

Intent to Injure and Severe Head Injuries in NCAA Division I Women's Ice Hockey

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Abstract

Women's ice hockey has the highest rate of concussion injuries of any NCAA sport. Unanticipated checking in ice hockey is a significant contributor to the rate of serious head injuries. This study evaluated NCAA Division I women ice hockey players', coaches', and referees' opinions as to intent to injure, aggression, and the non-checking rule. Major penalty minutes were also analyzed for the 2013-2014 season. Data revealed that intent to injure is not recognized by referees. Education of referees and the use of referees dedicated only to women's ice hockey are recommended as an attempt to decrease injuries.

Keywords: Cognitive Strategies; Gender Issues; Injury; Intentions; Motivation

Introduction

Intent to Injure and Severe Head Injuries in NCAA Division I Women's Ice Hockey. Beginning with the first organized indoor ice hockey game played on March 3, 1875; involvement in the sport has grown to international levels of participation, changes in rules and equipment have occurred, and collegiate organized hockey has been initiated and flourished. Today, NCAA men's and women's programs exist at all levels of play in the United States. Organized women's university level ice hockey has been played in Canada since 1892. However, although some early women's programs did exist, it was not until June 23, 1972 with the initiation of "Title IX" that proliferation of collegiate women's ice hockey programs occurred in the NCAA [1]. Women's ice hockey became a medal sport in the Olympics in 1998. Women's ice hockey has been dominated by teams from the USA and Canada. These two

countries have the largest number and the most accomplished women ice hockey players in the world.

In 1997-1998 organized collegiate women's ice hockey in the United States became a reality when a grant from the United States Olympic Committee and the NCAA funded the establishment of the American Women's Ice Hockey Alliance. The NCAA officially began sponsoring women's ice hockey championships during the 2000-2001 seasons. The NCAA lists 34 Division I women's ice hockey programs. They represent several different major athletic conferences, but the teams play in 4 specific hockey organizations. These are The Western Collegiate Hockey Association, Hockey East, College Hockey America, and the Eastern Collegiate Athletic Conference. There is one independent team that does not belong to any of these organizations [2].

The rules for women's and men's ice hockey are similar with the exception that NCAA rules for women's ice hockey prohibit body checking during [3-6]. Body checking in women's ice hockey can result in a minor, a major, or a disqualification penalty. The type and severity of the penalty is determined by the referee [7]. The rule also states that incidental contact can be determined by the referee to have occurred when it is felt that two players unintentionally collide. This type of contact is not penalized if the referee makes a subjective decision about the non-intentionality of the contact [7]. The non-checking rule has resulted in less frequent instances of contact during women's ice hockey competition as compared to men's games of similar levels of expertise. However, the rule has in no way eliminated body contact in women's competition [6]. There still exists a significant amount of body checking that is both intentional and unintentional [3,4,8]. This is significant because 96% of the injuries sustained by women ice hockey players and 79% of injuries sustained by men are related to contact [4]. The number of impacts sustained by Division I female ice hockey players is significantly lower than male Division I hockey players (1.5 ± 0.7 vs 3.2 ± 1.4 $p \leq 0.0001$) [9].

Concussion is the most common ice hockey injury in both sexes [10-12]. Of particular concern is the high rate of severe head injuries in women's ice hockey. Concussions rates for women players are greater than those of men players. Male players have a rate of 1.47 concussions/1000 player hours. Female players have a rate of 2.72/1000 player hours [13]. During women's ice hockey game competition 21.6% of player injuries were reported to be concussions [10,14].

Attempts to explain this pattern of injury rates have suggested that decreased upper body strength of women players when compared to their male counterparts, makes it more difficult for women to tolerate checking forces when they occur [9,15,16]. Nevertheless, no sound evidence exists that relates body size in ice hockey players to the rate of concussion. Research reported by Mihalik found that players with greater static neck strength did not experience lower resultant head acceleration following checking that those of lesser cervical muscle strength [16].

Research that studied the effects of anticipated collisions versus non anticipated collisions has shown that anticipated collision result in less-severe injuries than unanticipated collisions, especially for median intensity impacts [9,17,18].

The hypothesis of this research is that the non-checking rule in women's ice hockey disguises the amount of aggression and intent to injure that occurs in this sport. A good understanding of to what degree intentional violations of the non-checking rule occur and how they are dealt with will facilitate the development of interventions for decreasing potentially aggressive and injurious acts that include closed head injuries.

