BIOL3000 LAB REPORT

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The Effects of Home Game Advantage on Individual Offensive Player Performance, Individual Goalie Performance, and Number of Home and Away Game Wins During NHL Regular Season Games

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Abstract:

Introduction: Over the decades, home game advantage has been a widely debated topic in sports in terms of its impact on whether a team will win or lose. Many studies have looked at college-level sports and have found an impact on home game advantage due to multiple factors. While it has been predicted that home game advantage may not impact professional sports as significantly as college-level sports, there is not enough research to support or deny this prediction. The present study aims to examine the impacts of home game advantage on the NHL hockey league by analyzing potential factors such as individual player performance, individual goalie performance, and the number of wins at home and away games.

Materials & Methods: The data was collected from the official NHL website (nhl.com); data was compiled for each of the 3 factors from the 2014-2015 regular season to the 2018-2019 regular season. Specific filters were applied to select for the desired information, and the data was organized into tables on Excel files. These files were converted to CSV files, which were imported into RStudio for data analysis using statistical paired t-tests as well as data visualization (boxplots).

Results: For each of the 3 factors that were predicted to affect home game advantage in the NHL league, a statistical difference was found ($p < 0.001$, $n = 31$). This means that individual player performance and goalie performance were impacted by home game advantage and seemed to increase performance; similarly, the number of wins was impacted by home game advantage, and teams received more wins during home games compared to away games (on average).

Discussion: While the results of the study support the idea that home game advantage can ultimately impact whether a team wins or loses, there are potential limitations and confounds in the present study that should be recognized. The results of this study should therefore prompt future work that aims to further determine the effects of home game advantage in professional sports leagues.

Introduction:

The idea of "home game advantage" in sports is an extensively spoken-about topic across multiple disciplines. While the term can be loosely thrown around in conversation, it has been disputed that there are no sports in which sports teams or individual athletes are overall more successful away from their home venue (Allen & Jones 2013). This phenomenon surrounding the fact that athletes are considerably more successful depending on their location has been a topic of interest in sports psychology for decades (Nevill & Holder 1999). The factors that attest to a home game advantage include the familiarity of conditions and territorial instincts, travel fatigue, crowd size, crowd composition, and referee bias (Nevill & Holder, 1999; Allen & Jones 2013; Pollard & Gomez 2015). This concept has also been explored from different perspectives, including the examination of physiological or psychological effects that influence athletic performance at home (Allen & Jones 2013; Pollard & Gomez 2015).

The home advantage phenomenon has been hypothesized to exist at all levels of sports, however, college-level sports have exhibited the most noticeable difference in athletic performance based on location (Pollard & Gomez 2015). This level of play is believed to experience the most significant impact of home game advantage due to multiple factors which will be later discussed (Pollard & Gomez 2015). While it would be expected that professional leagues would display a greater discrepancy in player performance between game locations due to the level and intensity of play as well as the sizes of crowds, it has been predicted that college-level sports may be impacted at a greater level (Smith 2003; Pollard & Gomez 2015; Carron et al. 2005).

The most influential factor of home advantage is argued to be the psychological impact of players' familiarity of conditions and crowd composition (Jamieson 2010). With respect to college sports, campus communities can be considered close-knit, socially homogeneous groups that may be more intimidating for a visiting team due to the social demographic and maturity levels of athletes and fans. College athletes that live and practice on campus become very familiar with their home surroundings and can have a harder time feeling comfortable at a different location (Pollard & Gomez 2015). On the other hand, professional athletes become more familiar with bigger cities and travel more often, therefore away locations may not feel as intimidating, and the unfamiliarity of opponent venues should be less significant (Pollard & Pollard 2005; Pollard & Gomez 2015).

An idea that stems from the familiarity of a home venue is the territorial model proposed by Neave and Wolfson (2003). Athletes playing for a college or university feel a sense of security on home grounds that are consistently displaying team names, college logos, and mascots; athletes may also feel the need to protect their own "territory" in this sense (Neave & Wolfson 2003; Pollard & Gomez 2015). While professional leagues do not have the same campus atmosphere, stadiums are also usually catered towards the teams, and players can spend up to 5 consecutive years playing for a team, which will inevitably increase the territorial home feeling (Neave & Wolfson 2003). The territorial model likely has physiological effects on athletes, which could contribute to home game advantage.

