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Claremont McKenna College

**Positional Advantage: Factors Behind the Uneven Geographic
Distribution of Top Chess Players**

Submitted to
Professor Peter Uvin

By
Julia Schulman

For
Senior Thesis
Fall 2023
December 4th, 2023

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Abstract

This paper seeks to explore the reason behind the uneven geographic distribution of top chess grandmasters. FIDE rating data, country data, and survey data given to chess grandmasters are gathered to determine the validity of the hypothesis: That the two main influences in whether a country has a higher or lower number (and percentage) of top grandmasters are chess culture and federation/government support. The research tests the correlation between several variables and explores whether or not there is quantitative and qualitative support for this assumption. Individual studies in the latter end of this paper explore the countries on a case-by-case basis to explore the factors that aren't immediately visible when observing the data alone.

Section 1: Introduction

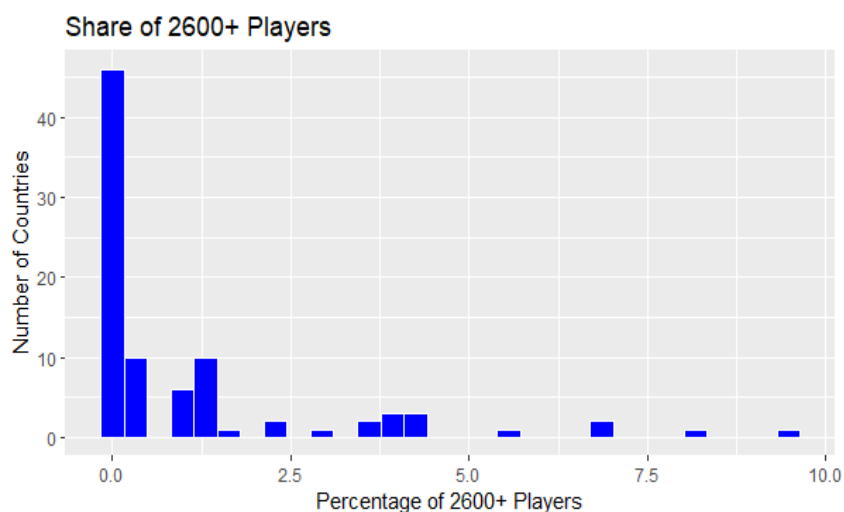
Bobby Fischer was all alone.

In the mid-20th century, chess was not a popular sport in the United States, and the young American received little support from his federation. By winning the 1972 World Chess Championship, Fischer had completed the ultimate underdog fantasy: A lone man stands against a powerful chess nation.ⁱ There are outliers, like Fischer, but much more common are the stories that aren't told.

Becoming a top chess player is a herculean task, one that is difficult to accomplish alone. According to the October 2023 FIDE (international rating system) rating lists there are 1813 grandmasters.ⁱⁱ 232 of these players are rated 2600+, approximately 13%. There are 89 federations¹ with grandmasters. If the number of 2600+ players were evenly distributed, each of these 89 countries would have approximately three 2600+ players or around 1.1%.

While natural variance is expected, when observing the data, it becomes clear that certain countries have a larger share of 2600+ players than others.

Figure 1: Each federation with a grandmaster's percentage of 2600+ FIDE-rated players



¹ See methodology for more details on what is counted as a federation.

Section 2: Hypothesis

Going into this project, my belief was that the most influential factors in how many strong grandmasters a country has would be a combination of widespread chess culture and federation support. I aimed to see whether the data would strongly confirm these assumptions, strongly contradict them, or fall somewhere in the middle.

Section 3: Defining Chess Strength

Isolating a variable that can represent chess strength in a country is a surprisingly difficult task. Several papers have devised ways to do this. A student at Singapore Management University, Leung Weiwen, chose to use the “average ratings of the top ten active players, number of grandmasters, number of international masters, and total number of titled players.”ⁱⁱⁱ While this seems like an interesting way to display strength as a whole, I decided on a more top-down approach: looking at the global distribution of the strongest chess players in the world.

Countries with many strong grandmasters are able to distinguish themselves in team tournaments such as the Chess Olympiad, can create mentorship programs between players, and have an increased chance that one of those players makes it into the uppermost echelon of chess. All of these help a country become a power player in the chess sphere. But what is a “strong grandmaster?”

The term “strong grandmaster” or “top player” in this paper is used to convey that a player is within a top percentage of all grandmasters, and does not speak to general skill level or potential.

When choosing which variable would be used to represent these players, I considered several options. I wanted a metric that could distinguish between different ratings. Using the

number of grandmasters for this doesn't fully recognize countries that have been fostering talent at a high level. The metric should be able to differentiate between a country with four 2400 FIDE-rated grandmasters and four 2650 grandmasters.

Table 1: Countries with the highest number of grandmasters

Country Name	#gm
Russian Federation	186
United States	106
Germany	97
Ukraine	87
India	81
Spain	60
France	55
Serbia	53
Hungary	51
Poland	51

I chose not to use average rating as a metric because it heavily favors countries with smaller numbers of grandmasters, specifically countries that are newer on the chess scene and don't have as many older grandmasters who are still active. Countries with older grandmasters tend to be ones with a long history of chess culture, and it seemed odd to choose a metric that would penalize this.

Another possible definition of "strong grandmaster" or "top grandmaster/player" could be to use the number of "super grandmasters." A super grandmaster is a grandmaster over 2700 FIDE.^{iv} This specific subset of grandmasters often receives special opportunities and invitations. That being said, it's a very small pool. According to the November 2023 FIDE list, only the top 37 players in the world are super grandmasters. Defining the dependent variable that way yields too small a population of cases to base research on.

The best metric to use would be one with a large enough sample size to have enough data to pull from, but also a rating that is difficult to reach without outside factors being at play.

Hence, I decided to employ the number of grandmasters above 2600 FIDE as my cutoff point to define “top/strong grandmaster.” The thought process behind choosing 2600+ is that while it takes a lot of support to become a grandmaster, to reach over 2600 arguably takes something more than just an individual alone. Becoming a 2600+ FIDE-rated player means playing strong tournaments against other high-rated players. These tournaments are often held in a diverse set of locations, such as Uzbekistan, Kazakhstan, and the Isle of Man, among others.^v This is extremely pricey for an individual, and these tournaments can be a month long. As a result, accomplishing this rating without any outside guidance or support would be extremely difficult for most players. While some tournaments (especially invitationals) cover some or all of the costs for stronger players, this is not a guarantee. Chess is not very lucrative for most. Therefore, it may be more likely for a player to be able to become 2600+ if there are other factors, besides pure talent at play.

I also chose a second metric for my dependent variable, namely the number of 2600+ FIDE-rated players as a proportion of the total number of grandmasters in a country. This metric allows for smaller countries to compete against larger ones.

The two main metrics used to measure chess strength for the purpose of this paper are:

1. The number of 2600+ FIDE-rated grandmasters
2. The percentage of 2600+ FIDE-rated grandmasters per grandmaster.

Section 4: Methodology

The rating data was pulled from the October 2023 FIDE rating list. It is important to note that most countries have a national rating system as well, which would be useful in determining the total number of rated players. Some countries, such as the United States, have a large number of players who have national ratings but not FIDE ratings.^{vi} However, gathering national rating data for each country would be difficult, and impossible in some cases. The minimum rating to be included in such lists differs per country. Instead, I chose to use FIDE rating, as its uniform and FIDE ratings are the only ones eligible for international titles, such as grandmaster.