Ice hockey is an aggressive sport. The element of intimidation and checking are part of modern men's hockey [3,19,20]. Even at the adolescent level checking is taught and allowed as part of boys' hockey [17]. Adolescent boys and girls may participate on the same teams, and women ice hockey players who played co-ed hockey as youths have been experienced checking as part of the game. Women ice hockey players have also been exposed to checking when they are watching men amateur and professional ice hockey players use checking as part of their game play, and when they compete with other women players use checking as part of their playing strategy [20-24]. . This exposure has resulted in the development of a socially constructed attitude that validates aggression and checking in ice hockey [20,23-25].

Aggressive play becomes commendable and is encouraged by teammates, coaches and fans [7]. Aggressive ice hockey players have been found to have success in obtaining the puck for play and success in scoring goals during competition [3,26]. Increased aggressive play has a direct correlation with winning in ice hockey competition. Two types of aggression in sports have been identified. Instrumental aggression is goal oriented and facilitates winning in sports. Hostile aggression is responsive to a provoked stimulus. Intent to injure may be the result of either of these types of aggression [20]. In ice hockey, the most obvious form of hostile aggression is fighting. Fighting occurs in all levels of ice hockey competition, but is more common in "Junior" level play and professional play. Boarding, slashing, high sticking, butt-ending, and tripping can also all occur during ice hockey competition and are associated with intent to injure. These acts can represent either form of aggression and may or may not be in response to provocation. When not provoked they represent instrumental aggression [20].

A perceived level of legitimacy can develop in athletes who then justify intent to injure or rule violation as a strategy for success during competition [21,26]. Individual ego goal orientation towards participation and extrinsically motivated players reinforce these strategies

[23,27,28]. Finally, the basic concept of winning and losing in sports competition reinforces ego goal orientation [28]. It is difficult to eliminate the element of aggression in sport competition because of its correlation with winning. Ice hockey referees are accountable for determining whether or not players chose to perform rule violating aggressive acts [3]. Intent is difficult to evaluate when subjective judgments and criteria are used to make this determination. Attempts to objectify criteria for making these judgments do not eliminate the need for subjective evaluations by the referees.

An assessment of aggressive play with an evaluation of intent to injure will be attempted by contacting NCAA Division I women's ice hockey players, coaches, and referees and asking them to voluntarily and anonymously fill our surveys. The purpose of this research was to evaluate rule violation and "intent to injure" in Women's NCAA Division I ice-hockey, and on the basis of the results, suggest a strategy for decreasing head injuries.

The use of penalty records has been reported as being another useful measure of aggression in sports [7]. Review of major penalties in Division I women's ice hockey for the 2013-2014 season will also be used in this paper as a measure of aggression and when it occurs during the 2013-2014 season.

Methods

Three separate IRB approved anonymous surveys were developed for distribution. One survey was specific for Division I women's ice hockey players; one for Division I women's ice hockey coaches; and one for Division I ice hockey referees who officiate women's games. Each of the three survey formats was different and they were all designed to identify whether or not aggression and intent to injure had been either experienced or observed from the perspective of the individual filling out the survey. The coaches and referees were also asked to address whether or not they felt the non-checking rule contributed to the rate and severity of injuries. Women players were not asked to incriminate themselves by identifying their own attempts to injure other players, but rather were asked to identify whether they felt that they had experienced an intentional attempt to be injured by another player,

Major and minor penalty minutes for the entire season and playoffs were reviewed. For the purpose of evaluating intent to injure, only major penalties were recorded and analyzed. Statistical evaluations of the rate of occurrences of penalties at either home or away and analysis of

penalties from the standpoint of what period in which they occurred was also investigated.

Distribution of the surveys to players was carried out by having athletic trainers of each of the school teams surveyed distribute the surveys to the individual players on their teams and then return the surveys to our research department. Surveys were distributed to a minimum of 2 teams in each of the women's division I ice hockey leagues so as to get a national overall representation of results and not just a regionalized opinion. A total of 13 teams returned surveys, and 228 players completed the player survey (about one third of all NCAA division I women ice hockey players).

Distribution of surveys to all division I hockey coaches was done by mailing the surveys to each coach. Both head coaches and assistant coaches were surveyed. A total of 64 coach surveys were distributed and 24 completed surveys were returned. Distribution of the surveys to referees was also done by mail. A total of 67 referee surveys were mailed out and 42 of these were complete and returned. The survey results were then collectively recorded and evaluated.

