RSGC
Royal St. George's College

The Young Researcher

2021 Volume 5 | Issue 1

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Recommended Citation
Livingston, L. (2021). The correlation between climate and professional soccer player production in Canada. *The Young Researcher,* 5 (1), 122-131. http://www.theyoungresearcher.com/papers/llivingston.pdf

ISSN: 2560-9815 (Print) 2560-9823 (Online) Journal homepage: http://www.theyoungresearcher.com

The Correlation Between Climate and Professional Soccer Player Production in Canada

Lucas Livingston

In this study, the relationship between Canadian professional soccer player production and regional climate is quantitatively assessed. The correlation between these two variables is determined using Pearson's correlation coefficient and thoroughly discussed. All Canadian provinces were examined, with climate data being retrieved from the Government of Canada's climate normal data. The territories were not considered. The correlation coefficient between average annual temperature and professional player production was found to be 0.60, a strong positive correlation. The correlation between average annual precipitation was determined to be negligible at 0.08. The findings of this study indicate that generally, Canadian provinces and territories with high average annual temperatures and high average annual precipitation rates have moderately high rates of professional soccer player production compared to other Canadian provinces.

Keywords: soccer, soccer development, sports development, climate, professional sports, Canadian soccer.

Introduction

Canada, in conjunction with the United States and Mexico, is set to host the 2026 Men's World Cup. As such, the recent development of Canadian soccer has become a topic of great interest. In the summer of 2020, twenty-year-old Alphonso Davies became the first Canadian to win the UEFA Champions League, the most prestigious club soccer accolade. Additionally, the inception of the Canadian Premier League in 2017 gave Canada its first national professional soccer league. Historically, Canada has lagged behind in soccer player development, but perhaps a change is imminent. According to FIFA's Big Count, in 2006 there were 150 Canadian professional soccer players worldwide. 13 years later, that number has almost doubled, now standing at 280 professionals (FIFA, 2020). Despite recent growth, Canada's number of professional players is far below that of countries with comparable populations, such as Saudi Arabia and Morocco, which have 738 and 930 professionals, respectively (FIFA, 2019). Research into the factors that contribute to a nation's soccer player development is minimal. One crucial factor when examining a nation's soccer development is the regional climate. Yet, this factor remains largely overlooked. The existing literature is confined to Nicholas Holt's (2002) comparison of the soccer talent development systems in England and Canada, in which the effect of climate on soccer development systems is briefly touched upon. Holt concludes that the climate of a region has an effect on its talent production, but the extent to which this effect is prevalent remains unaddressed. As far as it is clear, no other studies analyze the effect of climate on soccer player production. This study intends to remedy the research gap that exists by answering the question: what is the correlation between climate and soccer player production in Canada? This research question allows for the exploration of the relationship between climate and soccer player production within Canada. All Canadian provinces were examined. This study explores the correlation between climate and soccer player production per capita within Canada. A secondary correlational data analysis was employed to collect research and an archival correlational study followed, in which the climates of Canadian provinces were correlated with their number of professional soccer players per capita (professionals per 100,000 males) from the respective province. As a result of the research, the global gap regarding the effect of climate on sports development and player production has begun to be addressed. Correlational research exploring the relationship between two variables previously unaddressed is vital in order to find causation and in turn, affect training regimes, funding, and talent development, globally and across different sports (Curtis, Comiskey, and Dempsey, 2016).

Literature Review

Scholars are yet to establish a quantitative relationship between climate and soccer player production. The little amount of qualitative data on the subject remains speculative at best. The effects of weather on soccer performance, and sports performance in general, have been researched rather thoroughly, while the long-term effects of a region's climate have not. The existing research relating to the effect of climate on soccer is confined to one paper, Holt's (2002) comparison of the soccer talent development systems in England and Canada, in which the effect of climate is touched upon briefly. Holt used documentary analysis, fieldwork, and interviews with Canadian and English youth coaches to compare the respective development systems. Holt finds that the physical environment is a substantial hindrance to the Canadian soccer system . During the winter months, outdoor soccer is only possible in the western coastal regions of British Columbia. Holt goes on to speculate as to the effects of this on Canadian talent development. Holt provides no data or evidence to support the notion that a lack of access to outdoor soccer for long periods harms development. This research is set to quantitatively affirm or negate Holt's assumptions. In a broader context, Song and Zhang (2017) explore the relationship between climatic factors and sports development in general. Song and Zhang infer that climatic, geographic, and topographic factors all have a substantial influence on the feasibility and development of sports in different regions.

