 0.526 and the model had an adjusted R Square value of 0.475 meaning that the predictor variables tested explain 52.6% of the variance in the rankings assuming that every variable explains the dependent. The ADNOVA had an F value of 10.289 which suggests the fit of the model was significant, the ρ value of was 0.000 and the P Plot (Figure 6) visually suggests the data is normally distributed. Multicollinearity testing showed no significant issues (Table 6) as tolerance levels were greater than 0.1 and VIF values were less than 10 in each of the predictor variables.

Table 6 Multicollinearity Results for Shooting

	Tolerance	*VIF*
Coastline	0.776	1.288
Temperature	0.477	2.098
GDP	0.609	1.643
Elevation	0.797	1.255
Status of Women Index score	0.321	3.115
Democracy Index score	0.503	1.986
Population	0.595	1.680

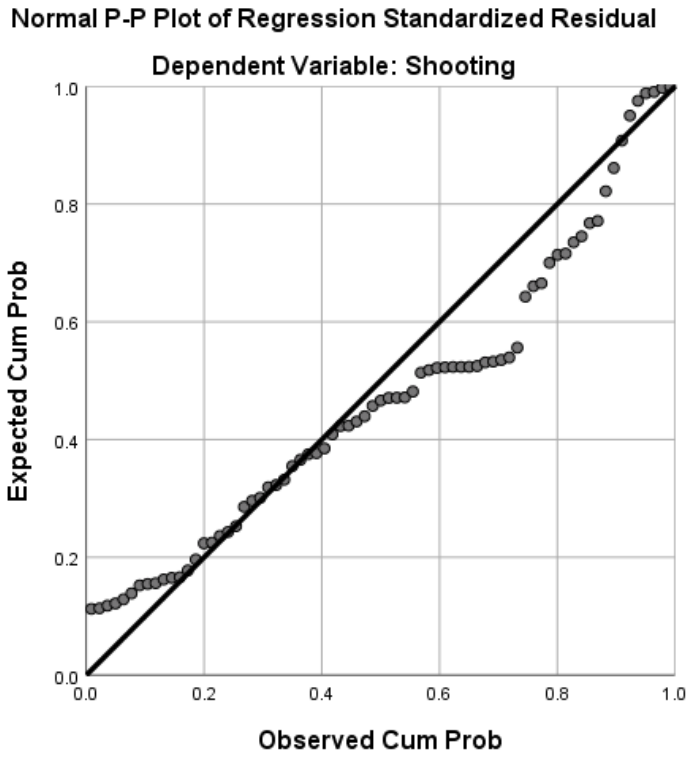

Figure 6 P Plot for Shooting

The standardised coefficient values tell us that unlike other sports groups, the greatest variable impact on shooting was average temperature (β = -0.435, ρ = 0.001), population (β = 0.432, ρ = 0.000) and GDP (β = 0.238, ρ = 0.033). The next most impactful variables were total coastline length (β = -0.163, ρ = 0.098), and average elevation (β = -0.148, ρ = 0.126). The least impactful variables were the Democracy Index score (β = -0.095, ρ = 0.432), and the Status of Women Index score (β = 0.080, ρ = 0.599).

Swimming

The final group of events to be analysed using the multiple regression model was Swimming (eight events). The Durban Watson test had a result of 2.136 which is between the critical values of 1.5 < d < 2.5 so it can be assumed that there is no first order auto correlation in this data. The R Square value for swimming against all the tested factors was 0.748 and the model had an adjusted R Square value of 0.732 meaning that the predictor variables tested explain 74.8% of the variance in the rankings assuming that every variable explains the dependent.

The ADNOVA had an F value of 47.93 which suggests the fit of the model was very significant, the ρ value of was 0.000 and the P Plot (Figure 7) visually suggests the data is normally distributed. Multicollinearity testing showed no significant issues (Table 7) as tolerance levels were greater than 0.1 and VIF values were less than 10 in each of the predictor variables.

Table 7 Multicollinearity Results for Swimming

	Tolerance	*VIF*
Coastline	0.830	1.205
Temperature	0.453	2.209
GDP	0.461	2.167
Elevation	0.737	1.357
Status of Women Index score	0.322	3.106
Democracy Index score	0.400	2.501
Population	0.461	2.167

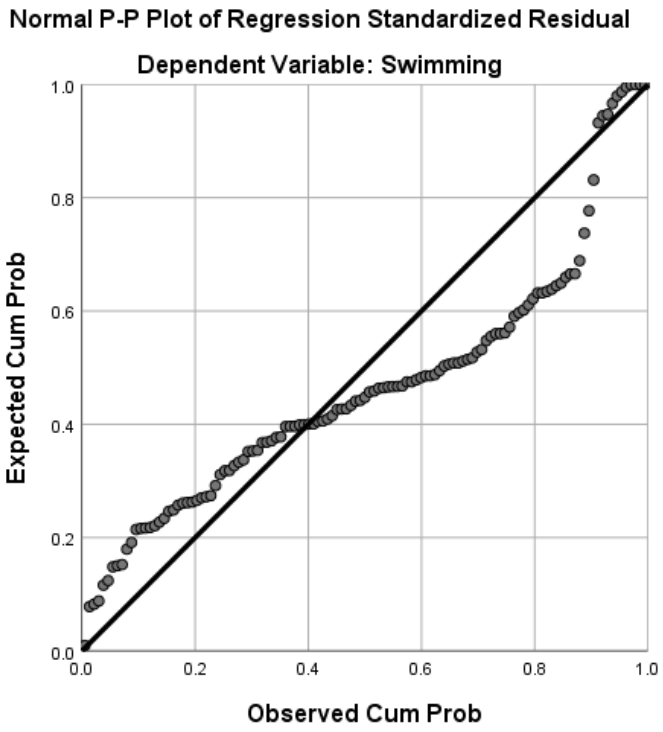

Figure 7 P Plot for Swimming

The standardised coefficient values tell us that as with most other sports groups, the greatest variable impact on swimming stood out as GDP (β = 0.751, ρ = 0.000). The next most impactful variables were average temperature (β = -0.203, ρ = 0.005), average elevation (β = -0.171, ρ = 0.002), and total coastline length (β = 0.138, ρ = 0.009). The least impactful variables

were population (β = 0.070, ρ = 0.314), the Status of Women Index score (β = 0.053, ρ = 0.527), and the Democracy Index score (β = -0.021, ρ = 0.780).