The sense of territorial protection has been associated with a pre-game surge in testosterone (Neave & Wolfson 2003). Higher testosterone levels can increase players' aggressivity, confidence, and overall performance, which may be a direct result of improved athletic performance at home (Fothergill et al. 2017). This factor may be more of an influence

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due to the average age of college athletes compared to professional athletes, considering testosterone levels are highest around the age of 19 (Severson 2019).

Although college-level athletes are predicted to be affected by home game advantage more significantly than professional athletes, it is predicted that player performance can still be influenced by the game location in professional sports as well. The purpose of this study is to determine if home game advantage exists at the highest level of sports; in this case, the National Hockey League (NHL) will be used to test this prediction. Since almost all of the research on home game advantage has been studied at college-level sports, the present study aims to determine if the factors contributing to home game advantage can affect the performance of elite athletes as well. In particular, the factors analyzed in the present study will include individual offensive player performance (measured by the number of goals scored by forwards), individual goalie performance (measured by save percentage), and the number of wins at home and away games for each NHL team. Each of these factors will be compared between home and away game conditions for 5 consecutive seasons: from the 2014/2015 regular season to the 2018/2019 regular season. The results of this study may provide insight into whether the home game advantage is truly impactful and should therefore be considered when scheduling regular season, as well as "higher stake" play-off games, such as the Stanley Cup, to provide fair accommodations for each competing team within the league. As many sports leagues and associations pride themselves on fairness and equality, this should be of utmost importance to them when considering game scheduling and should be noted with a high level of importance.

Methods and Materials:

Collection of Data

      All data for the number of home game wins, away game wins, goals scored by offensive players, and goalie save percentages were collected by the National Hockey League and available on nhl.com. This website contains up-to-date data on all parameters within the NHL and is able to be sorted by season, game, team, and players. The data on nhl.com is updated consistently after each game played in the NHL.

Analyzation of Data

      The first factor measured to assess the presence of a home game advantage was if teams in the NHL won more games at home (home wins) or away (away wins). This was done by accessing data from nhl.com and applying filters specific to the desired information. First, the "Statistics" tab on the website was selected, followed by "Teams" and then "By Season". In order to select for the five consecutive seasons we are analyzing, underneath the "Seasons" tab, "2014-15" was selected as the star date, and "2018-19" was selected as the end date. The "Franchise" was also specified, and had to be done for each individual team, and then "More Filters" was selected. Underneath "Game/Opponent", "Home" was selected, and "All results". The number of home games won was recorded, as well as the total number of games played at home. This was repeated for "Road" and the number of road games won, as well as the total number of road games played was recorded. For example, the series of steps to collect data: Statistics > Teams > By Season > Select Seasons > Select Franchise > More Filters > Game/Opponent (Home or Road) > Get Stats. After the application of filters, the only tab

changed was Home or Away. It can be noted that during a regular season, each team in the NHL plays an equal number of home and away games. The total number of wins for home and away were recorded in an Excel table to be imported into RStudio for statistical analysis and data visualization.

To determine the difference in the offensive player performance, we analyzed the difference in the total number of goals scored by offensive players (forwards) on home ice versus away ice. Only the number of goals scored was used; assists were not counted towards the number of points awarded to players. The "top three" forwards for each team throughout the five seasons were picked to use in order to display how player performance may differ based on game location. The selection of players per team was based on whether the player had consistent points throughout all 5 seasons; while some players did not play certain seasons due to injuries or league trades and therefore did not score any goals during that year, these zeroes did not have a significant impact on our results. To analyze player performance with respect to goals scored by offensive players for each team in the NHL from the 2014/15 season to the 2018/19 season, a series of filters were also applied. On the NHL website (nhl.com), the "Statistics" tab was selected, followed by the "Skaters" and then the "By Season" tab. The "More filters" was also selected in order to specify the results. Each season was looked at separately by selecting the desired season in the drop-down tab, and then "Franchise" was specified, along with "Position" for which "All forwards" was selected. Underneath the "Game/Opponent" drop-down tab, "Home" or "Road" was selected and the total number of goals scored for each situation was recorded for the team for the specific season. For example: Statistics > Skaters > By Season > More Filters > Season (2014-15) > Franchise (Anaheim Ducks) > Position (All forwards) > Game/Opponent (Home or Road) > Get Stats > Record total number of goals for home versus

