CBÜ Beden Eğitimi ve Spor Bilimleri Dergisi
CBU Journal of Physical Education and Sport Sciences
Volume: 18, Issue: 2, 2023
E-ISSN: 2149-1046
DOI: 10.33459/cbubesbd.1307573
URL: https://dergipark.org.tr/tr/pub/cbubesbd

Exploring Predictors of Team Performance in Curling Championships: An Investigation of Factors Predicting Success

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Research Article
Received: 31/05/2023 Accepted: 23/12/2023 Published: 31/12/2023

Abstract

Curling is one of the most popular sports of the Olympic Winter Games. As strategy is very important for curling, it is called “chess on the ice”. Given the exponential surge in sports-related data, the analysis of game performance has assumed paramount importance, as it provides a valuable avenue for improving overall athletic performance. The aim of this research was to examine the effect of some parameters on championship performance of elite level curling teams. The data used in this study were taken from the World Curling Federation Historical Results database. World Mens/Womens Curling Championships (2021 – 2022 – 2023) and European Mens/Womens Curling Championships results (2019 – 2021 – 2022) included in the study. A multiple linear regression analysis was conducted to determine the extent to which the independent variables, namely Draw Shot Challenge distance, shot performance, stolen points for, stolen points against, hammer efficiency, force efficiency, and difference of generated and given points, explained team success. Statistical Package for Social Sciences 24.0 software used for statistical analyses. The results revealed an R-value of 0.902 and an adjusted R-squared value of 0.804. In the study investigating the factors influencing team success in World and European Curling Championships, it was concluded that the difference of points generated and given points, Draw Shot Challenge distance, and hammer use efficiency predicts championship success.
Keywords: Chess on the ice, Strategy, Game analysis

Curling Şampiyonalarında Takım Performansı Yordayıcılarının Araştırılması: Başarıyı Yordayan Faktörlerin İncelenmesi

Abstract

Curling, Kış Olimpiyat Oyunları'nın en çok izlenen branşlarından biridir. Stratejinin curling için büyük öneme sahip olması nedeniyle curling "buz üzerinde satranç" olarak adlandırılmaktadır. Günümüzde sporla ilgili verilerin hızla artmasıyla birlikte, oyun performansının analizi genel spor performansını iyileştirmek için son derece önemli bir yol sağlamaktadır. Bu araştırmanın amacı, elit seviyedeki curling takımlarının şampiyona performansını etkileyen bazı parametrelerin incelenmesidir. Araştırmada kullanılan veriler, Dünya Curling Federasyonu şampiyona sonuçları veritabanından alınmıştır. Çalışmaya dahil edilen veriler, Dünya Erkek/Kadın Curling Şampiyonası (2021 - 2022 - 2023) ve Avrupa Erkek/Kadın Curling Şampiyonası sonuçlarını (2019 - 2021 - 2022) içermektedir. Çoklu doğrusal regresyon analizi, Draw Shot Challenge mesafesi, atış performansı, çalınan puanlar, çaldırılan puanlar, çekiç hakkı kullanım verimliliği, rakibi bir sayı almaya zorlama durumu ve şampiyonada alınan – verilen edilen puanların farkı gibi bağımsız değişkenlerin takım başarısını ne ölçüde açıkladığını belirlemek için yapılmıştır. İstatistiksel analizler için SPSS 24.0 yazılımı kullanılmıştır. Sonuçlar, R değeri 0.902 ve düzeltilmiş R-kare değeri 0.804 elde edilmiştir. Dünya ve Avrupa Curling Şampiyonalarında takım başarısını etkileyen faktörleri inceleyen bu çalışmada, alınan – verilen puan farkı, draw shot challenge mesafesi ve çekiç hakkı kullanım verimliliğinin şampiyona başarısını yordadığı sonucuna varılmıştır.
Anahtar Kelimeler: Buz üzerinde satranç, Strateji, Maç analizi