I used Pearson correlation for all the data except for population-based data in which I used Kendall. This is because population has large outliers which Kendall is better suited to handle.

I gathered the data on population, internet, national income, and electricity from the World Bank. I used the most recent year for which the data is available (all of which are no more than five years old.)^{vii} The only countries included in the data are the 89 ones with grandmasters, as those are the countries that this paper concerns. One of these is FIDE, which is not a country but a federation under which some Russian players decided to compete in order to be able to participate in international events. However, so as not to lose these grandmasters, the data will treat the FIDE Federation as a country. Federation and country are used interchangeably. England, Scotland, and Wales are all combined into the UK for the purpose of this project. All the figures, correlations, and data analysis were done in R.

One of my main independent variables is federation support. To determine this, I sent out a survey to grandmasters from different countries with the following questions.

Country:

Directions: Please bold the answer that applies to you. Feel free to add any notes if you think they will be helpful/as clarification. If you have any questions don't hesitate to ask me. If you don't think you can answer a question, type N/A.

NOTE: For this survey, government and federation are the same/interchangeable.

1. Has your government/federation provided you with enough funds to fully cover any chess-related expenses? (Tournaments, training, travel costs etc.)

Yes = 2, I did receive funds, but they were not sufficient to cover all costs = 1, No = 0

2. At any point, has your government/federation paid you a salary equal to or more than the average yearly salary of your country to study chess?

Yes = 1, No = 0

3. Has your government/federation offered you any monetary incentives (including gifts with monetary value) for winning a chess tournament or representing your country in a chess tournament?

Yes = 1, No = 0

4. Have you participated or been offered participation in a government funded training program for chess?

Yes = 1, No = 0

5. When representing your country at chess tournaments, does your government/federation cover all expenses? (Olympiad, World Rapid and Blitz, etc.)

All expenses/events of this nature are covered = 2, Some expenses/events of this nature are covered=1 No expenses/events of this nature are covered = 0

6. The majority of my chess training growing up was covered by:

A = My parents/family, B = a private organization/sponsorship, C = my government/federation

If other, or a combination of several, please explain here:

Questions 1-5 create a scale from 0-7 to determine federation support.

0-2: Low support

3-4: Medium Support

5-7: High support

Question six is to provide qualitative data and extra insight.

The next part of the survey is a scale from 0-6 intended to provide more information on chess culture that can be used in the country case studies in sections six and seven. I decided not to use this as a quantitative measure as survey data from a small set of people creates certain

issues discussed in section 5.4. A better measure for this is the number of players, the reasons why are highlighted in section 5.1.

Pt 2.

2. Does anyone else in your family play chess at a high level (titled player)?

Yes = 1, No = 0

3. How many people from your hometown growing up played chess.

Most kids were taught/played chess = 3, Some kids were taught/played chess = 2, Few kids were taught/played chess = 1 No one but me was taught/played chess (to my knowledge) = 0

4. If you attended any public or private institution, was chess considered a popular sport?

Yes = 1, No = 0

Note: if you were homeschooled, you may still be able to answer this question for the nearest school to you, or the school your siblings went to? If you are unsure, answer NA

5. Was it easy to access strong tournaments in your home country growing up (Where you faced opponents with a rating equal to or higher to yours?)

Yes = 1, No = 0

The last section of the survey is a short answer. Question one provides another internal validity test of chess culture. The second question provides qualitative data. For example, should a grandmaster answer that the biggest influence in their chess is other players from their country, or people they grew up playing with, this would support the idea that chess culture plays an important role in the level a player reaches.

Short answer:

- Would you consider your country to have a strong chess culture? Why or why not.
- What/who do you think had the biggest influence in your decision to play/continue to keep playing chess growing up (i.e., family, school, government, friends, grandmaster from the country, etc.)
- Did you/do you feel that your government/federation supports your chess. Why or why not?
- Are you the child of immigrants? If yes, where are your parents from?

Ch 5: Testing the Variables

Section 5.1: Chess Culture/Number of Players

Number of players (unadjusted for population) is a metric that will be used as a proxy to indicate the level of chess culture in a country. If there is a strong chess culture, chess will be taught in schools, played within families, and a larger number of individuals will have chosen to compete and gain an international rating.

Table 2: Number of players

Country Name	#players
Russian Federation	39404
India	38851
Germany	30280
Spain	30198
France	28824
Iran, Islamic Rep.	13243
Poland	13169
Italy	12923
Turkiye	9829
United States	9031

When looking at countries with a large number of players, Russia has the most. Russia has a significant number of world champions and dominated the chess scene through the 20th century. Russia has a long history of chess and this is clearly shown in the numbers.^{viii}

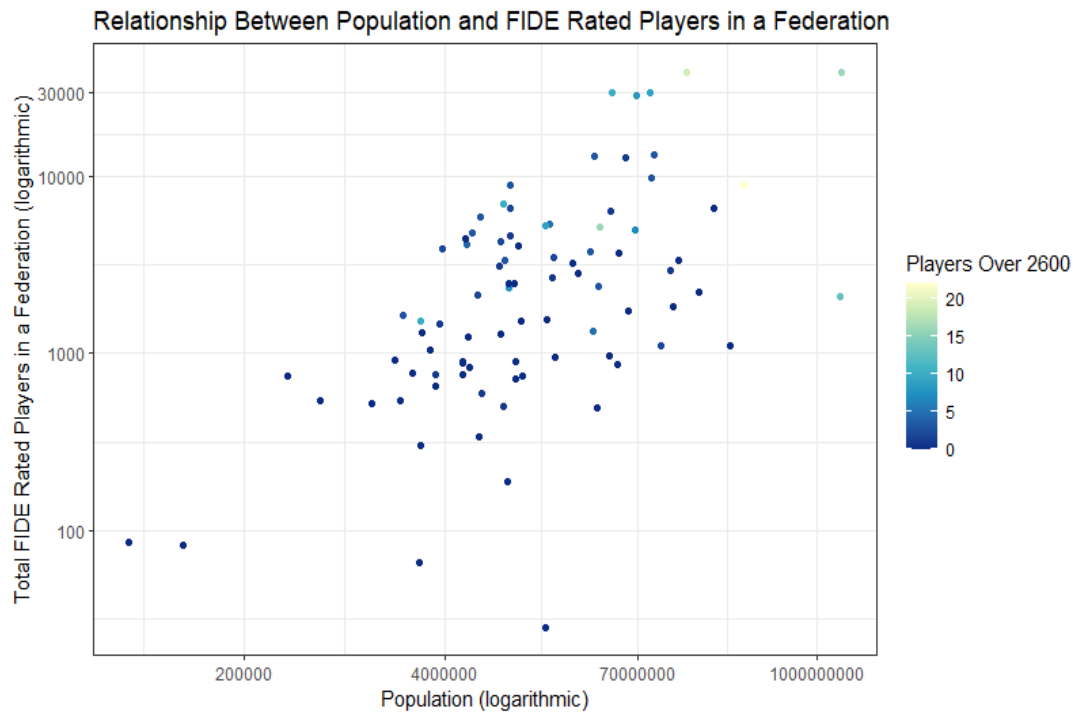
It's important to note that the United States is slightly deflated in this list, as they have over 25,231 players that have a national rating over 1000 (which is the starting point for FIDE ratings).^{ix} However, the United States is behind other countries in players with an international rating.