This study explores the effect of long-term climate factors on the development and subsequent production of soccer players. Thornes (1977) on the other hand, explores the effect of weather on many sports, one of which is soccer. Similarly, Zhou et al (2019) examine the effect of weather on Chinese Super League soccer games and finds different outcomes in matches relating to the weather. Both these studies explore the effects of daily environmental conditions on match performance, whereas this study explores the effects of long-term climatic factors on player production.

While this study is set to examine the correlation between climate and soccer development, many others have explored the relationship between soccer development and different phenomena. The relative age effect, for example, is a bias in high-level sport which dictates that those born early in the relevant selection period are overrepresented in their respective sport. The relative age effect has been extensively researched in many sports and within many countries. Helsen, Van Winckel, and Williams (2005) find that across ten countries' national youth soccer teams, players born in the first three months of the relevant year are vastly overrepresented, proving the relative age effect in national European youth soccer. Multiple other studies have been conducted to explore the relative age effect in different countries, such as Del Campo et al's 2010 study examining the relative age effect in Spanish youth soccer players, which revealed the existence of the relative age effect in Spanish youth soccer. Additionally, Delorme, Boiché, and Raspaud (2010) were able to prove the relative age effect's prevalence in female youth soccer. Redkva, Paes, Fernandez, and da-Silva, (2018), in a study examining the relationship between individual soccer match performance and field tests, use Pearson's correlation coefficient to determine the numerical coefficient. This specific correlational test was employed in this study to determine the correlation between climate and soccer player production in Canada. With this study exploring the effect of climate on soccer development, the possibility for new studies exploring climatic effects on soccer in different regions and contexts is opened. There is, as far as is clear, no scholarly research regarding the effect of a region's climate on sports player production. This is a significant gap that must be resolved.

This study has begun filling the gap. This study explores the correlation between annual climatic factors and soccer development.

Similarly to this, many studies have been conducted to find a correlation between climatic factors and another variable. These studies must be analyzed in order to effectively gauge ways in which climate may be quantified and correlated. Ikegaya and Suganami (2008), examine the correlation between climate and crime in Eastern Tokyo. To quantify climate, they use both monthly average temperature and humidity to create a discomfort index. They then use a Poisson regression model to predict the incidence of murder and hit and runs on days with differing types of weather. Although that study provides insight on how to quantify climate on a day-to-day basis, this study explores average climatic conditions over long periods of time. Similarly, Toespu et al. (2020) analyzes the correlation between daily weather and the number of Covid-19 cases in Jakarta, Indonesia. The paper employs a secondary data analysis of both Covid-19 data and weather data from the Meteorological Department of Indonesia. Then the Spearman's rank correlation test — an alternative to the Pearson's correlation coefficient — is used to determine the correlation. Interestingly, rather than combine a number of climatic variables into one index like Ikegaya and Suganamami (2008), Tospeu et al. (2020) individually test different climatic variables' correlation with daily Covid incidence. The strongest correlation of all the climatic variables tested was the average temperature of the respective day. The correlation coefficient was found to equal 0.392, which indicates a weak positive correlation between the daily incidence of COVID-19 and average temperature. Srinivasan et al (2007) explore the correlation between climatic conditions and the risk of testicular torsion in adolescent males. Patients who were diagnosed with testicular torsion over a nine-year period were retroactively studied. The season, temperature, humidity, and atmospheric pressure at the time of onset of symptoms were analyzed as well. Spearman's rank correlation was then performed to find the relationship between atmospheric temperature and the frequency of testicular torsion. The relation of the climatic variables to the incidence of testicular torsion was individually assessed and their correlation coefficients subsequently examined. It was concluded that only the increasing of the atmospheric temperature correlated with the incidence of testicular torsion. The correlation coefficient was found to equal -0.94, a very strong negative correlation.