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INTRODUCTION

Curling, regarded as a blend of bowling and chess, is a winter team sport played by more than 2 million people worldwide, across various age categories (Kostuk et al., 2001). In curling, two teams, comprised of four individuals each, aim to strategically deliver curling stones with the objective of placing them as close as possible to the center of the designated target area called the “house” (Bradley, 2009; Steele et al., 2014). Having originated in the 16th century, curling initially found its roots in Scotland, where it was played on frozen lakes (Wieting & Lamoureux, 2019). Over time, the sport has gained substantial recognition and currently ranks among the most popular and widely viewed Olympic sports (Turriff, 2016). Distinguished by its unique characteristics, curling stands out as the sole target sport in which the trajectory of the projectile can be altered even after the athlete has released the curling stone (Buckingham et al., 2006) and is called ‘chess on ice’ (Haggerty, 2013). Curling games take place on designated ice surfaces known as "sheets," which typically measure 5m x 45m in size (Kostuk & Willoughby, 2006). Strategy plays a paramount role in the sport of curling, as players are required to engage in continuous forward-thinking, anticipating and planning several moves ahead (Westlund-Stewart & Hall, 2017). Based on the predetermined strategy or the existing position of the rocks, teams in curling have the flexibility to execute various shots. These include delivering their srocks in the house, eliminating the opponent's rocks from play, displacing opponent rocks away from the house, or strategically placing their own rocks as guards to influence subsequent moves (Neyedly, 2012). At the conclusion of an end, which occurs after the delivery of 16 rocks, the primary objective in curling is to accumulate the highest number of rocks positioned closer to the center of the house than the nearest rock of the opposing team. The goal is to secure a greater count of rocks in favorable proximity to the center of the house compared to the opponent's rocks (Otani et al., 2016). The hammer shot holds significant importance in curling as it serves as the final shot of an end and has a direct impact on scoring. The team delivering the hammer shot possesses a strategic advantage, as they have the opportunity to influence the final positioning of stones in the house and potentially earn higher scores based on the outcome of their shot (Ahmad et al., 2016).

In light of the rapid growth in sports-related data, the analysis of game performance has gained paramount significance as a means to enhance overall athletic performance (Park & Lee, 2013). By delving into the extensive pool of available data, teams and athletes can extract valuable insights, patterns, and trends to inform their strategic decision-making, optimize training approaches, and ultimately elevate their game performance. Sports analysis utilizing data can offer valuable information to individuals who enjoy watching sports broadcasts across various disciplines, including soccer, baseball, basketball, tennis, ice hockey, and curling (Schumaker et al., 2010). A research study has identified a noteworthy disparity in playing patterns between successful and unsuccessful teams (Hughes et al., 1988). Specifically, the findings indicate that successful teams tend to exhibit a significantly higher number of ball touches per possession compared to their less successful counterparts. In another research study, an analysis was conducted on the relationship between goal scoring and the number of touches per possession in a sporting context. Research concluded that the passing tactics of a team are dependent upon the skill levels of the players of each team, and the tactics best suited

to a particular team can be gauged by match and analysis (Hughes, 2003). Keith and Kent (Willoughby & Kostuk, 2004) conducted a relevant study in the field of curling game analysis, where they surveyed elite curlers at the global level. The objective of their research was to ascertain the preferences and probability estimates of these high-caliber curlers concerning specific game outcomes. The study found that there were distinct differences in the individual preferences and estimations of likelihood among the participants involved in the research. In their respective studies, Kim & Yoon (Kim & Yoon, 2008) and Kim (Kim, 2009) conducted analyses to examine the variations in strategic frequency exhibited by curling teams from Korea, China, and Japan. In the sport of curling, there is a widely acknowledged understanding that the team having the advantage of throwing the last stone at both the opening and closing ends has a higher chance to win the game. Most of the situations teams will want to give the hammer to the opponent in the next end by taking multiple points. Since hammer is an extremely important factor in the curling game, studies on this concept are available in the literature (Ahmad et al., 2016; Kostuk & Willoughby, 2006; Kostuk et al., 2001; Park & Lee, 2013).

When the literature is reviewed, it is seen that research on curling are related to sports psychology (Collins & Durand-Bush, 2010, 2014, 2019; Paquette & Sullivan, 2012; Shank & Lajoie, 2013; Stewart & Hall, 2016; Tamminen & Crocker, 2013; Westlund-Stewart & Hall, 2017), engineering (Buckingham et al., 2006; Gwon et al., 2020; Heo & Kim, 2013; Ito & Kitasei, 2015; Kawamura et al., 2015; Lee et al., 2019; Masui et al., 2016), sweeping (Bradley, 2009; Kim et al., 2021; B. Marmo et al., 2006; B. A. Marmo et al., 2006; Yanagi et al., 2008), hammer shot (Ahmad et al., 2016; David, 2012; Kostuk & Willoughby, 2006) and strategy (Otani et al., 2016; Willoughby & Kostuk, 2004, 2005). However, no study has been found on effect of draw shot challenge distance, generated points, hammer efficiency and team shot percentage on championship performance. The aim of this research is to examine the effect of some parameters on championship performance of elit level curling teams.

