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# Bigger Bodies, Bigger Bruises: How men's collegiate hockey player sizes affect injury rates 1989-2004

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University of New Hampshire  
Senior Honors Thesis

# **Bigger Bodies, Bigger Bruises:**

How men's collegiate hockey player sizes affect injury rates 1989-2004

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Without these people, the idea for this project and all the way up to its completed state could not have flourished to its full extent.

## **Background and Objective**

University of New Hampshire Senior defenseman Damon Kipp steps onto the ice. He looms at a staggering 6'2" and 205 lbs. Kipp is not unique, however. In most sports today, an athlete not only must possess skill and ability, but this ability must also be matched by the player's size and power. Every year, athletes seem to skyrocket in size, with coaches becoming more selective about the size of player that they will accept. Moreover, throughout their hockey careers, players such as Kipp suffer many injuries, but usually bounce quickly back into the game. What if, however, these injuries had been more permanent, or even life-threatening?

In recent years, it seems scholarly research has increasingly focused on how athletes have sustained severe injuries, often displacing them from the game for weeks at a time. A simple database search will yield such articles and literature as anything from "Bigger, Faster, Stronger" (Shepherd, 2004) to "The Epidemiology of Sport-Related Concussion" (Daneshvar et al., 2011). Clearly the topic has become of greater interest to scholars, concerned about the implications of increasing player size on a variety of sports. The awareness has not been limited to academia, however, as the public also is progressively more conscious of the matter. In 2001, for example, high school football player Chris Canales suffered a life-altering spinal cord injury during the senior night football game. He was left unable to walk. Just a year later, his father, Eddie, created the nonprofit organization called Gridiron Heroes to help other injured high school athletes. Such spinal cord injuries have been sustained by many other athletes, not just in football, but other sports as well. It is instances like Chris' that have brought the issue

into the public light, and speculation has arisen that many of these injuries can be accounted for by the larger size of players.

The changes in athlete sizes have been documented in many sports, including football, baseball, track and even gymnastics. Much of the current literature regarding athlete size and morphology focuses on specific age groups, such as youth players or professional teams. Injury research focuses on type or location of injury on the body, but does not speculate as to why the rise in injury rates has been occurring. Research in hockey has tended to look at youth players or professional teams. Research on collegiate hockey is particularly timely since no significant scholarly literature can be found regarding the subject, even though there are several scholarly articles that discuss the topic of collegiate athlete size and injury rates in other sports.

Thus the question remains: just how much have men's collegiate hockey players changed in size over time, and does this change correlate with the increasing trend in player injuries seen at the collegiate level within the sport? In an attempt to answer this question, this study examines collegiate hockey player morphology from the 1988-1989 season to the 2003-2004 season. Sampling was from both divisions I and III and many different teams across the country. Specific and descriptive statistics for each year, such as mean height, weight, BMI, and growth rate (%) were calculated and analyzed. The averages from each year were then correlated with the increasing injury trend seen within the same time period.

## Definition of Terms

On this page the list of terms are of 5 standard terms as defined for the purposes of this study and is compiled here for the reader's convenience.

**Pearson  $r$** - According to Pagano (2007), "A measure of the extent to which paired scores occupy the same or opposite positions within their own distributions" (pg. 113.) It is measured on a scale of -1 to 1, and expresses the magnitude and direction of a correlation.

**Regression**- According to Pagano (2007), "A topic that considers using the relationship between two or more variables for prediction" (pg. 555).

**$R^2$** - According to Ha (2012), "The proportion of the variability in Y that is explained by X" (pg. 258)

**BMI**- body mass index, as calculated by mass in kilograms divided by height in meters, squared. In English terms, it is calculated by mass in pounds times 703, divided by height in inches, squared.

**Injury** – According to Agel (2007), "A reportable injury in the ISS was defined as one that (1) occurred as a result of participation in an organized intercollegiate practice or competition *and* (2) required medical attention by a team certified athletic trainer or physician *and* (3) resulted in restriction of the student-athlete's participation or performance for 1 or more calendar days beyond the day of injury. If an off day followed the injury event, athletic trainers were asked to assess whether the injured athlete would have been able to participate" (pg. 174).