While some studies have briefly explored the relationship between climate and soccer development, no study, as far as it is clear, has provided a quantitative analysis of the relationship. The existing literature is confined to a broad overview of the climate of Canada's effect on soccer development when compared with that of England's. This study explores the correlation between male professional soccer player production and climate amongst all Canadian provinces. This study is beginning to fill the existing gaps in the field of soccer player production and climate in Canada, and in turn, begin to fill the global research gap.

Methodology

This study examines the correlation between soccer player development and climate amongst all Canadian provinces. A secondary data analysis was employed to collect research on the two variables needed for the study, and an archival correlational analysis using Pearson's correlation coefficient followed. The climate of each Canadian province was quantified according to the average annual temperature and precipitation. Climate data for each province was obtained through the Government of Canada's historical climate records, which show climatic averages from 1981-2010 (2020). A professional soccer player is defined as one who is listed on the active roster of a club competing in one of a nation's top three professional soccer leagues — in accordance with the FIFA 2019 Professional Football Report (2020). Professional players born outside of Canada that choose to represent Canada in international competition were categorized by the Canadian province they first lived in while under the age of 18. If the player in question has never lived in Canada or came to Canada after the age of 18, they were excluded from the study. This caveat is to ensure that the measured Canadian players were adequately representative of whatever region they were developed in.

In the context of this research, the climate is defined as the average annual precipitation and temperature of the province from 1981-2010. The annual average temperature and precipitation of the province are measured by the mean of the average annual precipitation and temperature of the three most populated cities in the respective province. Climate data (average annual precipitation and temperature) was retrieved from the Government of Canada's historical climate normals for each province (2020). This study considered only male players due to the novelty of professional women's soccer around the world. The correlation is calculated according to the Pearson Correlation Coefficient, also known as Pearson's r, or the bivariate correlation, which is used in correlational research of a similar nature. The difference between Pearson's and Spearman's correlation coefficients is that Pearson's coefficient works with a linear relationship between the two variables whereas the Spearman Coefficient works with monotonic relationships as well. Pearson's coefficient proved to be better suited to this study.

Data as to the number and birthplace of professional Canadian soccer players playing outside of the United States and Canada at the onset of the 2020 season was retrieved from the website Soccerway.ca. Soccerway maintains one of the world's largest soccer databases, providing reliable data on over 800 soccer leagues and cups from more than 130 countries. Data on the number and birthplace of Canadians playing in either the Canadian Premier League, Major League Soccer, USL Championship, and USL League 1 as of the beginning of the 2020 season was obtained from the roster of each club in the respective league and is represented in the Appendix.

In order to effectively compare and contrast the number of professional players produced by each province or territory, the number of male professionals was divided by the total population of the province (as of the fourth quarter of 2020), as found by the Government of Canada (2021), and multiplied by 100,000, that is (#of Professionals/population)*100,000. This effectively determines the number of professional soccer players in a province per capita (per 100,000) — this is to ensure that each province's data is comparable to each other. Pearson's correlation coefficient was used to determine the correlation between the climate and professional soccer players per capita. This is based largely on existing correlational research on weather/climate and another variable, including that of Tosepu et al. (2020), Shirzadi et al(2015), and Srinivasan et al(2007). The classification of the correlation between climate and soccer player production in Canada was then determined by Pearson's correlation coefficient classification (as shown below).