Countries may have a rapidly increasing chess culture; however, it takes time for this to diffuse down enough to affect the number of players. The countries that are highest on this list will be the ones with a long history of chess culture that spans generations.

One interesting finding from the survey data in the chess culture section is that certain factors that are attributed to chess culture are not always uniform across different areas of the same country. Multiple players from the same country had different numbers. For example, one Indian grandmaster answered that chess was not a popular sport in his school, while one answered that it was. One French grandmaster marked that few kids were taught to play chess in his hometown, while another marked that no kids (other than him) were taught to play chess in his hometown, clarifying that he came from a smaller area. This answer is especially useful in highlighting that the number of players and the strength of chess culture are not always spread out evenly. However, the number of players offers a decent jumping ground to start to understand this complicated metric.

To answer the potential argument that the number of players is just a proxy for population instead of a measure of chess culture, I tested the correlation between the two. Interestingly enough, the correlation between the number of players and population is .36, which is weak.

Figure 2: Relationship Between Population and FIDE-Rated Players in a Federation



Correlation between population and total number of players in countries with grandmasters

Two-sided 95% bootstrap confidence interval for the true Kendall correlation coefficient based on 9999 bootstrap replications and the bca method

Sample estimate: 0.3635773

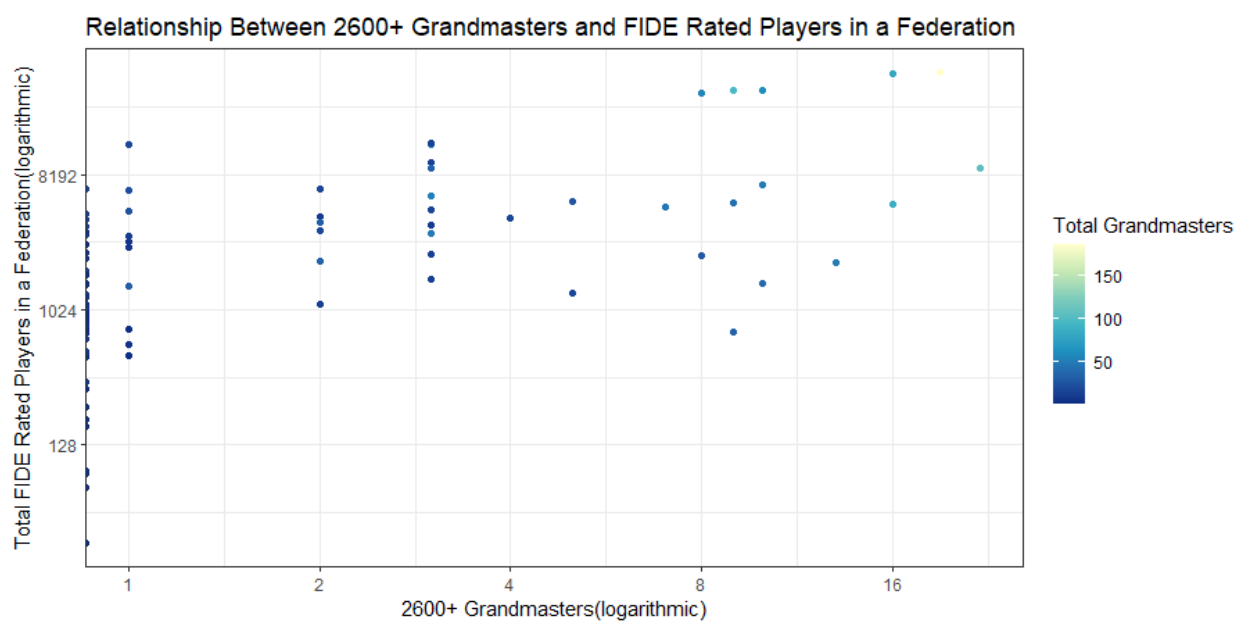
Confidence interval:

2.5% 97.5%

0.2319215 0.4878369

It's still important to keep a country's population in mind when judging how many players they have, but relatively smaller countries with strong chess cultures, such as Poland, are able to hold their own in the list.

Figure 3: Relationship Between 2600+ Grandmasters and FIDE Rated Players in a Federation



Correlation between the number of 2600+ grandmasters and the number of total players in countries with grandmasters

Two-sided 95% bootstrap confidence interval for the true Pearson correlation coefficient based on 9999 bootstrap replications and the bca method

Sample estimate: 0.6237503

Confidence interval:

2.5% 97.5%

0.4043792 0.8296833

There is a decent correlation between the number of players and 2600+ grandmasters. Logically this makes sense. Having more players means a higher chance for one of them to become 2600+.

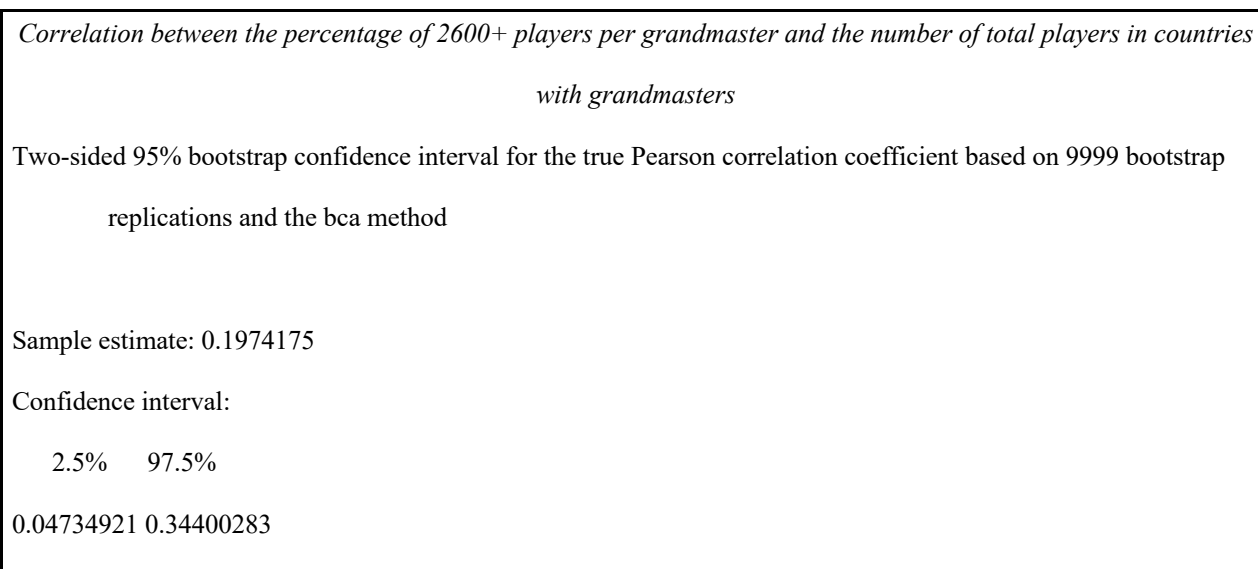
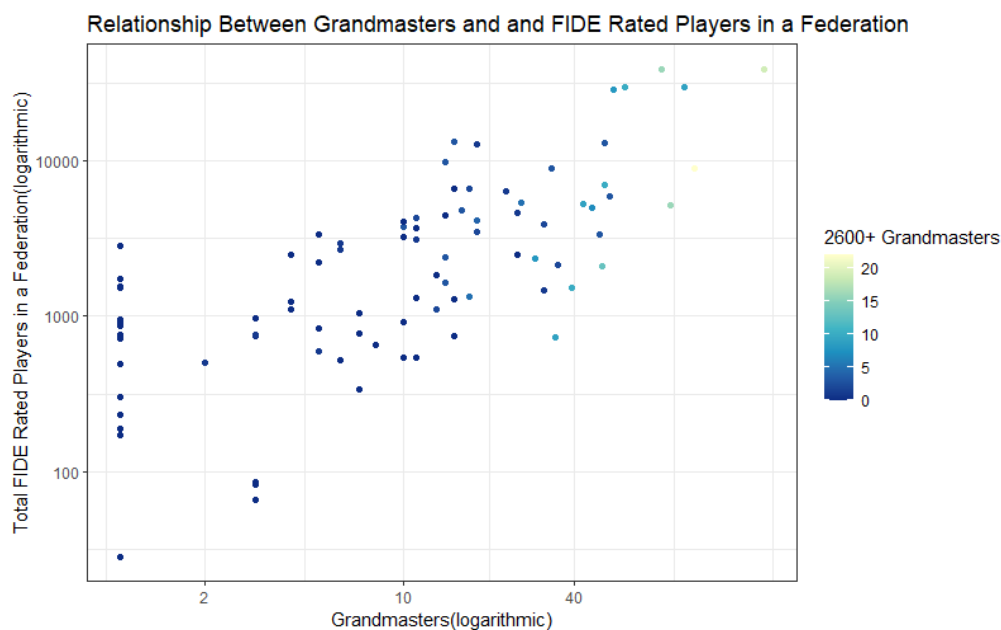