## **Review of Literature**

In light of the seeming increase in player size, researchers Kevin Norton and Tim Olds (2001) set out to determine exactly how much athletes have changed in size over the past century, and at what rate, in their publication “Morphological Evolution of Athletes Over the 20<sup>th</sup> Century”. The study examined twenty-two different professional level sports, not including hockey. Each sport provided unique insight into athlete morphology, with different changes in player size depending on the sport in question. For most sports within the study, however, the optimum player size and weight to be successful within a particular sport (that is, the size of players best suited for that sport) became narrower as the years went on. In shotput, for example, athletes were shown to increase in size over time, outstripping the growth rate of the secular population.

As Norton and Olds (2001) put it, “Athletes in many sports have been getting taller and more massive over time... In open-ended [contact] sports, more massive players have an advantage” (pg. 763). Conversely, the study showed that elite distance runners decreased in body mass index (BMI), while sprinters sharply increased their BMI over time. Therefore, it can be extracted from Norton and Old’s research that changes in athlete’s size are dependent upon the nature of the sport. That is, the size of athletes will change in size in a way that is advantageous for their particular sport. Basketball players will get taller, swimmers will have broader shoulders and longer arms, defensive players in football will want to gain weight, and so on.



Although Norton and Olds shed light on a broad range of sports, hockey was not included in their study. Researchers John Cranfield, Kris Inwood, and Andrew Ross, however, specifically inspected the NHL (National Hockey League) in their article, "The Borders of Size" (2011). The study was quite extensive, focusing on 1909-2008, but including some information about earlier hockey years as well, and noted differences in player size based on where they were born and the position they played. The researchers commented that in 1880, when hockey was just becoming popular as a competitive sport, the average player was 5'9" and 168 lbs, making the average body mass index 24.8. About a hundred years later in 1970, the average pro-league hockey player was 6'1", 200 lbs, and had a BMI of 26.4. The study shows a clear upward trend in the size of major league hockey players. Ross et al. (2011) note, "Over the twelve decades (1880-2000), hockey players gained, on average, approximately 28.3 lbs in weight, or 16.65% (2.57 lbs, or 1.51% per decade)" (pg. 6).

Ross also commented that this increase in size is attributable to better nutrition and health care, but also to player selection (Ross, personal communication, March 2011). Coaches opt for the bigger players as part of their selection process. Forty years ago, for example, a coach might pick any players who were above 5'6" and weighed at least 160 pounds. Today, the bar that players must reach is growing higher and higher. A coach today might only choose players above 5'8" and 175 pounds. Professional hockey players must increasingly fit within a rising minimum in terms of height and weight, bulking up more and more to fit the new standards.

Interested in this topic of athlete morphology, researcher Joelle B. Yamamoto (2008) examined player sizes in four different sports: football, basketball, baseball, and tennis, but at the collegiate level. Rosters, media guides, and other documents were photographed by Yamamoto and reviewed to determine basic descriptive statistics (ie, *mean, median, standard deviation, and confidence intervals*) for each sport in terms of height, weight and BMI. All sports saw a statistically significant change in all three areas from the 1950's-2000's. Tennis players changed the least in size, while football players saw the largest increase. Interestingly, the position of the players in some sports was shown to have an important role in how much the mean size increased over time. Wide receivers in football, for example, tended to weigh less at a given height than defensive linemen. Offensive and defensive linemen, in fact, observed the greatest increase in size of all the football positions.

Yamamoto (2008) suggests that, for many sports, as the game becomes more competitive, players must become increasingly specialized in size for their position. As Yamamoto (2008) concluded, "In football, basketball, and baseball, size matters such that bigger athletes have a competitive advantage over smaller athletes" (pg. 125). Yamamoto also notes that larger players are at a greater risk for medical issues due to their size, such as heat exhaustion, artery disease, and obesity. Though this fact is likely true for hockey, it is not an issue explored within this study.