Discussion

Summary of Results

Throughout the statistical analysis, GDP was consistently the most influential variable, with the exception of Shooting where it was the third most influential after average temperature and population. Over all the tests average temperature often had significant influence, followed by total length of coastline. It was expected that population would have a large influence however the mean of the variable impact placings (Table 8) indicates it falls in the middle of the list. The consistent least influential factor was the national score on the Democracy Index score.

Table 8 Variable Influence Ranks and Mean Ranking on Dependent Variables Tested

	Overall Jokl Ranking	*Athletics*	*Cycling*	*Gymnastics*	*Shooting*	*Swimming*	*Mean*
Coastline	4	3	6	2	4	4	3.8
Temperature	2	6	7	3	1	2	3.5
GDP	1	1	1	1	3	1	1.3
Elevation	3	7	4	5	5	3	4.5
Status of Women Index score	5	5	2	6	7	6	5.2
Democracy Index score	7	4	5	4	6	7	5.5
Population	6	2	3	7	2	5	4.2

As each dataset value was typed by hand there is risk of human error, however no mistakes were found when the data was checked.

It is also possible that the reason the Democracy Index score and the Status of Women Index score variables had such a poor influence over the physical geography variables is due to

incomplete data. Some nations that compete in the Olympics are not considered countries in these indexes and consequently do not have data. This was often the case with small nations that are part of another country's territory.

Results Key Notes

Some results data could not be included in this study as the participants who earned those Jokl points were members of the Independent Olympic Athletes Team, or Members of the Team of Refugee Olympic Athletes. This may have potentially impacted the statistical output of the regression model.

The results may also indicate a "false" positive, as whilst the Multicollinearity Test indicated that no variable was correlated with one another, it is possible that there are indirect links between variables such as average temperature and level of development of a country (and by extension, GDP), with many of the least developed nations can be found within warmer climate bands (UNTCAD 2021). This would need to be investigated in order to be ruled out in further in future studies.

Relation of Results to Aims

Geography does appear to have some impact on national sporting success however the model tested has at best explained 74.8% of the results data tested, and it was often lower when individual sports were tested – as low as 20.1% in cycling. As such whilst it is clear from the data that certain variables such as GDP had a significant influence in most of the models tested, this significant influence does not translate to a determining factor. As national sporting success is a complex subject, there are too many micro and macro variables outside of geography with influence.

There are, however, some clear trends both on a general and a more specific scale. Despite the accessible nature and high participation level of athletics, GDP stood out as the most influential variable. The proportion of which was a similar level to that of swimming and the overall Jokl rankings. GDP remained the standout most influential variable in gymnastics, and was although less prominent, was also the most influential variable in cycling.

Shooting and cycling both require expensive equipment on the athlete scale, as well as expensive infrastructure on a national scale, so logic would suggest that these sports would require higher levels of GDP than others. The statistics suggest otherwise, with GDP being only slightly ahead of the other variables in the case of cycling and being only the third most influential variable in the case of shooting. It is possible that this assumption is reflected elsewhere, for example there were far higher numbers of participants in Athletics and Swimming, so the numbers being tested for shooting and cycling likely already filter out athletes from nations who might not have the resources to produce high level success in these sports. Further research could look at these sports in more detail outside of the Olympics as only countries who have achieved quota places are able to send participants.

Limitations of this Study

This study covers geographical variables in national sporting success; however, this subject is much wider than geography. It would not be possible to complete a full-scale detailed study of what causes national sporting success within the constraints of sticking to one academic discipline, let alone the constraints of an undergraduate dissertation. As this study only looks at geographical variables it cannot rule out other cross discipline factors such as biology and sports science, variables which may change the results of the regression model output if they were included.

This study only looked at five sports from the Rio 2016 Olympics, and not all events from each sport were included in the study. It is possible that with the inclusion of other events, other sports and data from other Olympics, the regression model would again produce different results.

As only data from the Rio 2016 Olympics was used, this study does not consider any external mitigating factors that may have influenced a country's national sporting success such as natural disasters, financial crises or impacts of conflict.

Finally, as data was taken from a Summer Olympic games, it is highly likely that the results from the multiple regression model may have been different if a Winter Olympics had also been included, particularly in regard to the influence of average temperature on success.

Recommendations for Further Research

There are several areas to this subject which could be explored with further research. A biological study could investigate further any trends in genetic profiles of successful athletes. It could also investigate the direct impacts of training and competing at high altitude in comparison to low altitude, and the direct impacts of training and competing in high temperatures in comparison to low temperatures. This could be explored both in general sporting terms as well as in the context of specific sports as it may influence some greater than others.

A finance/economics study could investigate more deeply trends in how participating nations use their wealth and to what extent money is actually spent on sport. This could link into studies about athletes who compete in nations which are different from the ones in which they have been born, and the impacts of "buying athletes". An investigation of this type could also include political science expertise and explore the impacts of sports policy and efforts to make sport a cultural practice.

Further research would also be recommended on countries that specialise in specific sports, and the circumstances in which these specialisations occur.