Figure 4: Relationship Between Grandmasters and FIDE-Rated Players in a Federation



Correlation between the number of grandmasters and the number of total players in countries with grandmasters

Two-sided 95% bootstrap confidence interval for the true Pearson correlation coefficient based on 9999 bootstrap replications and the bca method

Sample estimate: 0.7611417

Confidence interval:

2.5%	97.5%
0.5607707	0.8901291

The correlation was stronger between the number of players and the number of grandmasters than it was between the number of players and the number of 2600+ grandmasters. This could suggest that chess culture has slightly more to do with how many grandmasters a country has than how many 2600+ grandmasters they have. Perhaps chess culture is important in making the initial leap to grandmaster, but in order to reach that next level another factor must be present. This supports the initial hypothesis.

Section 5.2: Players Per Capita

Even though population and the number of players do not have a strong correlation, it still is useful to have a variable that adjusts for population. The most obvious variable would be to express the number of grandmasters relative to a country's population.

I found that the players per capita metric skews heavily in favor of smaller countries (It's difficult to argue that Croatia has a much stronger chess culture than Russia). However, it does allow countries with a larger percentage of their population playing chess to be recognized.

Table 3: Countries with the largest number of players per capita

Country Name	playerspercapita*1000
Iceland	1.943778737
Croatia	1.018382283
Serbia	0.888667858
Montenegro	0.878621879
Czechia	0.857280989
Slovak Republic	0.835934394
Denmark	0.806094540
Slovenia	0.779004269
Norway	0.760005342
Hungary	0.737154315
Spain	0.634816927
Greece	0.631256920
Armenia	0.554361638
Latvia	0.493402685

Smaller countries dominate this list.

Table 4: Countries with the lowest number of players per capita

Country Name	playerspercapita*1000
China	0.001491630
Senegal	0.001576296
Indonesia	0.004021127
Vietnam	0.011197772
Bangladesh	0.012980306
Morocco	0.013107807
Philippines	0.015749458
Korea, Rep.	0.016854322
Algeria	0.021334688
Qatar	0.024296944
Egypt, Arab Rep.	0.026074243
Mexico	0.026437157
United States	0.026956522
India	0.027194630

At first glance, countries like China and India seem to be misplaced in this. These countries are generally assumed to be incredibly strong at chess, so why are they ranked so low with the indicator of chess culture when adjusted for population?

Two factors could be at play:

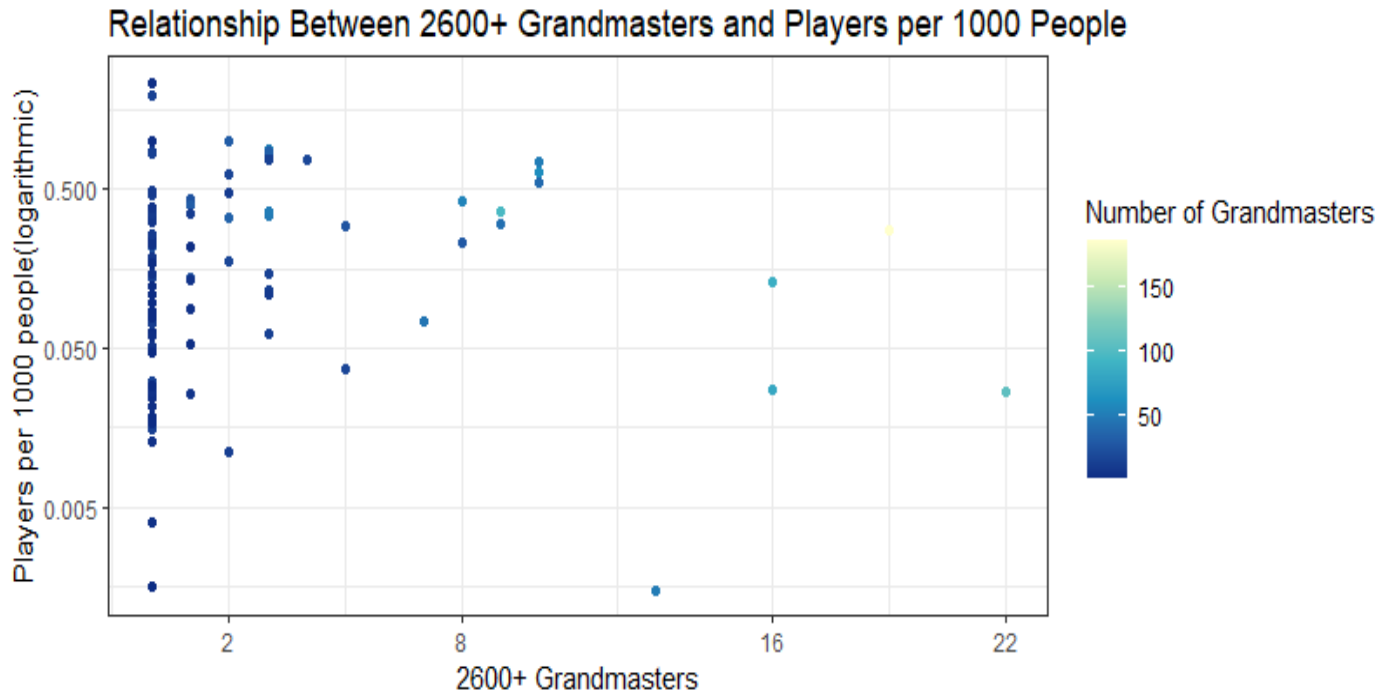
- The populations of these countries are so big, that the data is getting skewed (this is likely most or at least part of the explanation.)
- These countries don't have a strong chess culture when examined through the lens of how many total people in the country play chess.