METHOD

Study Design

The data used in this study were taken from the World Curling Federation Historical Results database. Since World Curling Federation sharing publicly its database after 2019, World Mens/Womens Curling Championships (2021 – 2022 – 2023) and European Mens/Womens Curling Championships (2019 – 2021 – 2022) results included in the study. The championships in 2020 could not be assessed as they were canceled due to the COVID – 19 pandemic. The competitions played in Pacific Asia, America and Europe B – C groups were excluded as they were open to all countries and there was an excessive difference between the participating teams in the World rankings. As World Curling Federation officially publish draw shot challenge distance, team shot percentages, stolen ends, hammer efficiency, generated points and gained points for every game from championships, all parameters taken from World Curling Federation website.

Ethical Approval

This research has obtained ethical approval from the Ethics Committee of the Faculty of Sports Sciences at Atatürk University, with approval number 10, July 03, 2023.

Statistical Analysis

In order to answer if parameters such as draw shot challenge distance, shot percentage, stolen ends for, stolen ends against, hammer efficiency, force efficiency and generated point difference effect team success, the normal distribution of the data was tested and it was found to have a normal distribution. The assumption of multicollinearity was assessed by examining the variance inflation factor (VIF) and tolerance values in the multiple regression analysis. All VIF values were found to be less than 10 (ranging from 1.23 to 2.05), and the tolerance values ranged from 0.41 to 0.83. Additionally, the Durbin-Watson test was applied to the data, revealing a value of 1.76, indicating no presence of autocorrelation. Pearson correlation analysis was conducted to determine the relationships between variables. Pearson correlation analysis was also performed to examine the relationships between team success and draw shot challenge distance, shot percentage, stolen ends for, stolen ends against, hammer efficiency, force efficiency, and generated point difference. Subsequently, a multiple regression analysis was conducted to determine the extent to which the independent variables, such as draw shot challenge distance, shot percentage, stolen ends for, stolen ends against, hammer efficiency, force efficiency and generated point difference predicted team success. A significance level of 0.05 was adopted in this study. All statistical analyses were run in SPSS 24.0 version.

FINDINGS

Table 2. The means, standard deviations, and correlation results among the dependent and independent variables

	$\bar{X}$	ss	1	2	3	4	5	6	7
1. TS	54,9	28,5							
2. DSC	38,1	18,5	-0,53**						
3. SP	79,8	5,1	0,75**	-0,60**					
4. SPF	11,2	4,6	0,68**	-0,34**	0,57**				
5. SPA	36,3	12,0	-0,56**	0,29**	-0,55**	-0,37**			
6. HE	51,1	12,9	0,79**	-0,42**	0,73**	0,55**	-0,65**		
7. FE	0	26,9	0,66**	-0,42**	0,61**	0,40**	-0,36**	0,61**	
8. DIF	54,9	28,5	0,88**	-0,46**	0,79**	0,70**	-0,69**	0,88**	0,73**

TS: Team Success, **DSC:** Draw Shot Challenge Distance, **SP:** Shot Percentage, **SPF:** Stolen Points For, **SPA:** Stolen Points Against, **HE:** Hammer Efficiency, **FE:** Force Efficiency, **DIF:** Difference Between Generated and Given Points

As it is seen in Table 2. There is a positive correlation between SP and TS (r = 0.75**), indicating that higher shot percentages are associated with higher team success. There is also a positive correlation between SPF and TS (r = 0.68**), suggesting that teams that successfully steal more points tend to have higher overall success. When HE variable is evaluated there is a positive correlation between HE and TS (r = 0.79**), indicating that higher hammer efficiency

is associated with higher team success. When it is looked at force efficiency variable there is a positive correlation between FE and TS (r = 0.66**), suggesting that higher force efficiency is associated with higher team success. Most notable finding of the study is strong positive correlation between DIF and TS (r = 0.88**), indicating that a larger difference between generated and given points is associated with higher team success.

There is a negative correlation between SPA and TS (r = -0.56**), indicating that teams that given fewer stolen points tend to have higher team success. There is a negative correlation between DSC and TS (r = -0.53**), indicating that as the draw shot challenge distance increases, team success tends to decrease.