In order to effectively measure the relationship between climate and player production, two correlational tests were done. The first was to determine the correlation between annual average temperature, in Celsius, and professional soccer players per capita. The second was to determine the correlation between

Correlation coefficient	Correlation
$R_{XY}=1$	Perfectly positive
$0.7\leq R_{XY}<1$	Strong positive
$0.5\leq R_{XY}<0.8$	Moderate positive
$0.1\leq R_{XY}<0.4$	Weak positive
$0\leq R_{XY}<0.1$	Weak positive
0	Null
$-0.1\leq R_{XY}<0$	Very weak negative
$-0.4\leq R_{XY}<-0.1$	Weak negative
$-0.7\leq R_{XY}<-0.4$	Moderate negative
$-1\leq R_{XY}<-0.7$	Strong negative
$R_{XY}=-1$	Perfectly negative

average annual precipitation and professional soccer players per capita. The two individual R-values represent the statistical correlation between the respective climatic factor and soccer player production. The average of the two R-values was then calculated in order to determine the overall statistical correlation between climate and soccer player production in Canada.

In the event of an outlier appearing in the player per capita value (per 100,000 people), a mathematical determination as to whether the data point is an outlier was to take place, using the interquartile range. According to the IQR method of outlier detection, an outlier is defined as a point that falls more than 1.5 times the interquartile range above the third quartile or below the first quartile — with the data regarding professionals per capita (PPC) being divided into four quartiles from smallest to largest. If a value was determined to be an outlier, the R-values for both the data set including the outlier and omitting it would be calculated. This provides two perspectives of the data.

Findings

Table 1 shows the climate of each Canadian province and their respective professionals and professional per capita.

The Atlantic provinces – Newfoundland and Labrador, New Brunswick, Nova Scotia, and P.E.I – were aggregated to omit needless variance and outliers. Additionally, the population of the combined Atlantic provinces is more comparable to that of each of the other provinces.

Figure 1 - Correlation Between Average Annual Temperature and PPC

A strong positive correlation is evident in figure 1. Figure 2 shows the correlation between annual precipitation and players produced.

Figure 2 - Correlation Between Average Annual Precipitation and PPC

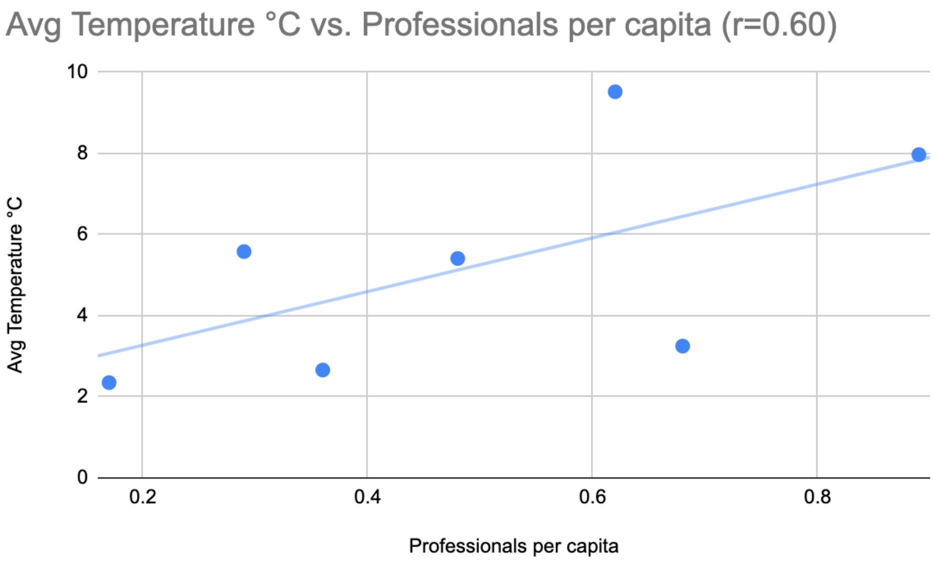
The line of best fit in figure 2 runs slightly upward and horizontally through the graph starting at around an annual precipitation of 2500, indicating that the precipitation that yields the highest PPC is a moderate one. This indication however, cannot be confirmed by a correlational test. The average of both the r-values from the correlation between temperature and PPC and precipitation and PPC without outliers equals 0.34, a weak positive correlation.