Whether or not an increase in athlete size outstrips the growth rate of the general population or not, these increases in size can ultimately lead to non-collision injuries, and even medical complications. That is, whether the weight gain is coming from muscle or from fat, it

can still have huge implications for injuries during game play. Though these medical complications are largely recognized by the public eye and have concerned researchers in recent years, the number and severity of injuries caused by larger players involved in collisions has not been as recognized by the public. An overweight football player is not only at risk for the medical complications listed above, but also can pose a larger threat for the opposing team. However, that is largely the point--defensive linemen want to be bigger in order to help defend their teammates. Although being a larger player means an increased risk for complication and injury, this seems to be a sacrifice athletes and coaches are willing to make for the sake of game play. Unfortunately, reducing contact in sports such as football and hockey is a touchy subject for devoted fans.

Many avid hockey fans would argue that player contact is a part of the sport, and without it, the game would not be as exciting. Scott Morrison from CBC Sports commented on this topic in one of his articles, saying, "Talk to coaches and, while concerned about the injuries occurring in fights, they say the presence of a "threat" on the bench or the ice allows "skill" players to skate faster and be braver and be more comfortable" (Morrison, 2007). Morrison also noted that at the level of professional hockey, players know what they are signing up for, and know the inherent risks they could encounter in game play. Although nobody wants to see an athlete with serious or devastating injuries, such as a broken bone or a concussion, Morrison clearly did not want player contact to be ruled out of the game.

Fans such as Morrison clearly want to see some action in the game, including player contact and fighting. But is this player contact really affecting the amount of injuries a player

can sustain? Would it be possible to arrive at some sort of happy-medium between reducing the damaging effects of player contact while in turn keeping excitement levels up? Do athletes really understand the risk of the game they play or how likely they are to be injured upon player contact? There is a vast need for research in these areas in order to keep injury levels at a bare minimum while keeping the game popular.

The American Academy of Pediatrics (2005) also recognizes the medical complications that may occur due to weight gain or loss of athletes, especially in youth. They stated, "With the growth and advancement of youth sports, children and adolescents are becoming more involved in sports in which weight control is perceived to be advantageous for the individual and/or team" (pg. 1557). These younger athletes naturally strive towards and look up to their collegiate counterparts. The push for larger athletes in sports such as body building, football, and even hockey is a difficult trend to stop, despite recommendations from the American Academy of Pediatrics. This is due in part to a natural increase in the size of the general population, more intense training programs, and a more regimented selection process. These findings also reveal the need for more research that looks at the increase in player weight, and the need for solutions to the injuries it can cause.

Norton and Olds (2001) further note that optimal player size correlates greatly with a longer, higher-paid, and more successful career within several sports, such as the NBA and NFL (pg. 771). The advantages of the most favorably-sized players can come with a down-side as well: increased chance of injuries. Past investigators of ice hockey injuries have looked at specific factors, such as geographical location, gender, age, location of injury on the ice, or

injuries within a certain region of the body. However, Jeff Deits et al. (2010) aimed to examine a broad range of ice hockey players, from recreational to professional, within the US over a period of 16 years. Staggeringly, 93.5% of all injuries occurred among male players (pg. 467), with the most common injuries occurring to the face, shoulders, and hands/fingers. According to Deits et al. (2010), "Ice hockey is a unique sport in which players can skate up to 30 mph (48 kph) and hit pucks at speeds up to 100 mph (161 kph), with the almost constant possibility of colliding with another player..." (pg. 467). This constant possibility of collision is what sets the stage for athlete injuries. It is also predicted by Deits et al (2010) that injury rates will likely increase in the coming years. Deits et al (2010) noted that this reflects the popularity of the sport, but in order to stop the upward trend scientifically-based interventions would have to be implemented. This would involve better analysis of data and finding the true causes of injuries, and is what this study attempts to do.