Additional Notes

Further geographical study would likely be multidisciplinary in nature. For example, a closer look at the effects of altitude might include biological impacts such as those on cardiovascular systems, and on stress responses and adrenaline. Altitude also has an impact on wind resistance, so a study on altitude might require expertise from aerodynamicists and sports scientists to assess the impacts of training and competing in these conditions. A study like this might also involve psychological expertise as the impacts of having personal experience in certain conditions could influence sporting success. Similarly, an analysis of the impacts of training and competing in different extreme temperatures would also be multidisciplinary in nature.

Further study might also explore the impacts of conflict on national sporting success at major events such as The Olympics. In this study, of the 190 countries who participated in the Rio 2016 Olympics (Appendix 1), 6 are currently considered to be “at war” (World Population Review 2020). In the Overall Jokl Rankings the success of these countries varied greatly, with Libya having the fewest number of Jokl Points and being ranked in 190th place, and Turkey having the greatest number for Jokl Points and being ranked in 37th place.

Another area for further study is the specific impacts of globalisation, including athletes who can live and train in countries other than the ones they compete for, athletes with dual nationalities, and athletes who have significant ease of access to international competition such as those living in the European Union. The impacts of Brexit on British athletes would be particularly worthy of future investigation as not only has international training and competition been made more difficult, but with the loss of free trade, athletes may be at a disadvantage in sourcing top level sporting equipment.

When conducting a financial investigation there are some key areas that are recommended for further research. The first is the level of funding awarded to Sporting National Governing Bodies across a country as these govern much of how athletes achieve success within their country. More detail could then be looked at the direct involvement of people through investigation of salaries awarded to coaches, coaching development programmes, support staff and volunteers. Competition and training opportunities would also be worth investigation, both on a national and an international scale, as well as funding going into training camps, facility development and maintenance, and competition hosting.

In a more general sporting level, a financial investigation could conduct an inquiry into funding and spending by National Institutes of Sport in nations participating in high level sporting events. Access to specific types of support (such as sports psychology and sports medicine) to athletes would be of particular interest. The investigation should also assess patterns in sports development of a nation including available grant funding opportunities, grassroots support, and talent identification programmes.

Finally, a financial investigation should assess differences in patterns between national GDP and individual athlete wealth, and the impacts these patterns have on national sporting success.

A political investigation would need to start with giving Democracy Index score scores to those smaller nations which compete for themselves but are politically a part of a larger nation, such as Island Nations that are part of colonial territories. The study would then need to assess the value of sport to each nation, the value of specific sports to each nation and the policies in place to support sporting development and performance.

Conclusion

This study anticipated that geography impacts national sporting success but does not go as far as to determine it. The multiple regression model explains 71.9% of the overall Jokl Rankings indicating that this hypothesis can be accepted.

Total coastline length was expected to not determine sporting success, a hypothesis which can be accepted, as total coastline length appeared to corollate with national sporting success but only at a minor degree. It was anticipated that average temperature was unlikely to have a determining impact on national sporting success but that it may have some influence. This can also be accepted as average temperature was the second most influential variable, however it remained some distance behind GDP which was anticipated to have the highest likelihood of determining national sporting success. Whilst GDP did have the greatest influence overall, it did not have the greatest influence in every sport and the statistical output did not rank it at a height to which it could be considered a determining factor. Average elevation was considered to have a possible impact but to have an unlikely determining factor, being the fifth most influential variable of seven, it did not have a significant impact on sporting success. It was expected that the Status of Women Index score would influence national sporting success and have the potential to determine it, however it was the second least influential variable tested. Similarly, the number of Democracy Index score Points awarded to a nation was expected to influence national sporting success, but it was the least influential variable tested. Population was anticipated to have both a high probability of

determining national sporting success as well as having a high influence. This hypothesis can be rejected as whilst population appeared to be influential in athletics and indeed standing out on its influence in shooting, it was the fourth most influential variable of seven overall so it is likely that with shooting success can be better explained by other factors.

In reference to the research questions set out for this study (see page 10), it can be seen from Table 8 that some physical geography variables such as total coastline length and average temperature appear to rank highly in their level of influence on sporting success. The table also suggests that those particular variables rank higher than most of their human geography counterparts, however they are not the most influential and the success of nations who fit the model for these factors can likely be better explained by factors such as GDP.

It's difficult to accurately compare national wealth to factors such as national prioritisation nevertheless Table 9 gives a summary of the level of influence of GDP in comparison to the Democracy Index score Points. It is clear from this table and from all the other results that GDP is significantly more influential than democracy to national sporting success.

Table 9 β values for GDP and Democracy Index score Points

	Overall Jokl Rank	*Athletics*	*Cycling*	*Gymnastics*	*Shooting*	*Swimming*
GDP	0.729	0.739	0.345	0.648	0.238	0.751
Democracy Index score	0.030	0.066	0.073	-0.115	-0.095	0.021

One of the limitations of this study is the sheer volume of potential factors which could influence national sporting success, which meant that closer investigations valuable variable such as globalisation were not possible. Consequently, this factor remains a recommendation for further research.

This study found that population size does not determine elite national sporting success. There was also little consistency between the nature of any influence it might have between the overall Jokl Rankings and between the statistical outputs for the individual sports.

The results of this study are consistent with existing research on this subject. GDP was clearly the most influential variable to national sporting success out of the seven variables tested, and this matches results from similar studies. Whilst other studies occasionally found physical geographical factors correlated with sporting success, it was considered that the success of many of these nations could be better explained by other variables (Vagenas and Palaiothodorou 2019). This is also consistent with this study where average temperature and total coastline length appeared to have correlations, but minimal in comparison to the influence of GDP.

Population was expected to be of significant influence to national sporting success and this is backed up by older studies, however more recent studies have suggested that as national sport programmes have become more strategic in approach, population has become less relevant (Veerle De Bosscher et al. 2006). In this study population was not found to stand out in its level of influence on sporting success, indeed its influence was only fourth of the seven variables tested.