Table 2. The predictive levels of the independent variables on Team Success

R	R^2	Adjusted R^2	Std. Error
,902	,814	,804	12,603

Table 3. β and Beta correlation coefficients and significance levels of variables

	B	Std. Error	β	t	p
(Constant)	17,577	33,498		0,525	0,601
DSC	-0,191	0,073	-0,124	-2,611	0,010*
SP	0,263	0,389	0,047	0,675	0,501
SPF	0,723	0,334	0,127	2,166	0,032
SPA	0,408	0,354	0,066	1,15	0,252
HE	0,206	0,198	0,087	1,041	0,300*
FE	0,069	0,138	0,031	0,503	0,615
DIF	0,685	0,143	0,648	4,809	0,000**

TS: Team Success, **DSC:** Draw Shot Challenge Distance, **SP:** Shot Percentage, **SPF:** Stolen Points For, **SPA:** Stolen Points Against, **HE:** Hammer Efficiency, **FE:** Force Efficiency, **DIF:** Difference Between Generated and Given Points

Upon examining Table 3, a multiple linear regression analysis was conducted to determine the extent to which the independent variables, namely DSC, SP, SPF, SPA, HE, FE, and DIF, explained Team Success. The results revealed an R-value of 0.902 and an adjusted R-squared value of 0.804. This indicates that 80.4% of the total variance in Team Success can be explained by these variables. Furthermore, it was observed that the predictor variables DSC, HE, and DIF significantly predicted the dependent variable ($p < 0.05$).

DISCUSSION AND CONCLUSION

In a study investigating the factors influencing success in World and European Curling Championships, the impact of various variables, including the difference in points generated, draw shot challenge distance, championship shot percentage of the team, stolen ends, hammer use efficiency, and force efficiency success was examined. The study found that the independent variables used within the research predicted championship success with a rate of 80.4%. Shot percentage is recognized as an important factor in curling competitions (Park & Lee, 2017). Considering the significant importance of effectively utilizing the hammer in curling, it can be stated that the factors influencing success are accurately analyzed by the World Curling Federation.

In the conducted study, the factor that had the greatest impact on championship success was observed to be the difference between points generated and given. It is stated that the significance lies not in the exact point differential in curling games (Howard, 2010). This statement does not support the research findings. However, considering that teams winning against same level opponents with varying scores are often considered favorites in the championship, it can be argued that the research results accurately reflect the reality.

The study revealed that the second variable that significantly predicted championship success was the draw shot challenge distance. In curling, prior to the start of a match, teams engage in a crucial shot called the draw shot challenge, which determines the team that will have the advantage of the hammer in the first end. This shot, conducted after a 9-minute time allocation for both teams, is of great importance (Shank, 2012). When a team performs better in this shot, it is believed that they have a better grasp of the curl and speed on the ice. Therefore, it is expected that teams with better draw shot challenge distances would have higher success rates.

The research identified that the third factor that had the greatest impact on championship success was the ability to score points when the opponent has the hammer. Considering that successful teams in curling utilize the hammer more efficiently (Willoughby & Kostuk, 2004), it can be argued that the research findings align with this statement.

In the study, it was observed that team shot percentage did not significantly predict championship success. However, a previous study conducted in 2017 (Park & Lee, 2017) found a relationship between shot accuracy and team performance. The discrepancy between these findings and the research results may be attributed to the possibility of key shots, which are included in the analyzed championships, being executed with lower accuracy rates. Additionally, the concept of shot accuracy as a measure of success has been a topic of recent debate, which may further justify the inconsistency.

In the study investigating the factors influencing success in World and European Curling Championships, it was concluded that the difference of points generated and given, draw shot challenge distance, and hammer use efficiency predicts championship success.

This research is limited to the factors and scoring systems officially published by the World Curling Federation. However, there are other characteristics in curling championships that could be included in future research questions, such as the condition of the ice in terms of its curl and speed during the competition, the placement of the stones during shots, the type of shots (draw, take-out, etc.), and psychological factors. These additional factors can provide valuable insights and further enhance our understanding of team performance in curling.

Conflict of Interest: The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Researchers' Statement of Contribution Rate: Introduction, and Discussion part of manuscript was written by FA, Materials and Method section was written by DB, Results section written by SEE.

Ethical Approval: Ethics Committee of the Faculty of Sports Sciences at Atatürk University

Date: 03.07.2023

Issue/Decision Number: 105

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