away. The players are presented by who scored the most to least goals and the first three were selected; these players were also screened to make sure they had played all or most of the 5 consecutive seasons with that specific team. The total number of goals for home and away were recorded in an Excel table to be imported into RStudio for statistical analysis and data visualization.

Goalie performance based on game location was also analyzed, as a goalie's performance is determined by how many shots are saved (Sv%). Goalie save percentage is the number of shots stopped or saved by a goalie (Svs) divided by the total number of shots taken against the goalie (SA). The save percentage is displayed between 0 and 1.0, which corresponds to 0% and 100%, respectively. To analyze player performance with respect to goalie save percentage for each team in the NHL from the 2014/15 season to the 2018/19 season, a series of filters were also applied. On the NHL website (nhl.com), the "Statistics" tab was selected, followed by the "Goalies" and then the "By Season" tab. The "More filters" tab was also selected in order to specify the results. Each season was looked at separately by selecting the desired season in the drop-down tab, and then "Franchise" was also specified. Underneath the "Game/Opponent" drop-down tab, "Home" or "Road" were selected and the save percentage for each situation was recorded for the team for the specific season. For example: Statistics > Goalies > By Season > More Filters > Season (2014-15) > Franchise (Anaheim Ducks) > Game/Opponent (Home or Road) > Get Stats > Record Sv% (0.917 and 0.912). The only filter that differed was the selection of "Home" or "Road". Goalie save percentages for each team, across the five specified seasons for home and away locations, were organized in an Excel table to be imported to RStudio for statistical analysis (t-test) and data visualization.

After the construction of tables that contain information for each category, data sets were imported to RStudio in the CSV-UTF 8 (comma delimited) format (abbreviated as .csv). These CSV files were used to create 3 separate boxplots, which are displayed in the Results section of this study. Three separate statistical paired t-tests were also conducted using the data from each of the 3 CSV files, and the results from these statistical tests have also been reported in the Results section as well. An annotated R Markdown (RMD) file has been created with all relevant statistical information and codes for boxplot visualizations.

Results:

The results of the analysis found that there is a mean difference of 38.484 (CI: 95%, 22.071 - 54.897) between the average number of points scored at home games compared to away games. Because the number of points scored is reflective of individual offensive player performance, this means there is a significant difference in offensive player performance during home games compared to away games ($t_{30} = 4.789$, $p<0.001$). Figure 1. displays the number of points scored for both home and away games; the data was averaged using game points from 3 offensive players from each NHL team who had a consistent number of goals scored throughout all 5 seasons (n=31). The number of goals scored have been combined from the 2014-2015 regular season to the 2018-2019 regular season.
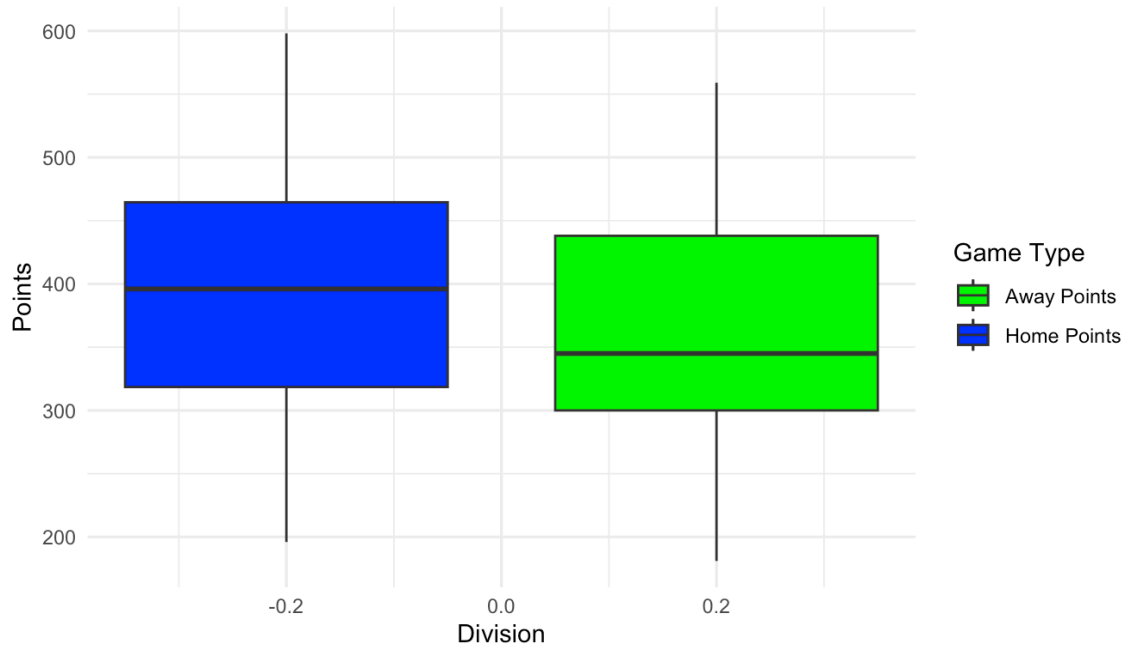
Figure 1. The average number of goals scored by 3 offensive players for each NHL team for both home and away games; the data has been combined from the 2014-2015 regular season to the 2018-2019 regular season (n=31).