Whilst the political state of a country was a common theme in existing literature, there was minimal consensus on the overall impact on sporting success. This is consistent with the results of this study where when political system was measured by the Democracy Index score, the multiple regression model indicated that this was the least influential variable out of those tested (Table 8).

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APPENDICES

Appendix 1 – Cumulative Data

	Country Code	Country	Overall Jokl Rank	Athletics	Cycling	Gymnastics	Shooting	Swimming	Coastline (Km) (2018)	Temperature	GDP (U	Elevation (I	Status of Women	Democracy Index	Population
1	USA	United States	3592.914482	1444.867	255.14	573.982456	330.1224	988.80639	19,924.00	7	21428	611.533	0.851	7.96	331,002,651
2	GBR	Great Britain	2202.09935	729.7491	413.69	503.347462	119.6592	435.657	12,429.00	8.5	2827	526.594	0.883	8.52	67,886,011
3	CHN	China	1906.082251	222.4478	11.541	479.907124	687.0458	505.14005	14,500.00	6.39	14343	6,005.63	0.725	2.26	1,439,323,776
4	ITA	Italy	1828.250156	288.5251	413.02	205.081272	484.0631	437.55784	7,600.00	11.86	2001	1,754.73	0.826	7.52	60,461,826
5	CAN	Canada	1506.767106	549.6181	190.79	318.789369	3.874105	443.69172	202,080.00	-6.89	1736	1,519.09	0.876	9.22	37,742,154
6	RUS	Russia	1477.993328		110.72	457.239278	564.318	345.71852	37,653.00	-6.24	1700	1,223.61	0.77	3.11	145,934,462
7	JPN	Japan	1361.390311	352.1404	82.662	493.461022	111.7794	321.34787	29,751.00	10.46	5082	1,271.44	0.823	7.99	126,476,461
8	GER	Germany	1344.126486	254.2964	161.07	175.9652	426.6047	326.18582	2,389.00	8.61	3846	862.812	0.856	8.68	83,783,942
9	FRA	France	1234.037335	137.7811	362.26	103.77236	199.1256	431.09931	3,427.00	10.72	2716	2,008.61	0.847	8.12	65,273,511
10	UKR	Ukraine	1136.135499	525.3093	87.894	134.143981	308.4953	80.29328	2,782.00	8.27	154	585.045	0.689	5.9	43,733,762
11	NED	Netherlands	1112.912373	232.5419	294.28	121.041378		465.04559	451	9.58	909	31.656	0.879	9.01	17,134,872
12	BRA	Brazil	1091.320553	199.1	100.89	308.145154	137.9555	345.22982	7,491.00	24.96	1840	1,056.09	0.7	6.86	212,559,417
13	AUS	Australia	1019.242945	321.0077	177.23	12.0735203		261.18291	25,957.00	21.48	1393	909.201	0.844	9.09	25,499,884
14	POL	Poland	760.361033	312.3701	249.59	13.1181003	40.68466	144.59787	440	7.97	592	562.192	0.838	6.62	37,846,611
15	BEL	Belgium	706.7595564	160.9635	288.27	76.9314716	34.14614	146.4475	66.5	9.79	530	510.887	0.827	7.64	11,589,623
16	JAM	Jamaica	683.8097196	673.0331		10.7765798			1,022.00	24.91	15.72	1,060.49	0.787	6.96	2,961,167
17	ESP	Spain	652.531625	174.3039	225.23	54.9206885	138.2834	59.791125	4,964.00	13.02	1394	2,247.64	0.86	8.29	46,754,778
18	RSA	South Africa	649.2116813	338.2027	139.81	17.5441705		153.65432	2,798.00	17.54	351	3,393.64	0.741	7.24	59,308,690
19	ETH	Ethiopia	647.6012215	644.031				3.5701737	0	22.61	96.11	4,121.72	0.651	3.44	114,963,588
20	SUI	Switzerland	647.2604338	145.2552	113.17	235.071785	118.5982	35.162721	0	5.87	703	4,290.85	0.893	9.03	8,654,622
21	SRB	Serbia	628.9134159	13.58436	236.48		322.5349	56.318121	0	10.35	51.41	1,344.77	0.839	6.41	8,737,371
22	KEN	Kenya	579.1023449	579.1023					536	24.29	95.5	2,586.30	0.7	5.18	53,771,296
23	BLR	Belarus	567.6155377	123.6104	66.744	182.797229	59.60645	134.85755	0	6.46	63.08	525.382	0.804	2.48	9,449,323
24	HUN	Hungary	557.5812579	58.17721	16.018	15.9955231	203.0318	264.35915	0	10.08	161	482.024	0.772	6.63	9,660,351