China, for example, has its own form of chess, called Chinese chess(Xiangqi).^x Despite having a large population, neither their number of pure players, nor the number of players per capita is extremely high.

India is a more controversial example. On one hand, it seems like India has a very strong chess culture. When asked in the survey whether the chess culture in India is strong, an Indian grandmaster responded, “Yes, in terms of numbers I think India has amongst the highest active players and the level of respect in society for chess is very high, which helps a lot.” Their players are celebrated by the people and government alike, and they are quickly rising to become a superpower on the chess scene.^{xi}

Hence, while chess is not widespread in India if we look at the entire population, it may well be very widespread amongst certain groups in India. Given wide historical variations in income and educational levels inside India, it seems possible that chess is highly culturally valued among educated classes, but not among hundreds of millions of subsistence farmers. This data isn't available, but it raises an interesting question: Can we consider a country to have a strong chess culture if chess only permeates through certain segments of society? It will be much easier for smaller countries to have widespread chess, so when it comes to chess culture, I believe the players per capita data is important in painting a more complete picture, but it cannot be used as the only indicator of chess culture.

Figure 5: Relationship between 2600+ Grandmasters and FIDE-Rated Players per 1000 People



The correlation between population and the number of 2600+ grandmasters in countries with grandmasters

Two-sided 95% bootstrap confidence interval for the true Pearson correlation coefficient based on 9999 bootstrap replications and the bca method

Sample estimate: 0.02038407

Confidence interval:

2.5% 97.5%

-0.1453387 0.2325092

There is no correlation, as expected since countries like China and India were ranked so low.

Next, I tested the relationship between the number of players per capita and 2600+ players per grandmaster

The correlation between population and the percentage of 2600+ players per grandmaster
 Two-sided 95% bootstrap confidence interval for the true Pearson correlation coefficient based on 9999 bootstrap replications and the bca method

Sample estimate: 0.004842718

Confidence interval:

2.5% 97.5%

-0.1723057 0.2282809

Players per capita had no correlation to whether a country had more strong grandmasters than the number of players did. Chess does not need to be widespread in every segment of a country for it to have strong chess players.

Section 5.3: Population

There was a surprisingly weak correlation between population and players, but what is the correlation between population and grandmasters over 2600?

The correlation between population and the number of 2600+ grandmasters in countries with grandmasters

Two-sided 95% bootstrap confidence interval for the true Kendall correlation coefficient based on 9999 bootstrap replications and the bca method

Sample estimate: 0.2210228

Confidence interval:

2.5% 97.5%

0.03856927 0.38309169

The correlation between population and the percentage of 2600+ players per grandmaster in countries with grandmasters

Two-sided 95% bootstrap confidence interval for the true Kendall correlation coefficient based on 9999 bootstrap replications and

the bca method

Sample estimate: 0.1450661

Confidence interval:

2.5% 97.5%

-0.03128338 0.30723027

There is no correlation for either.

The correlation between population and total number of grandmasters in countries with grandmasters

Two-sided 95% bootstrap confidence interval for the true Kendall correlation coefficient based on 9999 bootstrap replications and

the bca method

Sample estimate: 0.1298041

Confidence interval:

2.5% 97.5%

-0.01411967 0.27233753

The correlation between population and all three measures of chess strength is weak or non-existent, suggesting that population is not a key factor in whether a country has strong grandmasters (or even the number of grandmasters.)

Section 5.4: Federation Support

Becoming a grandmaster is expensive.^{xii} Reaching the top 12% of grandmasters is even more pricey. Being able to compete at that level means having chess be your full-time job. While some grandmasters can get away with tutoring, being able to travel and train usually requires

total focus. When a player is improving, they may not have access to private sponsorships like some super grandmasters, or wealthy parents to fund this expenditure. Sometimes a player can apply for a scholarship, such as the Kasparov Foundation which is available to young US chess players, but this isn't always available or able to fully fund chess.^{xiii} Federations' monetary support allows players to fully focus on chess. A federation can also support its players in other ways. In the surveys, one grandmaster reported that a chess accomplishment was incentivized by tax deductions. Another said that he was paid well by his federation for winning an important tournament. Another reported no monetary incentives or even reimbursements for big tournaments.

Federation support was by far the hardest variable to measure, yet one that I hypothesize is most likely to explain part of why certain countries have more strong grandmasters than others.

However, there is no public data available on the financial resources of a federation, or what they give to their players. To attempt to capture this, I chose to gather a mixture of quantitative and qualitative survey data from grandmasters in different countries and analyze individual countries as test cases.

There are only 1813 grandmasters in the world, which makes it a relatively small sample size. For this project, I received data from 30 grandmasters—a sample of less than 2% of the total population. Since this is such a small set, outliers are much more likely to skew the data, making any correlation difficult to determine. As a result, these data are to be treated as initial, subject to further research with larger samples.

Table 5: The mean score of federation support gathered from grandmaster survey data

Country Name	Federation Support
Azerbaijan	7.0
India	6.5
Uzbekistan	5.0
Norway	5.0
Greece	4.0
Italy	4.0
Spain	3.5
Israel	3.5
Netherlands	3.0
Lithuania	3.0
France	2.0
United States	2.0
Peru	2.0
Latvia	1.0

There are potential biases to note:

First, survival bias has to be taken into account. It's possible that those grandmasters who are still active are precisely those who have received monetary compensation from their federation—hence, the data overestimates federation support (but not its importance to players!).

Second, the community I drew from is international, and some of the questions could receive slightly different responses depending on the interpretation of the person who took the survey.

Finally, there are issues in creating a scale from scratch. The questions used the wording, “some, all, few” as it wasn't possible to ask for exact numbers, which leaves it up to interpretation. One answer could change the data for the country.

I also added an internal validity short answer question to determine if the score they gave and whether they believe they received support is consistent. This was not always the case.

Despite the data's limitations, there are some interesting initial insights to take from it.

Table 6: The mean of federation support gathered from grandmaster survey data side by side with other data

Country Name	#gm	over2600	2600pergm	Federation Support
Azerbaijan	29	8	0.27586207	7.0
India	81	16	0.19753086	6.5
Uzbekistan	17	5	0.29411765	5.0
Norway	18	4	0.22222222	5.0
Greece	17	2	0.11764706	4.0
Italy	18	1	0.05555556	4.0
Spain	60	10	0.16666667	3.5
Israel	49	3	0.06122449	3.5
Netherlands	43	9	0.20930233	3.0
Lithuania	11	0	0.00000000	3.0
France	55	8	0.14545455	2.0
United States	106	22	0.20754717	2.0
Peru	10	3	0.30000000	2.0
Latvia	10	0	0.00000000	1.0

On the surface countries that had players rate their support as high seem to have a higher percentage of 2600+'s. The highest-rated countries (Azerbaijan, India, Uzbekistan) all have a large percentage of 2600+ per grandmaster. All of these countries are within the top 20 of all countries for the percentage of 2600+ players per grandmaster.