Penalty minutes were reviewed as recorded from web based hockey stats website [29]. All of the games for the 2013-2014 seasons were reviewed and all of the major penalties were recorded for analysis. The play-off penalty statistics were also reviewed.

Results

The goal of the surveyed research is to test the hypothesis $H_o : p = 0.5$ in which the possibility of affirmative and negative answers in response to the questions in the surveys are equal. This research assumed that the probability distribution of the answers follow a binomial distribution. However, in these surveys, the probabilities of respondents selecting both "yes" and "no" answers are relatively higher than conventional assumptions that fit a normal Poisson distribution.

Statistical analysis of results in this study considered that there are a number of ways to evaluate two-sided confidence intervals for discrete data. In practice, two-sided p-value for testing $H_o : p = p_o$ can be calculated using three methods Central, Minlike, and Blaker [30,31]. For $H_o : p = 0.5$, p-values calculated using all three methods coincide.

The “Minlike” and “Blaker” testing methods can have inconsistencies [32]. In this paper, the “central” method was used to avoid such inconsistencies. We analyzed the data in R version 3.0.3 (<http://www.r-project.org/>). The statistical tests were conducted with 95% confidence interval using R package “exact2x2”, and the confidence intervals reported using the “central” method are nested.

Table 1 reports the survey results and comparisons of the responses with corresponding statistic (95% confidence intervals and p-values). A significant majority of the players felt that they had experienced an attempt to be injured by other players (p-value=0.0004). The players also felt strongly against justification of “an attempt to injure” as a part of women’s ice hockey (p-value<0.0001).

A coach is a major dimension of any sport. Even though intent to injure is a subjective decision made by a particular player, it is also fair to consider that there can be an influence of a coach in these decisions. A significant majority of the coaches surveyed in this paper do not feel

that intent to injure is a strategic part of women’s ice hockey (p-value<0.001), but 61.5% of coaches in this survey claim that they have witnessed intent to injure during women’s ice hockey games. The majority of coaches (66.7 %) think better ice hockey players are more aggressive (p-value=0.1516) and 79.2% of the coaches believe that the no-checking rule decreases the likelihood of injury during women’s ice hockey games (P-value=0.007).

In contrast to the players and coaches, a relatively smaller portion (14.3%) of the referees felt that they observed any intent to injure. Nevertheless, a significant majority of the officials (71.4%) believe that the players are prepared for aggressive play with the physical contact. A majority of officials (63.9%), though statistically insignificant, believe that violation of the non-checking rule does not increase injuries. They also felt that by creating parity and allowing women players to legally check would not be a significant factor that would change injury rates or their severity.

Questionnaire	Response		Statistic	95% CI	p-value
	Yes	No			
Players					
Have you ever felt that you have experienced an attempt to injure you during an ice hockey game?	141(0.618)	87(0.382)	0.618	0.552-0.682	0.0004
Do you feel that attempt to injure can be justified as being “part of the game” by women ice-hockey players?	65(0.285)	163(0.715)	0.715	0.652-0.773	<0.0001
Coaches					
Do you feel that intent to injure becomes accepted by women ice hockey players as a strategic part of playing ice hockey?	2(0.083)	22(0.917)	0.917	0.73-0.99	<0.001
Have you seen intent to injure occur during women’s ice hockey competition?	15(0.625)	9(0.375)	0.625	0.406-0.812	0.308
Are better ice hockey players more aggressive than mediocre players?	16(0.667)	8(0.333)	0.667	0.447-0.844	0.152
Do you feel that the no-checking rule in women’s ice hockey increases or decreases the likelihood of injury?	5(0.208)	19(0.792)	0.792	0.579-0.929	0.007
Referees					
Have you observed intent to injure other players by women ice hockey players during NCAA competition?	6(0.1428)	36(0.8572)	0.1428	0.054-0.285	<0.001
Have you observed intimidation as a part of the game of ice hockey?	15(0.3572)	27(0.6428)	0.3572	0.215-0.519	0.088
Do you feel that non-compliance with the non-checking rule by women’s ice hockey players causes injuries?	16(0.3809)	17(0.6391)	0.3809	0.236-0.544	0.1641
	Majority	Minority			
Have you observed a majority or minority of women’s ice hockey players to be prepared for aggressive play and physical contact?	30(0.7143)	12(0.2857)	0.7143	0.554-0.828	0.008
	Increase	Decrease			
Do you feel that creating parity by allowing all girls to check would increase or decrease the rate of injuries in women’s ice hockey?	25(0.592)	17(0.4048)	0.592	0.432-0.743	0.28

Table 1: Comparison of Survey Results; 95% Confidence Intervals are Reported for the Selected Statistic.