25	DEN	Denmark	540.4197178	70.67779	141.16		36.45037	292.13158	7,314.00	7.92	348	101.537	0.891	9.22	5,792,202
26	CZE	Czech Republic	493.8703101	101.745	184.69	0.65871116	184.3253	22.450297	0	7.88	246	1,480.72	0.82	7.69	10,708,981
27	KOR	South Korea	453.998386	71.78538	19.201	53.8204607	250.3536	58.83825	2,413.00	10.66	1642	843.72	0.816	8	51,269,185
28	PRK	North Korea	451.5052912	157.6057		142.416309	151.4833		2,495.00	5.4	28.5	1,925.40		1.08	25,778,816
29	BRN	Bahrain	441.2591213	428.786				12.47313	161	27.04	38.57	43.612	0.719	2.55	1,701,575
30	IND	India	429.6266878	118.9403		54.9431054	255.7433		7,000.00	24.14	2875	1,883.55	0.625	6.9	1,380,004,385
31	CRO	Croatia	403.7111678	84.12209	30.759	10.3359325	345.6491	16.966711	5,835.00	10.55	60.42	1,012.91	0.818	6.57	4,105,267
32	BAH	Bahamas	392.4166925	290.9933				101.42344	3,542.00	24.73	12.83	19.571			393,244
33	NOR	Norway	375.1513509	102.1308	57.194	13.7440391	159.1467	42.935385	83,281.00	1.02	403	1,729.64	0.904	9.87	5,421,241
34	GRE	Greece	349.5221227	42.3303	15.065		70.96836	221.15839	13,676.00	13.92	210	1,575.33	0.77	7.43	10,423,054
35	TTO	Trinidad and Tobago	344.6258393	292.1183		3.59051703		48.916978	362	26.05	24.1	292.084	0.788	7.16	1,399,488
36	SWE	Sweden	342.0703302	72.89542	100.46	15.1824882		153.53453	3,218.00	1.78	531	1,032.03	0.879	9.39	10,099,265
37	TUR	Turkey	288.3655897	208.277		8.42221772	67.81098	3.8553682	7,200.00	11.17	754	3,740.44	0.661	4.09	84,339,067
38	COL	Colombia	288.2657571	99.63499	144.52	14.3360378	5.739175	24.035258	3,208.00	24.37	324	1,837.03	0.691	7.13	50,882,891
39	NZL	New Zealand	276.4539743	28.30075	100.91	56.9735101	27.83024	62.437853	15,134.00	9.7	207	1,608.18	0.869	9.26	4,822,233
40	EGY	Egypt	252.8397074			3.91703517	146.5316	102.39107	2,450.00	22.46	303	991.072	0.583	3.06	102,334,404
41	AUT	Austria	251.9972966	14.95734	13.807	12.1523112	169.4832	41.597856	0	6.26	446	3,116.57	0.884	8.29	9,006,398
42	MEX	Mexico	246.0949616	74.88919	23.102	39.9903406	82.53719	25.576193	9,330.00	20.57	1200	3,443.64	0.693	6.09	128,932,753
43	LTU	Lithuania	244.8525104	135.7591	26.832	12.4810113		69.780654	90	6.46	54.22	335.194	0.835	7.5	2,722,289
44	ROU	Romania	239.6876561	47.66675		109.498102	24.7336	57.78921	225	9.06	250	1,298.34	0.767	6.49	19,237,691
45	CUB	Cuba	233.247944	60.48926	49.523	58.6075927	64.62763		3,735.00	25.27	100	327.597		2.84	11,326,616
46	ERI	Eritrea	232.6780426	222.7799	9.8982				2,234.00	26.31	6.5	2,508.75		2.37	3,546,421
47	SVK	Slovakia	231.9736952	12.19335	108.81	7.46999718	99.04386	4.4574135	0	7.72	105	1,486.51	0.813	7.17	5,459,642
48	POR	Portugal	228.9514588	95.07928	67.072	28.1627291	37.36955	1.2682066	1,793.00	14.73	238	1,058.34	0.856	8.03	10,196,709
49	IRL	Ireland	221.2766444	119.4287	57.889	19.0879989		24.870524	1,448.00	9.27	389	356.599	0.858	9.24	4,937,786
50	UGA	Uganda	204.5859629	198.1986				6.387361	0	22.43	34.39	3,790.16	0.678	5.02	45,741,007
51	IRI	Iran	200.6713443	1.655928			199.0154		2,440.00	16.92	445	4,106.32	0.657	2.38	83,992,949
52	ECU	Ecuador	192.7463823	149.4329				43.313489	2,237.00	21.51	107	3,453.45	0.772	6.33	17,643,054
53	FIN	Finland	188.8977386	28.7193	1.8842	31.1510673	85.88623	41.256911	1,250.00	1.61	269	503.694	0.891	9.25	5,540,720
54	CIV	Ivory Coast	188.1650644	185.9933				2.1717372	515	26.42	58.79	855.986	0.617	4.05	26,378,274
55	KAZ	Kazakhstan	187.3519479	49.35834	72.043	10.3759375	55.57444		0	5.78	180	1,163.96	0.786	2.94	18,776,707
56	SLO	Slovenia	177.7426343	44.76643	45.049		45.34578	42.581798	46.6	8.72	53.74	1,846.58	0.872	7.5	2,078,938