Additionally, there is a mean difference of 0.550% (CI: 95%, 0.424 - 0.677) between the average goalie save percentage for home and away games. Given that the average save percentage is reflective of goalie performance, this means there is a significant difference in goalie performance during home games compared to away games (t_{30} = 8.91, p<0.001). Figure 2. displays the goalie save percentages, averaged from each of the goalie(s) on each NHL team (n=31). The save percentages have been combined from the 2014-2015 regular season to the 2018-2019 regular season.
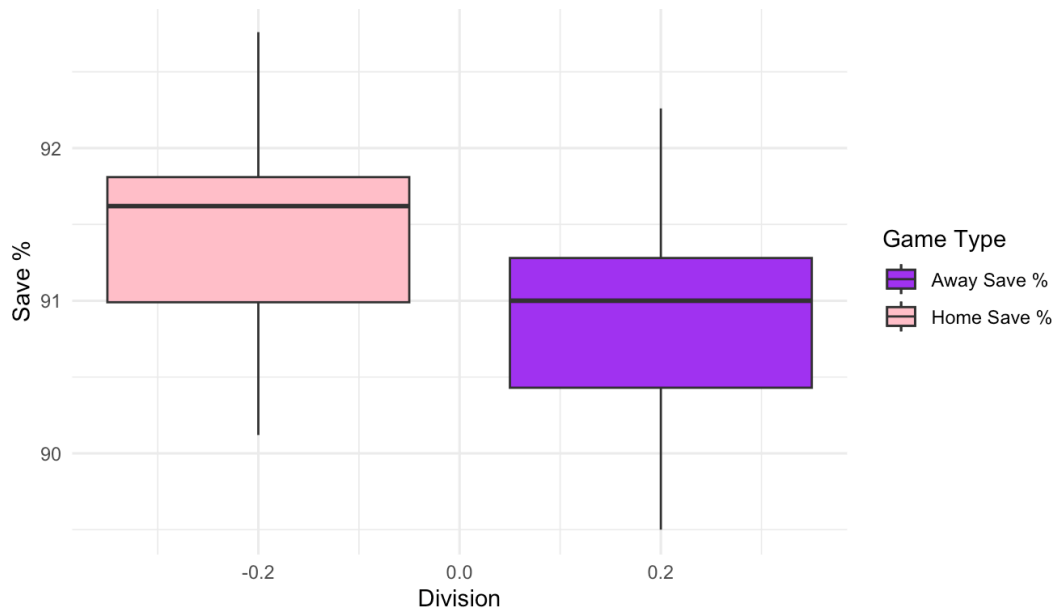
Figure 2. The average goalie save percentages for each NHL team for both home and away games; the data has been combined from the 2014-2015 regular season to the 2018-2019 regular season (n=31).