However, there are a fair number of outliers that don't support my hypothesis. Italy, which has a percentage on the lower side, was rated on the higher end for federation support.

Another outlier is Canada. Canada was given a .5 for support, yet has a percentage of 2600+ players per grandmasters of .21 with three grandmasters over 2600+. Ukraine was given a rating of 0 for support, with a percentage of 18. The final outlier, the US was given an average rating of 2 with 20%.

There are several explanations for these outliers on a case-by-case basis.

- There isn't a strong correlation between federation support and whether a grandmaster is able to become 2600+.
- The previously mentioned issues with the data are influencing the outcome
- The data doesn't account for grandmasters who switched federations.

It's common for a chess player to start playing for another country. Sometimes they've received a promise of additional support, other times their own country is going through political turmoil, or perhaps the federation they are switching to is just a nice place to live. These players will be listed under their new federations even if they made grandmaster or reached a rating of 2600+ playing under a different flag.

- Other factors can be used to supplement federation support.

The US is a clear example of a country where many players originally came from other federations. Canada had three grandmasters over 2600 at the time the data was taken. The top player, Evgeny Bareev changed federations from Russia.^{xiv}

Despite any potential reasons why, the quantitative data alone did not provide strong support for my hypothesis.

Section 5.5: Internet

It's fairly indisputable that the internet has a strong effect on chess. It allows for a wider reach of resources. Is the internet a key factor in whether a country has strong grandmasters? My hypothesis was that the correlation would be weak due to similar factors that caused a weak correlation between players and the percentage of people with access to the internet.

Correlation between % of the population with access to the internet and the number of 2600+ grandmasters in countries with grandmasters

Two-sided 95% bootstrap confidence interval for the true Pearson correlation coefficient based on 9999 bootstrap replications and
the bca method

Sample estimate: 0.05621175

Confidence interval:

2.5% 97.5%

-0.2742753 0.2245280

One possibility for this lack of correlation is that to reach a certain level of chess, a monetary investment is needed. While there are exceptions, chess is an expensive sport. Families who can afford to support their children's chess careers most likely will be able to access the internet, even if many in their country cannot.

I tested the percentage of 2600+ players per grandmaster as well, in case it changed anything, and while the correlation was slightly higher at .17, it's still weak.

Correlation between % of the population with access to the internet and the percentage of 2600+ players per grandmaster in countries with grandmasters

Two-sided 95% bootstrap confidence interval for the true Pearson correlation coefficient based on 9999 bootstrap replications and the bca method

Sample estimate: 0.1715701

Confidence interval:

2.5% 97.5%

-0.05454186 0.35281229

Section 5.6: Electricity

As expected, there wasn't a correlation between access to electricity and the number of 2600+ players

Correlation between the number of 2600+ players and the percentage of the population with access to electricity in countries with grandmasters

Two-sided 95% bootstrap confidence interval for the true Pearson correlation coefficient based on 9999 bootstrap replications and the bca method

Sample estimate: 0.1086699

Confidence interval:

2.5% 97.5%

0.05844732 0.16734137

For the second measure: 2600+ per grandmaster, there also was no correlation.

Correlation between the percentage of 2600+ players per grandmaster and the percentage of the population with access to electricity in countries with grandmasters

Two-sided 95% bootstrap confidence interval for the true Pearson correlation coefficient based on 9999 bootstrap replications and the bca method

Sample estimate: 0.1366648

Confidence interval:

2.5% 97.5%

-0.07025984 0.22334336

There was no correlation.

Section 5.7: National Income

Is there a correlation between adjusted national income and the number of 2600+ players?

Correlation between adjusted national income (US\$) and the number of 2600+ grandmasters in countries with grandmasters

Two-sided 95% bootstrap confidence interval for the true Pearson correlation coefficient based on 9999 bootstrap replications and

the bca method

Sample estimate: 0.09034062

Confidence interval:

2.5% 97.5%

-0.1236739 0.4105344

Correlation between adjusted national income (US\$) and the percentage of 2600+ players per grandmaster in countries with grandmasters

Two-sided 95% bootstrap confidence interval for the true Pearson correlation coefficient based on 9999 bootstrap replications and the bca method

Sample estimate: 0.1067687

Confidence interval:

2.5% 97.5%

-0.1117131 0.3151523

Perhaps the lack of correlation is due to similar reasons: wealthy families are able to give their children enough support to be able to reach a top level. Even if they receive support from other places, median income may not have much to do with this.

Section 6: Country Case Studies: High Ranking Countries

Section 6.1: United States

Table 8: United States data

Country Name	#gm	#players	over2600	2600pergm	Population	National Income Adjusted	% Individuals Using Internet	Federation Support
United States	106	9031	22	0.2075472	335020960	53327.34	90.62047	2

The United States' 2600+ per grandmaster rate is around 20%, which is on the higher end. That being said, the US also scored fairly low on federation support making it an interesting test case. When asked if he felt his federation supported him well, one grandmaster from the United States answered, "Mildly. They could definitely do more but on the other hand they do organize scholastic events such as Nationals that help jump start a chess career." Another answered, "US Chess gave me and most Americans practically nothing to support my chess. The only financial support they ever gave me was a travel stipend and hotel at an important tournament."

Chess culture is growing in the United States. The Queen's Gambit, chess personalities such as the Botez sisters or Gotham Chess, and media surrounding chess scandals have all boosted the popularity of chess in this country.^{xv} When asked whether he believes his country has a strong chess culture, a United States grandmaster responded, "The US has a weak chess culture, though it's growing stronger. Some big cities have long standing chess clubs and communities (e.g. NYC, Boston, San Francisco) and others have new clubs (e.g. St Louis, Charlotte), but many parts of the US still have little to no chess culture." Another said, "Yes. The simplest answer would be that we are a very big country! But I believe the Fischer boom also made an impact. Plus, currently with the generosity of Rex & Jeanne Sinquefield, US Chess has never been more dominant than it is now."

However, the number of players in the United States with an international rating still remains low. Without an international rating, receiving international titles, like grandmaster, is impossible. There is a recent push to have more FIDE-rated tournaments in the United States, but those currently are more expensive and harder to access than nationally-rated tournaments. If chess culture is lower, and federation support can't close the gap, why does the US have a large percentage of 2600+ per grandmaster? One possible suggestion can be found by looking at the United States top rating list.