57	BUL	Bulgaria	172.2462607	119.1142			20.26554	32.86648	354	10.7	67.93	1,555.19	0.801	7.03	6,948,445
58	PER	Peru	169.7618637	151.1916		9.47950567	6.460556	2.6301544	2,414.00	19.55	227	4,847.49	0.735	6.6	32,971,854
59	ISR	Israel	164.8913106	37.24597	14.414	5.05588003	32.53983	75.635825	273	19.48	395	932.099	0.815	7.86	8,655,535
60	MGL	Mongolia	154.4452134	37.13925			101.2811	16.024906	0	-0.59	13.85	4,872.12	0.776	6.5	3,278,290
61	UZB	Uzbekistan	150.8892965	91.45251		44.6153364	14.82145		0	12.21	57.92	1,156.88	0.71	2.01	33,469,203
62	GRN	Grenada	146.4421141	146.4421					121	26.5	1.23	633.216			112,523
63	NGR	Nigeria	141.778036	133.5597				8.2183766	853	26.95	448	1,078.99	0.604	4.12	206,139,589
64	VIE	Vietnam	131.455423	6.562199			4	114.902	5.9912056	3,444.00	24.22	262	1,282.84	0.707	3.08	97,338,579
65	BOT	Botswana	126.3456716	112.3376					14.008086	0	21.56	18.34	3,392.52	0.667	7.81	2,351,627
66	CHI	Chile	122.6032592	43.26521		71.0373038			8.30075	6,435.00	8.28	282	4,350.94	0.764	8.08	19,116,201
67	TAN	Tanzania	120.2615684	97.76791					22.493654	1,424.00	22.18	63.18	3,350.54	0.704	5.16	59,734,218
68	HKG	Hong Kong, China	119.0312632	25.08589	39.482				54.463354	733	24.04	366	104.99	0.731	6.02	7,496,981
69	QAT	Qatar	118.8081746	118.8082						563	27.09	183	88.424	0.73	3.19	2,881,053
70	PUR	Puerto Rico	109.9975596	62.70784			16.32725	30.962477		501	24.84	105	2,194.50			2,860,853
71	LUX	Luxembourg	104.8427783		56.108			48.734441		0	9.14	71.1	1,140.98	0.88	8.81	625,978
72	ZAM	Zambia	102.690773	95.55264				7.1381283		0	21.79	23.06	3,679.00	0.679	5.09	18,383,955
73	VEN	Venezuela	102.2354066	22.0626	2.3784	5.272221	5.211891	67.310301	2,800.00	25.32	482	1,142.28	0.717	2.88	28,435,940
74	AZE	Azerbaijan	97.81496198	32.56889	11.279	21.6929996	29.26864	3.0054873	0	11.81	48.05	2,133.49	0.65	2.75	10,139,177
75	CYP	Cyprus	96.08899813	89.04478	0	5.46254593		1.5816728	648	18.84	24.56	998.297	0.819	7.59	1,207,359
76	ARG	Argentina	90.09809527	34.41294	28.437	1.72431922	6.687962	53.248727	4,989.00	14.31	450	2,315.63	0.775	7.02	45,195,774
77	EST	Estonia	89.94092806	42.57679	47.364				3,794.00	5.24	31.39	189.164	0.873	7.9	1,326,535
78	TPE	Chinese Taipei[6]	89.75836698	11.08516	1.9775		64.06954	12.626118	1,566.30	23.31		3,773.00		7.73	23,816,775
79	TUN	Tunisia	88.28578566	16.48254			41.93672	29.866528	1,148.00	19.42	38.8	834.168	0.651	6.72	11,818,619
80	IOA	Independent Olympic Athletes	86.7831099	10.82481			65.05109	10.907215							
81	LAT	Latvia	85.80199613	75.19935	10.603				498	5.8	34.12	294.448	0.845	7.49	1,886,198
82	NAM	Namibia	83.03371575	67.49187	2.224		13.31786		1,572.00	20.2	12.37	3,588.56	0.748	6.43	2,540,905
83	LCA	Saint Lucia	80.8398343	66.52431				14.315523	158	25.56	2.12	551.887			183,627
84	FIJ	Fiji	79.55978606	54.61715			10.32497	14.617663	1,129.00	24.13	5.54	703.297	0.757	5.85	896,445
85	ALG	Algeria	72.82788648	26.02048		1.89685808	1.581673	43.328877	998	22.71	170	1,830.91	0.611	4.01	43,851,044
86	DOM	Dominican Republic	70.47669039	42.55984			14.32216	13.594697	1,288.00	23.73	88.94	1,313.94	0.726	6.54	10,847,910
87	KGZ	Kyrgyzstan	66.36781357	66.36781					0	2.13	8.45	8,658.25	0.721	4.89	6,524,195
88	GEO	Georgia	64.82913542	13.45658		29.8161269	18.86317	2.6932489	310	6.48	17.74	4,050.18	0.777	5.42	3,989,167
89	SIN	Singapore	63.84272304	5.317555			26.52181	32.003353	193	27.19	372	60.958	0.843	6.02	5,850,342
90	MAR	Morocco	61.24816337	42.20092	7.7674		2.725868	8.5540192	1,835.00	17.49	119	2,195.08	0.625	5.1	36,910,560