In an attempt to look more specifically at collegiate hockey injuries, Julie Agel et al. (2007) inspected player injury rates from 1988-2004 across all divisions. On average, the injury rate per year increased by 1.3% during game play (pg. 242), and 47.7% percent of these injuries came from "contact with another player" (pg. 246). This represents a dramatic increase in the number of injuries seen over time during game play. With half of the injuries being due to player contact, one would think that larger players would produce more force upon impact with another player and produce more serious injuries. Though this study look extensively at mechanism of injury, injury location, and differences between game injury rates and practice injury rates, they did not look specifically at how player sizes relate to the injury rates. Agel

(2007) recommends, among other things, that future authors should try to explain the reasons behind the important changes seen in injury trends, as well as examine ways to prevent player contact.

Scholarly articles have increasingly focused on the topic of player size and injury trends in many sports. Yet, as the previous survey of literature shows, no significant research has been done regarding collegiate hockey players and how their size affects injury rates, but there are signs that research in this area is greatly needed. It is this gap in the research that this study examines. The question remains, does male collegiate hockey player size, in terms of height, weight, and BMI, really make a difference in regards to the injury rate increase in that same time span.

## **Methodology**

The methods for this study were modeled in part on previous, similar scholarly articles mentioned in the literature review. These methods were altered to meet the needs of this research. Just like Yamamoto (2008), it was decided that photographs of the archival documents would be the best method of data collection. Taking Norton and Olds (2001) as a model, descriptive statistics were calculated. The exact methods for compiling and analyzing statistics came from consultation and discussion with Professor Edward O'Brien, Professor of Psychology at UNH, who specifically teaches many undergraduate and graduate level statistics courses.

The rosters and documents located in the University of New Hampshire Charles E. Holt American Hockey Archives are a treasure-trove for hockey fans and researchers. Located in these archives are documents dating well back in the early twentieth century. For this study, the archives proved an invaluable resource because these documents contain information with records of heights and weights for hundreds of previous collegiate hockey players. The archives endeavor to include all of American hockey, and are the official repository for the American Hockey Coaches Association, the Eastern College Athletic Conference, and the Hockey East Association.

Media guides were used in this study to piece together the story of how men's college hockey players have changed in size over time, and how this trend correlates to the rise in injury trends as seen in the Agel (2007) study, described above. Information in the archives is available dating back to the late 19<sup>th</sup> century; however significant data for this study is available

starting around the 1970's. For these years, individual data on hundreds of athletes is available in various documents. Data from the 1988-1989 to 2003-2004 seasons were collected from the archives. Two seasons of data were missing from the archives, 2002-2003 and 2003-2004. Tom Wilkins from UNH Media Relations provided a website with collegiate hockey rosters and stats from 1999 to the present to fill in the gaps, [www.collegehockeystats.net](http://www.collegehockeystats.net).

Digital pictures of the rosters from these documents (those with recordings of height, weight, and year) were taken and stored on a computer. The relevant information was extracted from these pictures, and placed into a statistical computer program. Height, weight, BMI, player position, and division were all recorded and coded into SYSTAT 11 and Excel for each individual player. BMI was calculated using the formula of  $[\text{weight (kg)}/\text{height}^2 (\text{m}^2)]$ . At least 30 data points per variable was necessary to make the study statistically sound, which was a standard that was determined upon consultation with Professor O'Brien. Given that this study had 4 different variables involved (year, height, weight, and BMI), at least 120 data points were needed per year, but the more, the better. Approximately 300 data points were taken from every year within the study, from various teams, locations, and divisions, in a systematic fashion. That is, the data for every player in a media guide was inputted into an Excel document, and later imported into SYSTAT 11 (statistics software) until a sufficient number was reached. In general, every player on a given team was entered, even if there were already enough players in the sample size. ECAC (Eastern College Athletic Conference) Media Guides were the most abundant in the archives, and thus these were the ones that were used.