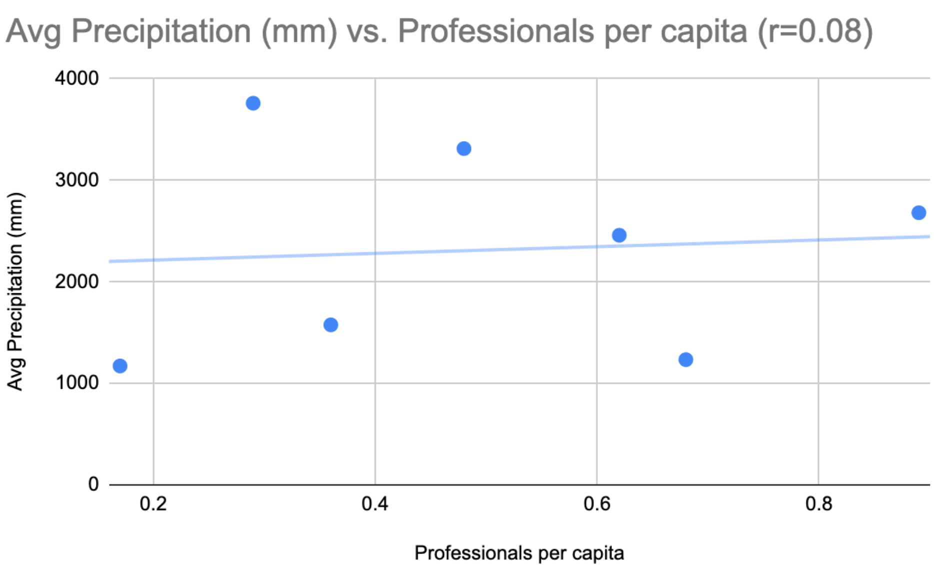
Discussion

All of the Canadian territories (Nunavut, North West Territories, and the Yukon), which were not examined in this study, have zero professional soccer players. All of these regions have temperatures of

Table 1

Province	Avg Temperature °C	Avg Precipitation (mm)	Professionals	Professionals per capita
Alberta	3.25	1233.5	30	.68
Atlantic Provinces	5.58	3760	7	.29
B.C.	9.52	2458.9	32	.62
Manitoba	2.66	1576.2	5	.36
Ontario	7.97	2680.8	131	.89
Quebec	5.41	3312.9	41	.48
Saskatchewan	2.35	1171.2	2	.17





less than 2°C and average precipitation rates of below 1005mm per year. The largely inhospitable environment of the territories would prove difficult for potential athletes to develop in, as demonstrated by the training of the Canadian Armed Forces in the Canadian territories (Lackenbauer & Lajeunesse, 2016). The only other Canadian province or territory with zero professional soccer players is Newfoundland and Labrador, which has a precipitation rate around four times that of Nunavut, the Yukon, and the Northwest Territories. The Canadian Prairie Provinces, Alberta, Saskatchewan, and Manitoba, all have similarly low precipitation rates of 1233.5, 1171.2, and 1576.2 millimetres per year respectively. They all have average annual temperatures of between 2.25°C and 3.25°C. Their PPC rates are dissimilar though with Alberta having a much higher rate of professional player production than Saskatchewan, with a rate of .17, and Manitoba with a rate of .36. This indicates that much more than just the climate of a region affects the rate of professional player production. The PPC of Canada's largest province (excluding territories) Quebec, may highlight another conclusion of Holt (2002), that the size of Canada, being so much larger than England, "causes a dilution of soccer talent and decreased (local) competitive opportunities." These factors create significant hindrances in the formation of a comprehensive talent development system.

The strong positive correlation of 0.60 evident in figure 1 indicates that within Canada, a higher annual average temperature yields a moderately higher rate of professional soccer player production. Additionally and interestingly, all provinces with an average temperature of 6°C or higher (B.C, Nova Scotia, and Ontario) have a PPC of .50 or greater, while not all provinces with a PPC of .50 or greater have an average temperature of more than 6°C (Alberta). With regard to annual average precipitation, two of the three provinces with a PPC of 0.6 or greater have average precipitation rates of between 2,000 and 3,000 millimeters per year, indicating, as the line best fit in figure 2 does, that annual precipitation rates of 2000-3000mm yield the greatest PPCs. A possible explanation for the slight positive correlation of 0.08 in figure 2 is the correlation between precipitation and temperature within Canadian provinces shown in figure 3.