Finally, there is a mean difference of 20.290 (CI: 95%, 17.158 - 23.423) between the average number of wins for home and away games. This means there is a significant difference in the number of wins for NHL teams during home games compared to away games (t_{30} = 13.227, p<0.001). Figure 3. displays the number of wins, averaged over all NHL teams (n=31). The total number of wins have been combined from the 2014-2015 regular season to the 2018-2019 regular season.
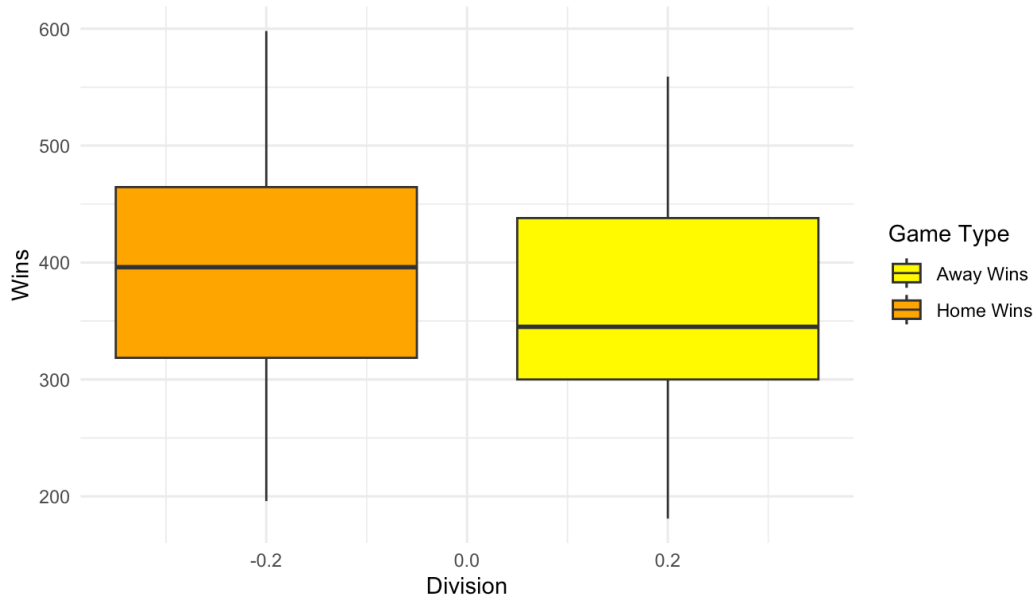
Figure 3. The average number of wins for each NHL team for both home and away games; the data has been combined from the 2014-2015 regular season to the 2018-2019 regular season (n=31).

Discussion:

The purpose of the present study was to examine factors that had a potential effect on home game advantage. The factors selected for this study included individual offensive player performance, individual goalie performance, and the number of wins at home and away games.

Individual offensive player performance was measured by the average number of points scored for each NHL team (n=31) from the 2014-2015 regular season to the 2018-2019 regular season. Three offensive players were chosen from every team; all players were required to have had consistent playing time and have consistently scored goals throughout all 5 seasons in order to accurately assess the number of points scored across all games for all selected seasons. Rather than choosing 3 different top-line offensive players from every year and for every individual team, we chose to select 3 players for every team and measure them across all 5 seasons. The

main reason for this is because each offensive player would be highly variable, so choosing 3 players from each team would allow for more consistency in our results.

Individual goalie performance was measured by the average save percentages for each NHL team (n=31) from the 2014-2015 regular season to the 2019-2020 regular season. Because the goalie for each team is highly variable from year to year, and oftentimes there are 2-3 goalies that play a consistent number of games throughout the regular season, the save percentages were averaged over all goalies, which varied between the team and the season.

The number of wins at home games compared to away games was another variable that was measured to examine the effects of home game advantage. This was measured by counting the number of wins for every home and away game for each NHL team (n=31) from the 2014-2015 regular season to the 2018-2019 regular season.