<b>Table 1. Exact sample size from each season</b>			
<b>Year</b>	<b>Sample Size</b>	<b>Year</b>	<b>Sample Size</b>
1988-1989	334	1996-1997	336
1989-1990	298	1997-1998	298
1990-1991	309	1998-1999	299
1991-1992	297	1999-2000	231
1992-1993	301	2000-2001	311
1993-1994	299	2001-2002	318
1994-1995	301	2002-2003	319
1995-1996	299	2003-2004	319

Injury data and trends for men’s collegiate hockey players and many other sports were found through The NCAA Injury Surveillance System, henceforth ISS. As put by their website, “The primary goal of the National Collegiate Athletic Association’s (NCAA) Injury Surveillance Program (ISP) has been to collect injury and exposure data from a sample of NCAA institutions in a variety of sports.” (Center, 2008). Although raw data from the ISS can be accessed by composing a research proposal and seeking access from the ISS, data from 15 different sports, which has already been analyzed and summarized, has been made publically available for the years 1988-2004 through various scholarly articles, such as Agel’s. In the Agel (2007) study, hockey players, number and type of injuries were analyzed by division, season, and activity (game or practice). Injury rates were taken from Agel’s article and entered into the computer

programs alongside the data on player size. As is noted about, Agel (2007) found that the number of injuries in the sport of ice hockey has been increasing over the years, but only speculated at the causes for this rise.

This study chose to look at collegiate male hockey players only. This was for several reasons. First, the majority of injuries occur amongst males, and a much broader range of data was available for men's teams than for the women's. Secondly, collegiate hockey itself has not been exclusively studied for trends in player size, although many other sports, such as football, track, and volleyball, have been. The collegiate teams also represent a solid intermediate between high school and professional teams. For many collegiate athletes, the end of college will mark the end of their athletic career. For some, however, it will be just the beginning of their professional athletic careers. Collegiate athletics includes a very wide spectrum of players, especially across the various divisions, which is why collegiate athletes were focused upon in this research.

Norton and Olds related the increase in size to the secular population, as noted earlier. This was advantageous for them to do, as they were looking at size alone and not relating it to injury rates. For Norton and Olds, finding out if the rate at which players are getting larger outstrips that of the general population was largely their point of their study. For the purposes of this study, comparing trends in hockey player size to the general population is not necessary. This research is intended only to look at if an increase in size, in terms of height, weight, and body mass index, has led to an increase in injury rates. Although comparing to the secular population would be interesting, it is not necessary for the comparison and therefore not

included in this study. Whether or not a player size growth rates outstrip the growth rate of the secular population or not, these size increases can still have implications for the injury rates.

Once data collection was completed, simple descriptive statistics (e.g. mean, median, and standard deviation) were calculated for each year within the study. The averages from each year were plotted and the annual growth rate of players was calculated. This data was then correlated and plotted with the data from the Agel (2007) study, and analyzed for the appropriate results. The main point of this research was to determine the average size of men's collegiate hockey players from 1988-2004, the rate of growth during this time, and if that trend correlates in any respect with the rise in injury rates as seen in the Agel (2007) study.

## Results

The average annual height, weight, and body mass index are presented in Table 1. Over the 16 years examined, the average size of a player went from 180.5 lbs (81.9 kg) and 70.8 inches (179.8 cm) to 190.1 lbs (86.3 kg) and 71.9 inches (182.6 cm). Figures 1, 2, and 3 show the trend line of average height, weight, and BMI (respectively) of the years within the study. Though there is a clear upward trend in each category, weight provides the least amount of deviation from the predicted trend line. Each one of the variables goes up over time, and weight is the most consistent.

As noted in Agel (2007), the average annual increase of 1.3% in injury rate is quite significant. Agel (2007) declares, "... (this) may be related to increased emphasis on strength training and player size. Bigger and stronger players increase the forces caused in collision, which may account for the game injury rates" (pg. 245). An injury, according to Agel (2007), must occur during intercollegiate practice or games, requires medical attention, and limited the athlete's performance for at least a day. For a full definition, see "Definition of Terms." Though Agel speculated that larger players might account for game injury rates, this was not a topic explored within the research.