Figure 3 - Correlation Between Average Annual Precipitation and Average Annual Temperature

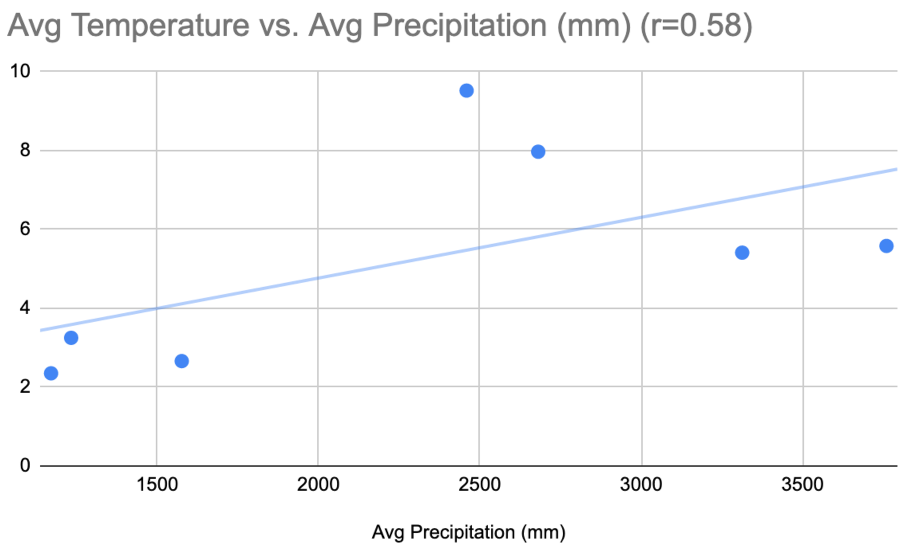


Figure 3 shows the correlation between precipitation and temperature. The existing correlation is prevalent to the same extent as the correlation between temperature and precipitation documented in figure 2. The strong positive correlation of .58 in this graph shows that Canadian provinces and territories with low levels of annual precipitation also have low temperatures. Areas with precipitation levels of less than 2000mm have average temperatures of less than 4°C, while areas with precipitation levels ranging from 3000mm to 5000mm have temperatures of more than 4°C and less than 6°C. Between the two annual precipitation levels of 2000mm and 3000mm are the two provinces with the highest annual temperatures, B.C and Ontario, which make up two of the three provinces with the highest PPC's, .62 and .89 respectively — possibly indicating that these provinces have the best climates for soccer player production in Canada. The climate of Alberta somewhat disproves this though, with a provincial climate similar to that of Manitoba and Saskatchewan and a PPC of .68, greater than that of British Columbia. Alberta's high PPC is also in disagreement with the findings of Nicholas Holt (2002), who placed particular importance on the possibility of outdoor soccer being a factor in Canadian soccer development and that this was only possible in the western coastal regions of British Columbia. Ontario and Alberta having the two highest rates of professional soccer player production per capita serves to amend the notions put forward by Holt (2002) in his section on climate, that is, that the inability of the Canadian provinces (B.C. excepted) to play outdoor soccer in all months of the year lead to poorer soccer development when compared to the player development of England.

Conclusion

The results of this study infer that, within Canada, regions with the highest average annual temperatures will generally produce higher numbers of professional soccer players per capita. With regard to precipitation, it can be concluded that high or low rates of annual precipitation have little bearing on the production of soccer players from that region. Conversely, it can also be observed that within Canada, provinces with moderate levels of precipitation, specifically 2000-3000 millimetres per year, have the highest rate of professional soccer player production per capita within Canada. This study serves to provide an exact numerical value for the effect a region's climate has with regard to the production of professional soccer players amongst the Canadian provinces — something that, as far as it is apparent, has not been explored before in any region. The real-world implications of these findings are vast. The speculative affirmation of Nicholas Holt's findings relating to temperature of a region and soccer player production imply that a lack of access to indoor facilities may affect, to a significant extent, the production and development of Canadian soccer players. But, little can be substantially concluded due to the little amount of data supporting the study. If Canada wants to be a real power on the international soccer stage, then consideration should be taken to fund indoor soccer facilities in the coldest regions and possibly subsidize the expense. Future exploration in this sparsely researched field of climate and sports development — in particular soccer development, must explore the effect of climate on professional player production in other countries and climates, and on different scopes. Additionally, the effects of other factors on soccer player production should be explored and contrasted.