In Table 2 a summary of the major penalties called during the 2013-2014 women's ice hockey season is reported by period in which they occurred. The columns list the number of games in which the penalties occurred. The sum of the total minutes of penalty time assessed is in parentheses. There were very few games in which penalties were reported during the first period of play, and only home teams were assessed major penalties during this period.

	Home team	Away team	Total
Period 1	4(45)	0	4(45)
Period 2	11(145)	7(110)	18(255)
Period 3	8(270)	12(305)	20(575)
Total	23(460)	19(415)	42(875)

Table 2: Number of games in which Major Penalty was called during the three Period of Play.

Figure 1 represents a bar plot of the sum of total major penalty minutes assessed during the 2013-2014 women's ice hockey season. Period one penalty minutes were not compared because there was no penalty minutes assessed for visiting teams during this period.

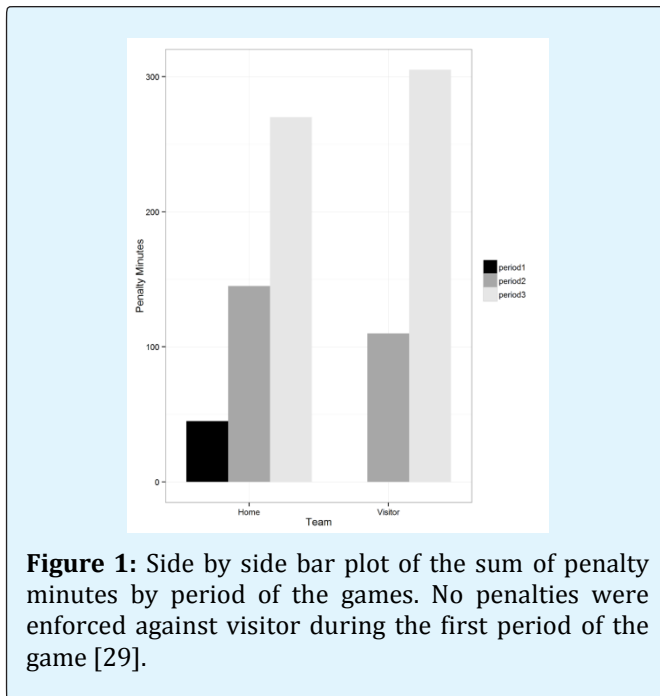


Figure 1: Side by side bar plot of the sum of penalty minutes by period of the games. No penalties were enforced against visitor during the first period of the game [29].

Comparison of sum of penalty minutes called during the second and third periods was made by finding the odds ratios [33]. For the second period, 57% (145/255) of the total major penalty minutes were called against the home team. Analysis of the third periods penalties show

47% (270/575) of the total major penalty minutes were called against the home team. For the second and third periods, the log odds ratio is 0.3981 (p-value=0.009) with 95% confidence interval (0.1011, 0.6952). The probability of major penalty minutes during the second period is about 1.1064 ($e^{0.1011}$) to 2.01 ($e^{0.6952}$) times greater for the home team [34-40].

There were 562 games played during the regular season of women's ice hockey during the 2013-2014 NCAA Division I season, and 38 playoff games. Comparison of the total number of major penalties called for the regular season games to that of the playoffs indicates that the average numbers of penalty minutes per game during regular season was about 12 times more than that of playoff season.

Discussion

NCAA division I collegiate Women's ice hockey is designed to be played without checking and focus on speed and skill of players. In spite of the rules which prohibit body checking, the game is played with a substantial amount of aggression and checking by the women participants. There are many factors which motivate women ice hockey players to use intimidation, aggression, and checking as part of their game strategy and violate the non-checking rule. These factors represent social constructs of learning that have been reinforced by players, coaches, fans, media, and personal ego orientation toward achievement [40-42].

Epidemiological evaluations of injuries of NCAA women ice hockey players have shown that a significant number of closed head injuries are experienced by women ice hockey players and that this sport is associated with a greater rate of concussion than any other collegiate sport. Evaluations of the etiological factors which are associated with this high rate of head injury indicate that unanticipated checking contact leads to more severe injuries to the head and neck than anticipated checking contact. The decreased upper body strength in female ice hockey players when compared to males is not felt to be a significant factor in determining why the rate of concussion is so high in women players [43].