To determine the difference between home games and away games, a statistical paired t-test was conducted for all 3 factors: individual player performance, individual goalie performance, and the number of wins. For each of the 3 factors that were predicted to affect home game advantage in the NHL league, a statistical difference was found (p<0.001, n=31). Based on the results of the study it can be assumed that individual offensive player performance, individual goalie performance, and the number of wins all have a significant effect on home game advantage.

The average number of home game wins for every team (across all 5 seasons) was 114.2 ± 14.456, while the average number of away game wins was 94.0 ± 13.37. The mean of the differences between home and away games was calculated to be 20.290. This means that every team in the NHL, on average, won approximately 20 more games in their home arena compared to their opponent's arena across all 5 seasons. This is approximately 4 more games per season.

Even though this may not seem like a large number, each team plays an average of 82 games throughout the regular season; each win counts as 2 points in the regular season standings, therefore 4 more wins at home equates to 8 points per season (Gaimday 2021). While this may not seem like a significant factor in regular season rankings, it is important to note that not all teams get scheduled the same amount of home and away games each year, which is especially crucial during playoff season. The NHL official website reports that each team is allotted exactly 41 home games and 41 away games for the regular season (NHL 2019); however, many sources have reported this to be false information. For example, in the 2020-2021 season, the New York Islanders played 44 home games and 38 away games, while the Las Vegas Knights played 38 home games and 44 away games (Bruins Analytics 2019). Although this is just one example, Bruins Analytics (2019) reports there have been numerous reports throughout the years similar to this. Factors such as canceled or rescheduled games, media attention from certain divisional match-ups, and unforeseen circumstances affecting the regular season time frame (such as COVID-19) can all influence the unequal distribution of home and away games (Bruins Analytics 2019).

During analysis, home and win game win percentages were calculated based on regular season games from 2014-2015 to 2018-2019 and averaged across all teams (n=31). The home game win percentage was calculated to be 51.94%, while the away game win percentage was calculated to be 44.52%. These percentages align with the results of our data because even though the number of wins is only slightly higher, on average, this percentage still demonstrates the prevalence of home game advantage in the NHL league.

Additionally, there are other variables that were not examined that may have an effect on home game advantage. For example, Carron et al. (2005) state that the number of hours a team

must travel to their opponent's city and the mode of transportation can indirectly affect player performance by affecting player fatigue, muscle stiffness/soreness, or lack of sleep from travel. There are situational travel differences between sports at the college level and professional levels that can be noted. College sports are usually played within regional conferences to minimize travel distances and avoid having to adapt to time zones, while professional teams, such as teams in the NHL, tend to travel more often due to playing teams across divisions. Traveling more may negatively impact performance at away locations, however, for professional teams it also becomes more routine (Pollard & Gomez 2015). Another factor to consider is the quality of travel accommodations. Professional leagues such as the NHL have private jets for the franchise to transport players in order to minimize travel time and increase comfort (Goss 2013; Carron et al. 2005). On the other hand, college teams do not have the same funding and often travel via bus, which can consist of long, uncomfortable car rides that may affect the sleep of players, which reduces athletic performance (Pollard & Gomez 2015). While professional sports teams seem to have accommodations that can help to reduce travel fatigue in players, travel hours and time zone changes could still have a potential impact on player performance and should be considered.

Another variable that is important to consider is the arena itself, and the external environment created by the number of fans, the size of the arena, and/or fan behavior. For example, the Winnipeg Jets' arena has a capacity of 15,321, while the Montreal Canadiens' arena has a capacity of 21,302 (GeoJango 2021). A difference of almost 6,000 seats can have a major influence on the number of fans, which can affect the energy, volume, and intensity created within the stadium. Fan behavior is also variable between each team and arena; for example, Toronto Maple Leafs are reported to have one of the most "ruthless" and disruptive fan bases,

and many fans have reported starting stadium-wide chants or causing physical disturbances (such as throwing objects onto the ice) to intimidate or offset the opposing team (Goss 2012). This would require an extra level of mental toughness during away games for many of the teams that play the Maple Leafs, which could have an effect on individual player performance and therefore ultimately affect the results of the game.