91	URU	Uruguay	58.96216878	51.06692				7.8952516	660	17.5	56.05	339.512	0.757	8.38	3,473,730
92	SYR	Syria	58.34542209	45.26808				13.077339	193	17.78	40.41	1,700.66	0.416	1.43	17,500,658
93	ARM	Armenia	54.17692046			22.0783244	18.76188	13.336713	0	7.26	13.67	6,081.36	0.72	5.54	2,963,243
94	MAS	Malaysia	53.74701592	25.50564			12.9664	15.274982	4,675.00	25.36	365	916.202	0.729	7.16	32,365,999
95	ANT	Antigua and Barbuda	52.6569489	43.34575				9.3112004	153	25.32	1.73	111.889			97,929
96	SKN	Saint Kitts and Nevis	52.44220056	52.4422					135	24.38	1.05	632.587			53,199
97	LIB	Lebanon	48.62821843	4.069265			31.69893	12.860028	225	15.8	53.37	3,273.73	0.599	4.36	6,825,445
98	OMA	Oman	47.45962775	32.94972			14.50991		2,092.00	25.44	76.98	902.909		3.06	5,106,626
99	SUR	Suriname	46.66999125	15.1994				31.470596	386	25.76	3.99	518.207	0.744	6.98	586,632
100	BDI	Burundi	44.56294947	36.73951				7.823444	0	20.02	3.01	4,963.51	0.616	2.15	11,890,784
101	MLT	Malta	44.55572909	11.34058			18.31693	14.898223	253	18.78	14.79	272.692	0.807	7.95	441,543
102	THA	Thailand	44.4876219	9.264475			25.74445	9.4787016	3,219.00	26.33	544	930.537	0.707	6.32	69,799,978
103	GHA	Ghana	42.95812022	33.15951				9.79861	539	27.26	66.98	592.103	0.724	6.63	31,072,940
104	CRC	Costa Rica	42.81987833	30.77622	12.044				1,290.00	24.52	61.77	1,846.02	0.779	8.13	5,094,118
105	GUY	Guyana	41.31949294	34.20692				7.1125704	459	25.73	4.28	705.495	0.741	6.15	786,552
106	TLS	East Timor	41.29824521		41.298				706	25.31	1.67	1,541.92			1,318,445
107	MDA	Moldova	38.42687303	38.42687					0	9.68	11.96	470.058	0.743	5.75	4,033,963
108	BAN	Bangladesh	38.20101662	4.838525			17.71838	15.64411	580	25.07	303	92.111	0.612	5.88	164,689,383
109	BOL	Bolivia	34.6850987	2.620982			3.754897	28.309219	0	20.93	40.9	4,178.20	0.765	4.84	11,673,021
110	SRI	Sri Lanka	33.32351382	29.26434			0	4.0591764	1,340.00	26.68	84.01	579.029	0.679	6.27	21,413,249
111	IVB	British Virgin Islands	31.93158346	18.39372				13.537865	80	27.62	1.027	263.584			30,231
112	KSA	Saudi Arabia	31.0629842	21.58428			9.478702		2,640.00	24.7	793	2,095.29	0.655	1.93	34,813,871
113	LES	Lesotho	30.44931393	30.44931					0	12.79	2.46	7,269.26	0.641	6.54	2,142,249
114	BAR	Barbados	27.73231123	22.60242				5.1298931	97	25.99	5.21	349.838	0.715		287,375
115	GUA	Guatemala	27.55748077	18.37259		6.3445127		2.8403801	400	23.3	85.3	2,436.83	0.68	5.26	17,915,568
116	SMR	San Marino	27.18231651	0			27.18232		0	14.66	1.655	963.52			33,931
117	LBR	Liberia	25.12711038	25.12711					579	25.46	3.22	708.965	0.608	5.45	5,057,681
118	ZIM	Zimbabwe	24.15488801	19.09457				5.0603198	0	21.33	21.44	3,203.39	0.726	3.16	14,862,924
119	PAK	Pakistan	24.14815862	2.131419			15.25045	6.7662889	1,046.00	20.01	278	3,297.52	0.46	4.25	220,892,340
120	LBA	Libya	22.73031636	12.09794				10.632375	1,770.00	22.12	52.08	1,362.17	0.546	2.02	6,871,292
121	VIN	Saint Vincent and the Grenadines	22.55746621	15.08946				7.4680044	84	26.66	0.83	964.586			110,940
122	RWA	Rwanda	22.30594179	15.41706	1.8661			5.0227564	0	19.08	10.12	5,558.10	0.743	3.16	12,952,218
123	PLE	Palestine	21.48490975	14.0206				7.4643053	40	19.53	15	1,050.30		3.89	5,101,414
124	ESA	El Salvador	20.98608702				0	20.986087	307	23.77	27.02	1,443.04	0.725	6.15	6,486,205
125	HAI	Haiti	19.7852142	10.08557				9.6996399	1,771.00	24.4	8.5	1,341.40	0.613	4.57	11,402,528
126	PNG	Papua New Guinea	19.74429092	19.74429					5,152.00	25	24.97	2,002.63	0.658	6.03	8,947,024
127	GAB	Gabon	19.09133359	16.27403				2.8173074	885	25.03	16.66	1,241.64	0.647	3.61	2,225,734
128	ALB	Albania	18.17239683					18.172397	362	11.57	15.28	2,259.20	0.759	5.89	2,877,797
129	MHL	Marshall Islands	18.07740123	2.406158				15.671243	370.4	27.58	0.221	26.962			59,190
130	MRI	Mauritius	16.64952877	6.408185				10.241343	177	23.07	14.18	685.108	0.752	8.22	1,271,768
131	CAY	Cayman Islands	15.45370377	14.4102				1.0435009	160	27.62	5.517	30.657			65,722
132	SLE	Sierra Leone	15.28541093	11.85971				3.425698	402	26.09	3.94	658.544	0.578	4.86	7,976,983
133	PAR	Paraguay	15.06609293	3.560148				11.505945	0	23.53	38.15	539.8	0.738	6.24	7,132,538
134	ARU	Aruba	14.97931365					14.979314	68.5	29.54	3.06	308.00			106,766
135	UAE	United Arab Emirates	14.50326916	11.80908				2.6941906	1,318.00	26.82	421	376.285	0.781	2.76	9,890,402
136	FSM	Federated States of Micronesia	14.40731399	3.887017				10.520297	6,112.00	27.05	0.4	349.987			548,914
137	MYA	Myanmar	13.78608811				8.674979	5.1111092	1,930.00	22.94	76.09	1,912.46	0.587	3.55	54,409,800
138	MNE	Montenegro	13.43721752					13.437218	293.5	14.90	5.49	3,380.02	0.791	5.65	628,066