Table 7: United States top players list^{xvi}

1	Caruana, Fabiano	g	USA	2794	11	1992
2	Nakamura, Hikaru	g	USA	2788	11	1987
3	So, Wesley	g	USA	2752	0	1993
4	Dominguez Perez, Leinier	g	USA	2745	0	1983
5	Aronian, Levon	g	USA	2723	11	1982
6	Sevian, Samuel	g	USA	2697	11	2000
7	Robson, Ray	g	USA	2696	0	1994
8	Shankland, Sam	g	USA	2674	11	1991
9	Niemann, Hans Moke	g	USA	2667	11	2003
9	Oparin, Grigoriy	g	USA	2667	0	1997
11	Xiong, Jeffery	g	USA	2659	11	2000
12	Liang, Awonder	g	USA	2640	7	2003
13	Kamsky, Gata	g	USA	2634	0	1974
14	Mishra, Abhimanyu	g	USA	2627	11	2009
15	Zherebukh, Yaroslav	g	USA	2620	3	1993
16	Naroditsky, Daniel	g	USA	2619	0	1995
17	Swiercz, Dariusz	g	USA	2615	0	1994
18	Yoo, Christopher Woojin	g	USA	2606	0	2006
19	Akopian, Vladimir	g	USA	2602	0	1971
20	Bruzon Batista, Lazaro	g	USA	2594	9	1982
21	Quesada Perez, Yuniesky	g	USA	2591	0	1984
22	Burke, John M	g	USA	2584	9	2001
23	Akopian, Varuzhan	g	USA	2576	11	1983
24	Ramirez, Alejandro	g	USA	2571	0	1988
25	Gareyev, Timur	g	USA	2570	0	1988
26	Kaldanov, Gregory	g	USA	2565	0	1959
27	Hong, Andrew	g	USA	2539	0	2004
28	Jacobson, Brandon	g	USA	2538	0	2003
29	Wolff, Patrick	g	USA	2531	0	1968
30	Guo, Arthur	m	USA	2529	0	2006

It's not uncommon for grandmasters to change federations, but the United States has an exceptionally large share who fall into this category. Levon Aronian switched from the Armenian Federation to the United States Federation in 2021.^{xvii} Grigory Oparin was previously part of the Russian Federation.^{xviii} Fabiano Caruana switched federations from Italy, but he was born in the United States.^{xix} Leinier Perez Dominguez switched from Cuba, and Wesley So switched federations from the Philippines.^{xxxi} There are several reasons a player would switch

federations. Sometimes, it's for quality of life. Other times they're incentivized monetarily, or through university scholarships. The United States has an especially generous supporter of chess, Rex Sinquefeld. Sinquefeld, an American businessman, has invested in large tournaments, like Sinquefeld Cup, and made St Louis, Missouri a hub of chess.^{xxii} Several colleges offer chess scholarships including Webster University.^{xxiii}

Another way players from the United States receive support is through the Kasparov Foundation and other similar organizations. The Kasparov Foundation sponsors young promising players, providing them with training and monetary support.

Personal wealth, or private organizations like these can supplement federation support.

Section 6.2: Russia

Table 8: Russia data

Country Name	#gm	#players	over2600	2600pergm	Population	National Income Adjusted	% Individuals Using Internet
Russian Federation	186	39404	19	0.1021505	143036336	8118.726	84.99467

Russia is another interesting case. In the 20th century, Russian players dominated chess, producing world champion after world champion.^{xxiv} Russia still produces a higher number and percentage of 2600+ players, which the data slightly understates.

It's important to note that a significant number of Russian players chose to switch Federations, or play under the "FIDE" federation in order to be eligible for international tournaments.^{xxv} This decreases the number of strong players immediately visible in the data. That said, Russia has produced a large number of 2600+ players.

Russia has an extremely strong chess culture, and is number one on the list for the number of FIDE-rated players.

A former Russian grandmaster noted that he did not receive money from his national federation, but was supported by his local federation. The quantitative data was excluded due to questions over the difference between local and national federations in Russia, and whether other players included this distinction in their surveys, however he gave his national federation a score of zero, and stated that they didn't support even as he passed the 2600+ threshold.

Russia is generally known as an involved federation. In response to the federation change of many grandmasters, Russia has taken action. An article on Chess.com states, "Andrey Filatov, president of the Russian Chess Federation, announced on Friday that they intend to sign 10-year contracts with promising young players to prevent them from leaving the country."^{xxvi} The article also notes that 141 Russian chess players changed their nationality in order to be eligible to compete in international chess events. The president of the Russian Federation responded saying, "If an athlete decides to change the country, he will have to return all the costs that investors incurred in his development and promotion." This suggests that Russia has invested monetary resources in its players. There may also be bias in my survey in that the Russian players able to change federations are the ones most likely to speak with me.

It's difficult to conclude the level and importance of the Russian Chess Federation's support on their ability to produce a large number of 2600+ players, but the data does show that chess culture is extremely strong in this country.

Section 6.3: Uzbekistan

Uzbekistan is a country that ranks high with a large percentage of 2600+ players per grandmaster.

Table 9: Uzbekistan data

Fed	Country Name	#gm	#players	over2600	2600pergm	Population	National Income Adjusted	% Individuals Using Internet	Federation Support
UZB	Uzbekistan	17	1332	5	0.2941176	36194172	1375.453	71.1	5

Uzbekistan, like China, does not have a large number of players, suggesting a still developing chess culture. However, the country is ranked high for federation support. An Uzbek grandmaster asserts that he feels much support from his government and federation, noting “After winning the 44th Chess Olympiad, our government began helping young players to participate in international tournaments in order to get IM, GM norms. Moreover, the government started covering the expenses for the training camps.” Uzbekistan has a large crop of talented young players, and this is reflected in recent victories.^{xxvii}

It’s interesting to note the potential correlation between the government helping chess, and Uzbekistan’s emergence as a power in the chess sphere.^{xxviii} For some countries, especially those without a large number of players, this seems to be a major factor.

Section 6.4: China

China is another interesting example of a country that ranked highly for 2600+ players.

Table 10: China data

Fed	Country Name	#gm	#players	over2600	2600pergm	Population	National Income Adjusted	% Individuals Using Internet	Federation Support
CHN	China	50	2106	13	0.26	1411878144	7572.282	70.05276	NA

China (as mentioned previously) does not have many internationally rated players, and chess culture is largely dwarfed by the popularity of Chinese chess. However, China has routinely been able to produce strong players, including the current World Champion, Ding Liren, and many Women’s World Champions.^{xxix} While the game wasn’t popular in the early 20th century, a string of successes in important chess competitions followed at the latter end of the 20th century. “As chess progressed in China, the state warmed up and provided more

support,” a FIDE article notes.^{xxx} The article notes that chess in China is similar to chess in Russia in that both have “robust” federation and government support. This includes a mentorship program where successful players help emerging talents.

Section 7: Cross Country Comparisons

Section 7.1: Azerbaijan and Israel

Table 11: Azerbaijan and Israel data comparison

Country Name	#gm	#players	over2600	2600pergm	Population	National Income Adjusted	% Individuals Using Internet	Federation Support
Azerbaijan	29	2361	8	0.27586207	10229190	3489.805	84.60000	7.0
Israel	49	3340	3	0.06122449	9693280	37545.239	90.12734	3.5

Azerbaijan and Israel make for an interesting comparison. The two countries have a somewhat similar number of players, with Azerbaijan having around one thousand less. The two greatly differ in the number of grandmasters, with Israel having twenty more than Azerbaijan. Despite this metric, Azerbaijan has far more 2600+ fide rated players than Israel. Consequently, Azerbaijan’s 2600+ per grandmaster rate is much higher than Israel’s. The two nations have similar populations. Israel was rated to have lower support from their federation by players, however, it’s also important to note that this data is limited.

In the grandmaster survey, an Azerbaijani chess player notes that his federation “became more supportive since we got a new president. The sport is seen as a means to represent my country. Therefore, most people support it.” Another grandmaster from Azerbaijan notes that he feels that both the president of the federation and the president of the country support him and chess.