Correlation scatter plots with injury rate for height, BMI, and weight are shown in figures 4, 5, and 6. A scatter plot shows the relationship between two variables, and this relationship is called a correlation. The closer the data points on the graph are to being a straight line, the higher their correlation will be. A correlation can be either negative or positive, represented by a line going from top left to bottom right, or bottom left to top right,

respectively. Linear trend lines are also plotted in these 3 graphs, representing the line of best fit for all of the data. This line helps to show what the height, weight, or BMI would be if there was a perfect correlation between the variables and the injury rate.

When calculating a correlation between two variables, a Pearson  $r$  coefficient is the qualitative outcome. This number represents the strength of the linear relationship between two variables, on a scale of -1 to 1, where -1 means a perfect negative correlation, 0 means no correlation, and +1 means a perfect positive correlation. What constitutes as a “good” or “significant” Pearson  $r$  coefficient for a given set of data depends upon the sample size, and the desired confidence interval a researcher is looking for (95% confidence intervals were used for this study). This value is known as the Pearson  $r$  critical value. If Pearson  $r$  is above the critical value (negative or positive), the data has a significant correlation.

The Pearson  $r$  critical-value for this data is .4973, meaning that any correlation at or above this value is statistically significant, with 95% confidence. That is, if the result presented a Pearson  $r$  value of above .4973, it has less than a 5% probability of being due to chance alone. If chance is ruled out of the factors for why a data presented a certain way, one can look for other influencing factors. In the cases of this study, those “other factors” that would influence injury rate are height, weight, and BMI. To tell just how much of the variability in injury rates was caused by height, weight, or BMI, an  $r^2$  value must be calculated. This number simply is the Pearson  $r$  coefficient squared, and represents the percentage of variability that was caused by a given variable.

For this study, only weight proved to be significant, with a Pearson  $r$  value of .537 ( $R^2 = .287$ ). Height and body mass index came close to this value, with Pearson  $r$  values of .461 and .455, respectively, but did not make the cut off point for the Pearson  $r$  critical value. In order to be significant, as explained above, the Pearson  $r$  coefficients for height and BMI would have had to be above the  $r$  critical value of .4973. Though these results are seemingly contradictory, upon further inspection they make sense.

Size is a not as clear a concept for the purposes of this study as originally thought, and has had to be refined for the purposes of this research. Height, for example, can be restrictive, because an individual cannot make themselves taller by any method of training or stretching. Weight, in contrast, is quite variable and can be changed by eating habits, lifestyle, training, and weight lifting, among others. Body mass index (BMI) is the most deceptive of them all, representing a ratio between height and weight. Many people believe that BMI is a measure of fitness, and that if you have a “normal” BMI you are healthy. For many individuals, this is true. However, the situation is skewed for athletes. Many athletes, because they have more muscle mass from weight training, would be placed in an “overweight” or “obese” category based solely on their BMI number. Of course, the athletes are not overweight, but dense from so much muscle and training. Size for athletes, then, is best captured by weight. Height can change minimally or to an insignificant degree, while BMI can fluctuate greatly amongst people of seemingly similar “size.”