Control of ice hockey competition requires enforcement of established rules. Most rules are made to assure fair play; however, the non-checking rule is also established to help prevent injuries. Referees have the responsibility of enforcement of the rules and

determining if a player chooses to perform an aggressive illegal check. Referees discourage rule violating behaviors by calling penalties, and set the standard for rule interpretation in each individual game. The possibility that they may also influence injuries that occur from illegal unanticipated contact adds an additional burden of responsibility to their role.

A statistically significant majority of the players surveyed in this study identify rule violations and intent to injure as part of women's ice hockey. A majority of the coaches surveyed in this paper were also found to identify intent to injure as part of the game. However, a statistically significant number of the referees who responded to this survey did not feel that intent to injure is part of the game of women's ice hockey. This difference raises the question of incorrect pre conceived biased judgmental opinions by referees. The job of a referee requires a subjective evaluation of observed play. Attempting to objectify this evaluation by creating standardized criteria for evaluations does not completely eliminate the subjectivity of the referees' evaluations. Subjective officiating can result in different levels of rule enforcement. Liberal enforcement of the non-checking rule could lead to more body checking by players who determine that they would be unlikely to be penalized for violating the rules. Although there is a non-checking rule in women's ice hockey, this survey indicates that a majority referees who officiate these games feel that players are prepared for contact during play. This indicates an additional preconceived bias that can affect a referee's subjective judgment.

Liberalization of officiating was observed when the distribution of major penalties called throughout the regular season was compared with the distribution of penalties called during the playoffs. Both men's and women's NCAA ice hockey playoff games are notoriously more aggressive than games played during the regular season. This also parallels the increased intensity and aggression observed in other levels of ice hockey competition during playoffs. Liberalization of the rules for women's ice hockey during playoffs can lead to an increased number of unanticipated body contacts and injuries.

The preponderance of major penalties called during the season occurred during the second and third periods of play. Almost no major penalties were called during the first period of play. Player frustration has been suggested as causes of rule violations late in a game (Aggression-Frustration Theory of Dollard). However, a change in game playing strategy (behavior modification) also

develops in response to assessment of a referee's level of rule enforcement. Subsequent increased aggressive play later in games liberally called during the first period of play can lead to increased injuries. Referees are also capable of behavior modification in response to observed player aggression. Our research has indicated that this assessment may be skewed. The dynamics of the player-referee relationship and behavioral changes that occur in response to each group's individual actions are variables that require extensive evaluations and may be impossible to accurately measure.

Establishment of consistency in officiating will decrease the likelihood of liberalization of the rules and then may decrease the severity and number of injuries. One possible step in reaching consistency could be the use of referees who are dedicated only to women's ice hockey. NCAA ice hockey referees officiate both men and women's competitions have to use two different standards by which to evaluate contact and checking. This variable can skew subjective determinations, and could be eliminated or decreased if a referee's responsibilities did not include both men's and women's contests.

The survey results also indicated that the surveyed players and their coaches did not feel that intent to injure should be justified as a playing strategy. Their response is interesting if one also considers the number of respondents who indicated that intent to injure is a reality in women's ice hockey. It would seem that with the number of players who identified intent to injure, somewhere there has to be an acceptance of this behavior. Again, an ego orientation toward play and a desire to win would justify rule violation and explain the disconnect of this scenario.

The most significant weakness of this research lies in the difficulty of trying to prove intent and not being able to specifically ask players to admit their own culpability. Not being able to ask this specific question limits our investigation to subjective assessments of another's actions. Although metacognition can help someone make a good subjective decision, the response is always an assumption and not a certainty. The relative percentage of players, coaches, and referees who responded to the surveys adds a level of credibility to our result.

The research was not designed to specifically identify what percentage of major penalties caused head injuries and what percent of head injuries were caused from specific types of non-rule violating play. It did not also address the precise time during game competition when

head injuries occurred. The paper does reinforce the need for additional specific research with regard to these topics.

Conclusion

Finally, it is hoped that the research presented here will have a positive effect on the subjective evaluations of play by women's ice hockey referees. The goal here is not to critique referees' performances to date, but rather to add information on the likelihood of intent to injure by women's ice hockey players and how this impacts unanticipated contact and head injuries. This additional information may encourage a stricter enforcement of the rules, more defined standards of rule interpretation by the NCAA, and result in a decreased concussion rate for women ice hockey players.

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