Limitations

The conclusions of this study are limited, due in large part to the little amount of data analyzed. As such, future research should explore this topic with greater swaths of data in order to solidify a conclusion. The USL League One is the third division of professional soccer in the United States. The only Canadian professional soccer team in the league, Toronto FC II, usually competes and fields a team composed of mostly Canadian players. In the 2019 season for example, the official TFC II roster had 24 Canadian players. In 2020 though, the team announced they would not play in the 2020 USL League One season due to COVID-19 restrictions. This limits the accuracy of the study's results, as in a regular season, there would be around 24 more Canadian professionals from varying provinces. Another limitation preventing entirely objective and accurate results is the method employed to account for a region's climate. As discussed previously, the climates of the top three most populous cities within each province or territory were averaged to present a climate representative of the whole area. This method is imperfect as the three most populous cities may not be an accurate representation of the area from which a professional soccer player could have originated, and is not an entirely accurate representation of an entire area's climate. While the climate of the region a soccer player develops plays a moderate factor in the development of the player, at least in Canada, it is far from the only factor, or most important one. Along with climate, Holt (2002) researches the effects on soccer player development of ability and relative age advantage, competitive exposure, coach education levels, and geography. Similarly, Song and Zhang (2017), explore the relationship between culture and sports development, in which it is concluded that a region's attitude toward specific sports may be influenced by climatic and geographic factors.

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Appendix A

All of the data used in the completion of the study.

Province	Avg Temperature °C	Avg Precipitation (mm)	Population (Q4 2020)	Professionals	Professionals per capita
Alberta	3.25	1233.5	4,428,082	30	.68
B.C.	9.52	2458.9	5,145,785	32	.62
Manitoba	2.66	1576.2	1,379,469	5	.36
New Brunswick	5.37	3573.5	781,282	1	.13
Newfoundland and Labrador	4.88	3919	520,961	0	0
N.W.T	1.37	865.9	45,037	0	0
Nova Scotia	6.45	4168.4	979,089	5	.51
Nunavut	-9.7	1000.3	39,288	0	0
Ontario	7.97	2680.8	14,733,506	131	.89
P.E.I	5.61	3379	159,747	1	6.26
Quebec	5.41	3312.9	8,575,812	41	.48
Saskatchewan	2.35	1171.2	1,177,782	2	.17
Yukon	-2.41	1003.2	42,165	0	0

Appendix B

Number of Professional Players From Each Province and Territory

Canadian professional soccer players in the 2020 Canadian Premier League rosters (provinces and territories without any players are not displayed).

Province	Professionals
Alberta	23
B.C.	16
Manitoba	3
New Brunswick	1
Nova Scotia	3
Ontario	60
P.E.I	1
Quebec	25
Saskatchewan	1

Canadian professional soccer players in the 2020 Major League Soccer rosters.

Province	Professionals
Alberta	3
B.C.	9
Nova Scotia	1
Ontario	25
Quebec	9

Canadian professional soccer players in the 2020 USL Championship rosters.

Province	Professionals
B.C.	2
Nova Scotia	1
Ontario	13
Quebec	3
Saskatchewan	1

Canadian professional soccer players in the 2020 USL League 1 rosters.

Province	Professionals
B.C.	1
Ontario	1

Canadian professional soccer players playing professionally abroad at the outset of the 2020 season.

Province	Professionals
Alberta	4
B.C.	4
Manitoba	2
Ontario	32
Quebec	4