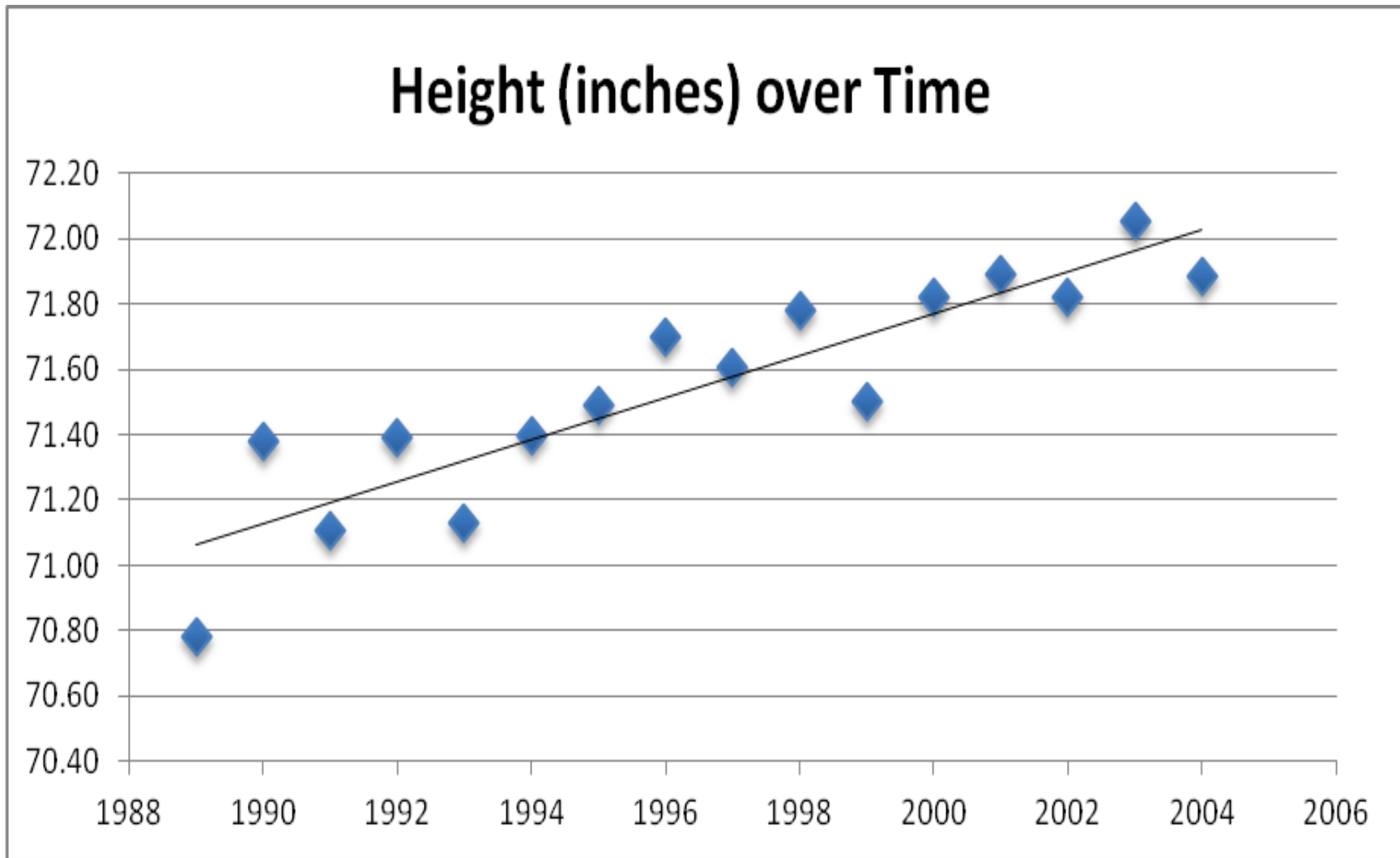
As the results of this study demonstrate, weight is the best predictor of injury rate out of the three size measurements, and the only measurement that is statistically significant. In fact, approximately 29% percent of the variability seen in the injury rate trend is due to changes

in weight. That is, 29% of the rise in injury rates during game play from 1988-2004 was due to increases in weight alone.