This gives an interesting clue (beyond the limited public and personally acquired data) into whether federation support plays a role in this. The president of the Azerbaijan Chess Federation is Mahir Mammadov, who is also currently a vice president of FIDE. ^{xxx}

There are visible markers of the federation’s support. Azerbaijan has been active in hosting some major tournaments including the FIDE World Cup. ^{xxxii}

On the other hand, when asked whether their federation supports them, an Israeli grandmaster stated that he does not as, “chess is not considered serious enough in my country.” Another grandmaster states that he was “supported enough in the past. Not even remotely enough but better than nothing.”

Section 7.2: India and Ukraine

Table 12: India and Ukraine data comparison

Country Name	#gm	#players	over2600	2600pergm	Federation Support
India	81	38851	16	0.1975309	6.5
Ukraine	87	5184	16	0.1839080	0.0

An interesting observation can be seen when observing the top players list of both India and Ukraine.

Table 13: Ukraine's 2600+ grandmasters. ^{xxxiii}

#	Name	Title	Fed	Rating	G	B-Year
1	Eljanov, Pavel	g	UKR	2697	4	1983
2	Kovalenko, Igor	g	UKR	2674	0	1988
3	Korobov, Anton	g	UKR	2667	10	1985
4	Volokitin, Andrei	g	UKR	2660	7	1986
5	Ivanchuk, Vasyl	g	UKR	2653	0	1969
6	Kryvoruchko, Yuriy	g	UKR	2652	7	1986
7	Ponomariov, Ruslan	g	UKR	2641	0	1983
8	Areshchenko, Alexander	g	UKR	2627	2	1986
9	Shtembuliak, Evgeny	g	UKR	2620	0	1999
10	Onyshchuk, Volodymyr	g	UKR	2619	0	1991
11	Drozdoskij, Yuri	g	UKR	2616	0	1984
12	Kononenko, Dmitry	g	UKR	2613	0	1988
13	Nyzhnyk, Ilyya	g	UKR	2611	0	1996
14	Bortnyk, Olexandr	g	UKR	2608	0	1996
15	Pilavov, Georgy	g	UKR	2607	0	1974
16	Kuzubov, Yuriy	g	UKR	2603	9	1990

Table 14: India's 2600+ grandmasters^{2xxxiv}

#	Name	Title	Fed	Rating	G	B-Year
1	Anand, Viswanathan	g	IND	2748	5	1969
2	Gukesh D	g	IND	2746	17	2006
3	Praggnanandhaa R	g	IND	2741	8	2005
4	Vidit, Santosh Gujrathi	g	IND	2715	7	1994
5	Erigaisi Arjun	g	IND	2713	16	2003
6	Harikrishna, Pentala	g	IND	2711	11	1986
7	Nihal Sarin	g	IND	2692	18	2004
8	Narayanan S L	g	IND	2668	9	1998
9	Sadhvani, Raunak	g	IND	2650	7	2005
10	Aravindh, Chithambaram VR.	g	IND	2638	9	1999
11	Puranik, Abhimanyu	g	IND	2627	18	2000
12	Aryan Chopra	g	IND	2626	9	2001
13	Karthikeyan, Murali	g	IND	2621	9	1999
14	Mendonca, Leon Luke	g	IND	2614	9	2006
15	Negi, Parimarjan	g	IND	2612	0	1993
16	Pranav, V	g	IND	2611	28	2006
17	Gupta, Abhijeet	g	IND	2606	11	1989
18	Sethuraman, S.P.	g	IND	2603	9	1993

On average the 2600+ players in India's list are younger. It is possible that the difference in federation support has allowed a new crop of 2600's, whereas in Ukraine it has not. (It's also important to note the events happening in Ukraine could be responsible for either the gap in support or the gap in average age.)

² This chart is taken from the most recent data, whereas the original number of grandmasters is taken from the October 2023 list, so there is a small difference in numbers.

Section 7.3: Norway and Italy:

Table 15: Norway and Italy data comparison

Country Name	#gm	#players	over2600	2600pergm	Population	National Income Adjusted	% Individuals Using Internet	Federation Support
Norway	18	4177	4	0.22222222	5496014	53514.25	94.60756	5
Italy	18	12923	1	0.05555556	58662524	25986.35	70.48343	4

Norway and Italy have surprisingly similar statistics. Both countries have 18 grandmasters. They both received similar quantitative markings for federation support. When asked if he felt supported by his federation a grandmaster from Norway said, “No. At the moment representing Norway in the Olympiad and similar events is unpaid. There is no training plan for the men’s team.” A grandmaster from Italy stated, “I received some support, for which I’m thankful, until a few years ago. Now it’s very limited.”

While Italy has more players than Norway by a significant margin, it also has a much larger population, which despite a weaker correlation still skews the data a bit, making it difficult to argue that one could have more chess culture than the other. Norway, however, has a prominent player and former World Champion Magnus Carlsen.^{xxxv} The presence of such a figure usually acts as an inspiration to others to play the game. This could be seen with Viswanathan Anand in India.

Section 8: Conclusion

The strong correlation between the number of players in a country and the number of top players that country has suggests that chess culture plays an important role in determining the global distribution of grandmasters. One of the most surprising findings of this thesis was that population had a relatively weak correlation to the number of FIDE-rated players in a federation.

This data supported my hypothesis. The stronger the chess culture a country has, the more children will play. Of these children, a percentage will be able to become grandmasters. Of that percentage, an even smaller group will become 2600+.

The qualitative data I gathered, and the case studies seemed to support that federation played a role in reaching 2600+. However, limitations with the quantitative data made a correlation difficult to prove. There were also some major outliers that seemed to go against my original hypothesis including, the United States, Canada, Italy, and Norway. The relatively small number of 2600+ players, especially in these countries, made it more difficult to establish if and why these cases were truly deviating from the hypothesis.

In fact, when looking more closely at the countries, an interesting observation was that in certain cases, other factors (such as a large donor, or the presence of a former World Champion) could be more important than federation support.

I wouldn't say that my hypothesis regarding federation support was strongly disproved, as the qualitative evidence gathered did seem to support that federation support was important. However, my hypothesis that chess culture and federation support *alone* would be the most decisive factors was contradicted.

Money did seem to be very influential, but it did not need to come from a federation alone.

Chess federations in a country are like political organizations. They're complicated and don't work uniformly. It also seemed as though there was a discrepancy in support. Some players from the same country reported receiving higher levels of support than others from the same nation. All of these factors make the uniform statement "Chess federation support is extremely important to whether a country has more than 2600+ players" a bit oversimplified.

That being said, there is a factor beyond the number of players (chess culture), population, or the median national income of the country, as countries with similar statistics in these areas still differed in the number of 2600+ players produced. It's possible this is due to natural variance, but it seems unlikely when examining these countries individually. In many of these cases, money was involved, whether it came from the federation or not.

Another interesting observation was that in countries without a large number of players (i.e., without a strong chess culture) federation and government support seemed to play a large role in their success. This could be seen in Uzbekistan, China, and Azerbaijan.

The numbers paint a fairly convincing, if dark, picture: The lone grandmaster from a federation without a strong culture or monetary support rising to the top ranks of chess is the outlier, not the norm. The influence of the country lurks behind their players, boosting or blockading their potential.

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