139	PLW	Palau	12.87832825	6.453034				6.4252944	1,519.00	27.57	0.28	182.597			18,094
140	SEN	Senegal	12.86282025					12.86282	531	28.08	23.58	175.173	0.661	5.81	16,743,927
141	MDV	Maldives	12.45016523	8.399175				4.0509905	644	27.63	5.73	21.229	0.671		540,544
142	KOS	Kosovo	12.37755475	1.841031			1.541895	8.9946288	0	11.1	7.93	2,656.81			1,810,000
143	BIH	Bosnia and Herzegovina	12.37164058	2.796507			9.575134		20	9.66	20.05	2,254.02	0.76	4.86	3,280,819
144	PHI	Philippines	12.23917033	1.432772				10.806398	36,289.00	25.48	377	1,070.97	0.709	6.64	109,581,078
145	JOR	Jordan	12.18383169	0				12.183832	26	18.65	43.74	2,519.60	0.629	3.93	10,203,134
146	BER	Bermuda	11.75013446					11.750134	103	23.22	7.484	72.743			62,278
147	MAW	Malawi	11.57483303	6.244578				5.3302554	0	21.99	7.67	2,808.33	0.626	5.5	19,129,952
148	TJK	Tajikistan	11.27584616					11.275846	0	3.3	8.12	9,691.61	0.701	1.93	9,537,645
149	BUR	Burkina Faso	11.11476767					11.114768	0	28.22	15.75	984.921	0.622	4.04	20,903,273
150	ROT	Team of Refugee Olympic Athletes	10.79491066	8.94101				1.8539005							
151	TGA	Tonga	10.6357723	2.814104				7.8216682	419	24.52	0.45	212.165			105,695
152	COK	Cook Islands	10.63283351	5.642676				4.9901575	120	24.8	0.355	184.559			17,564
153	LAO	Laos	10.45233419	2.483838				7.9684963	0	23.48	18.17	2,191.07	0.724	2.14	7,275,560
154	SEY	Seychelles	10.38978344	0.996753				9.39303	491	27.05	1.7	299.343			98,347
155	MKD	North Macedonia	10.29859965	5.360537			4.938063		0	9.98	12.55	2,717.19	0.806	5.97	2,083,374
156	CGO	Republic of the Congo	10.26574352	7.605676				2.660068	169	24.62	10.82	1,700	0.593	3.11	5,518,087
157	TOG	Togo	9.79634758	6.022075				3.7742728	56	27.04	5.46	850.503	0.665	3.3	8,278,724
158	MLI	Mali	8.723978803	7.146756				1.5772226	0	28.28	17.51	1,050.38	0.539	4.92	20,250,833
159	GUI	Guinea	8.337472765	6.147731				2.1897417	320	25.83	11.4	1,454.27	0.625	3.14	13,132,795
160	NIG	Niger	7.561020493	1.884251				5.6767691	0	27.38	12.93	1,511.38	0.554	3.29	24,206,644
161	ISL	Iceland	7.088599648			7.08859965			4,970.00	1.8	24.19	1640	0.888	9.58	341,243
162	CAM	Cambodia	7.080250634	0.145063				6.9351877	443	27	27.09	412.981	0.694	3.53	16,718,965
163	COM	Comoros	6.867043772	3.83441				3.0326336	340	25.59	1.19	1,650.15	0.632	3.15	869,601
164	PAN	Panama	6.717365499	0.735942		5.98142305	0		2,490.00	25.27	66.8	1,026.84	0.731	7.05	4,314,767
165	MOZ	Mozambique	6.643101574					6.6431016	2,470.00	23.76	14.93	1,170.71	0.675	3.65	31,255,435
166	CPV	Cape Verde	6.407850373	6.40785					965	23	1.98	1,124.59		7.78	555,987
167	NCA	Nicaragua	6.033437523				4.311706	1.7217318	910	24.76	12.52	736.723	0.712	3.55	6,624,554
168	ANG	Angola	6.011216788	2.360785			0	3.6504318	1,600.00	21.62	94.64	3,509.35	0.626	3.72	32,866,272
169	INA	Indonesia	5.718906271	5.718906					54,716.00	25.83	1119	1,121.56	0.703	6.48	273,523,615
170	BEN	Benin	5.207313319					5.2073133	121	27.51	14.39	878.371	0.659	5.09	12,123,200
171	BRU	Brunei	4.660297695	4.660298					161	25.31	13.47	325.181			437,479
172	SWZ	Eswatini	4.540715278	4.540715					0	19.73	4.41	2,074.48	0.613	3.14	1,160,164
173	COD	Democratic Republic of the Congo	4.335696224	4.335696					37	24.08	50.4	1,700.00	0.512	1.13	89,561,403
174	GUM	Guam	4.18484604	4.184846					125.5	27.93	5.92	500			168,775
175	GBS	Guinea-Bissau	3.980964242	3.980964					350	26.96	1.34	125.41		2.63	1,968,001
176	BHU	Bhutan	3.18333402				3.183334		0	11.9	2.45	9,015.38	0.657	5.3	771,608
177	ASA	American Samoa	2.651561155	2.651561			247.7498		116	26.83	0.85	1,265.65			55,191
178	SUD	Sudan	2.123995905					2.1239959	853	26.98	18.9	1,744.84	0.547	2.7	43,849,260
179	MTN	Mauritania	2.056777955	2.056778					754	27.75	7.59	859.799	0.583	3.92	4,649,658
180	AFG	Afghanistan	2.046133936	2.046134					0	12.92	19.1	5,905.75	0.373	2.85	38,928,346
181	MON	Monaco	2.034560907			2.03456091			4.1	9.57	7.19	152.477			39,242
182	GAM	The Gambia	1.6477414					1.6477414	80	27.43	1.826	72.674		4.33	2,416,668
183	MAD	Madagascar	1.161032282					1.1610323	4,828.00	22.48	14.08	1,783.01	0.622	5.64	27,691,018
184	KIR	Kiribati	1.152447805	1.152448					1,143.00	27.51	0.19	23.695			119,449
185	CHA	Chad	1.043500881	1.043501					0	26.87	11.31	1,701.23	0.553	1.61	16,425,864
186	CAF	Central African Republic	1.041074503					1.0410745	0	25.07	2.22	1,967.08	0.513	1.32	4,829,767
187	TUV	Tuvalu	0.56892915	0.568929					24	28.1	47.27	36.977			38,717
188	AND	Andorra	0.516426087				0	0.5164261	0	11.03	3.15	6,717.81			77,265
189	NEP	Nepal	0.419234246					0.4192342	0	12.09	30.64	6,901.26	0.717	5.28	29,136,808
190	SOM	Somalia	0	0					3,025.00	26.91	7.7	1,377.25	0.564		15,893,222