Finally, playing in a home arena can cause territorial and protective feelings, which have been associated with a pre-game surge in testosterone (Neave & Wolfson 2003). A home arena setting can have physiological effects by stimulating an increase in testosterone, which can ultimately increase a player's assertiveness, awareness, reaction time, cardiovascular efficiency, and confidence (Fothergill et al. 2017). An increased testosterone level experienced during home games compared to away games may dictate player performance and be a direct cause of increased performance at home locations.

While the results of our analysis support our initial prediction, the present study had potential limitations and confounds that could have affected these results. First, we did not factor the individual player performance of defensive players into our study. This is because there is no direct measurement of player performance for defensive players, unlike offensive and goalie player positions. We potentially planned to examine the number of shots blocked or the number of points scored by defensemen, however, defensive ability is often measured by the "lack" of events, such as the lack of points being scored against, so this would be a complicated metric to factor into our study. This is ultimately why we chose offensive and goalie player performance over defensive player performance, however, it should not be disregarded when looking at factors affecting home game advantage. Future research should aim to develop a suitable metric

to measure individual defensive player performance to further determine its effect on home game advantage.

The second potential limitation is the length of time used for our study. All variables were examined from the 2014-2015 regular season to the 2018-2019 regular season. For the present study, we did not examine any variables past the 2018-2019 regular season because of the events of the COVID-19 pandemic, which heavily impacted the NHL league. The regular season was suspended on March 12, 2020, and then was resumed on August 1, 2020 (NHL 2019). Because of this suspension, the regular season was cut short, and playoffs were canceled. This is the reason we chose to collect our data only up until the 2018-2019 season; while the league has resumed since COVID-19, we chose to only analyze the data from 5 consecutive years for consistency. Future research should aim to look at a higher number of seasons (for example, the 2000-2001 season to the 2018-2019 season) which would allow for a larger sample size. This would increase generalisability and allow for a more accurate description of home game advantage trends throughout the years. The NHL first started in 1917, meaning over 100 regular season years have occurred (NHL 2019). Looking at only a 5-year margin therefore may not allow for the most accurate evaluation of home game advantage, therefore future work is needed to further understand the impacts of home game advantage in the NHL league.

Finally, other factors such as coaching performance and individual player impacts, which were not controlled for in the present study, could have significantly affected our results. One example of this is the impact of exceptionally skilled offensive players, which can highly influence whether a team wins or loses. For instance, Connor McDavid, who plays for the Edmonton Oilers, has averaged approximately 112 points per season for the last 5 consecutive seasons and is the league's leading goal scorer (NHL 2019). According to the NHL, the average

offensive player scores approximately 45 points per season; this means that Connor McDavid has a 249% increase in terms of goals scored per season (NHL 2019). If Connor McDavid scores approximately 1.36 goals per game over an 82-game regular season, while the average offensive player only scores approximately 0.58 goals per game, then this means McDavid's team, the Edmonton Oilers, could have a significant advantage over an opposing team, regardless if the game is in a home or away arena.

In terms of coaching performance, there are many variables that could affect team dynamics, which would indirectly affect team performance. Sports analysis websites, such as SportsNet, often run diagnostic reports on team performance under certain coaches, and the results often show significant increases or decreases in team performance without the addition of new players or the occurrence of new injuries (SportsNet 2020). If coaching ability can highly impact a team's performance and thus their ability to win games, then future work should aim to control for this variable when examining the effects of home game advantage.

In summary, the present study demonstrates that home game advantage seems to ultimately impact whether a team wins or loses, and factors such as individual offensive player performance, individual goalie performance, and the number of wins throughout the regular season all seem to significantly impact home game advantage ($n=31$, $p<0.001$). Although our results show an impact of home game advantage on the NHL league, it is important to factor in potential limitations or confounds that may have influenced the results of the present study. Future research should aim to eliminate these confounds by increasing sample size as well as factoring for defensive player performance or external factors such as arena environment. Doing this may allow for a more accurate estimate of the effect of home game advantage on teams in the NHL hockey league.

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