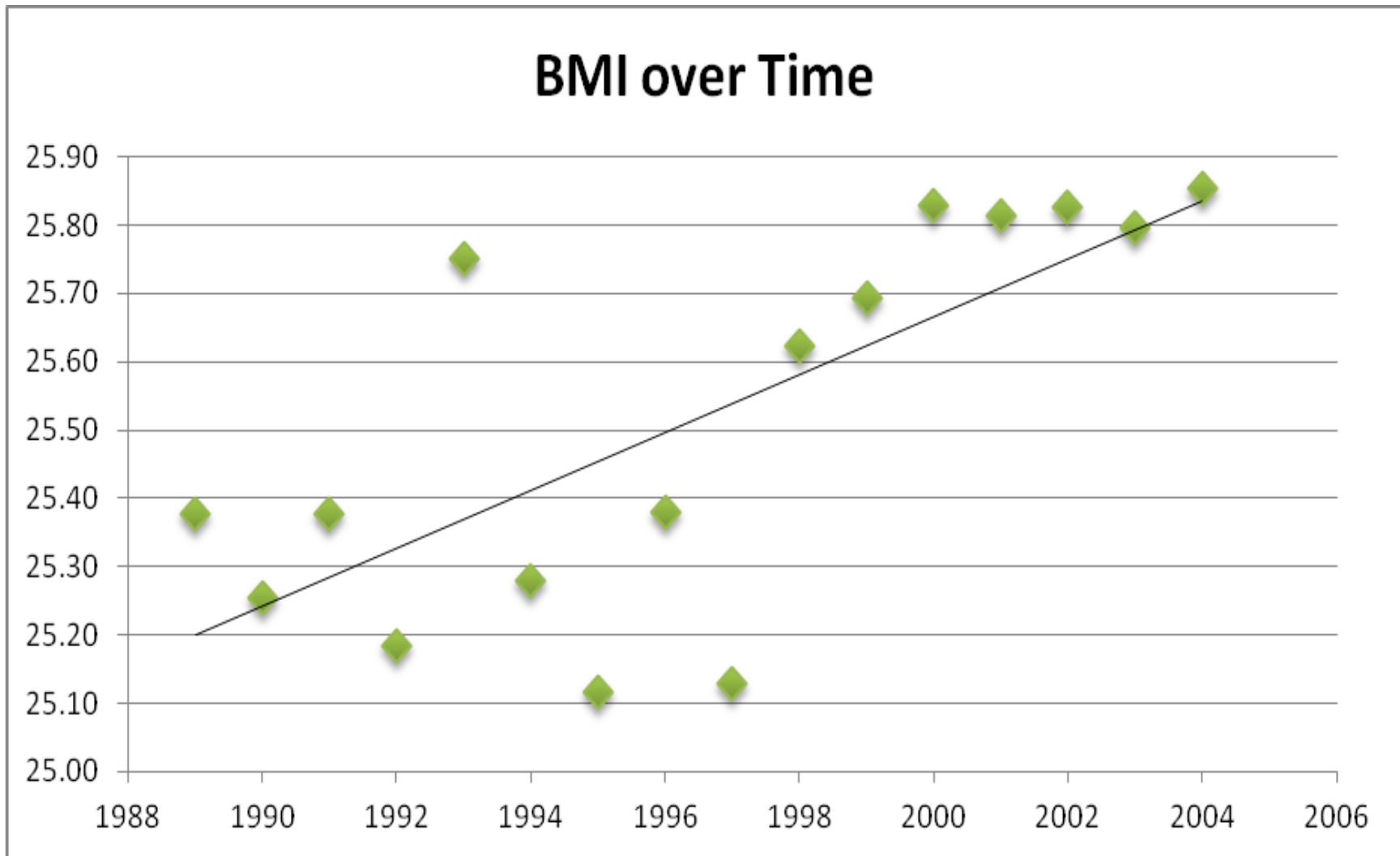
Year	Height (In)	(cm)	Weight (lbs)	(kg)	BMI
1988-1989	70.78	179.78	180.51	81.89	25.38
1990	71.38	181.39	182.97	82.99	25.25
1991	71.10	180.61	182.49	82.77	25.38
1992	71.39	181.33	182.49	82.78	25.18
1993	71.13	180.67	184.84	83.84	25.75
1994	71.40	181.35	183.23	83.11	25.28
1995	71.49	181.59	182.59	82.82	25.12
1996	71.70	182.12	185.60	84.19	25.38
1997	71.60	181.87	183.35	83.62	25.13
1998	71.78	182.32	187.89	85.23	25.62
1999	71.50	181.61	186.87	84.77	25.69
2000	71.82	182.23	189.66	85.22	25.83
2001	71.89	182.61	189.93	86.15	25.81
2002	71.82	182.43	189.66	86.03	25.83
2003	72.05	183.01	190.66	86.48	25.80
2004	71.88	182.59	190.14	86.25	25.85

**Table 2.** Average annual height, weight, and BMI for men’s collegiate hockey players 1988-2004. Results are presented in both English and Standard units.

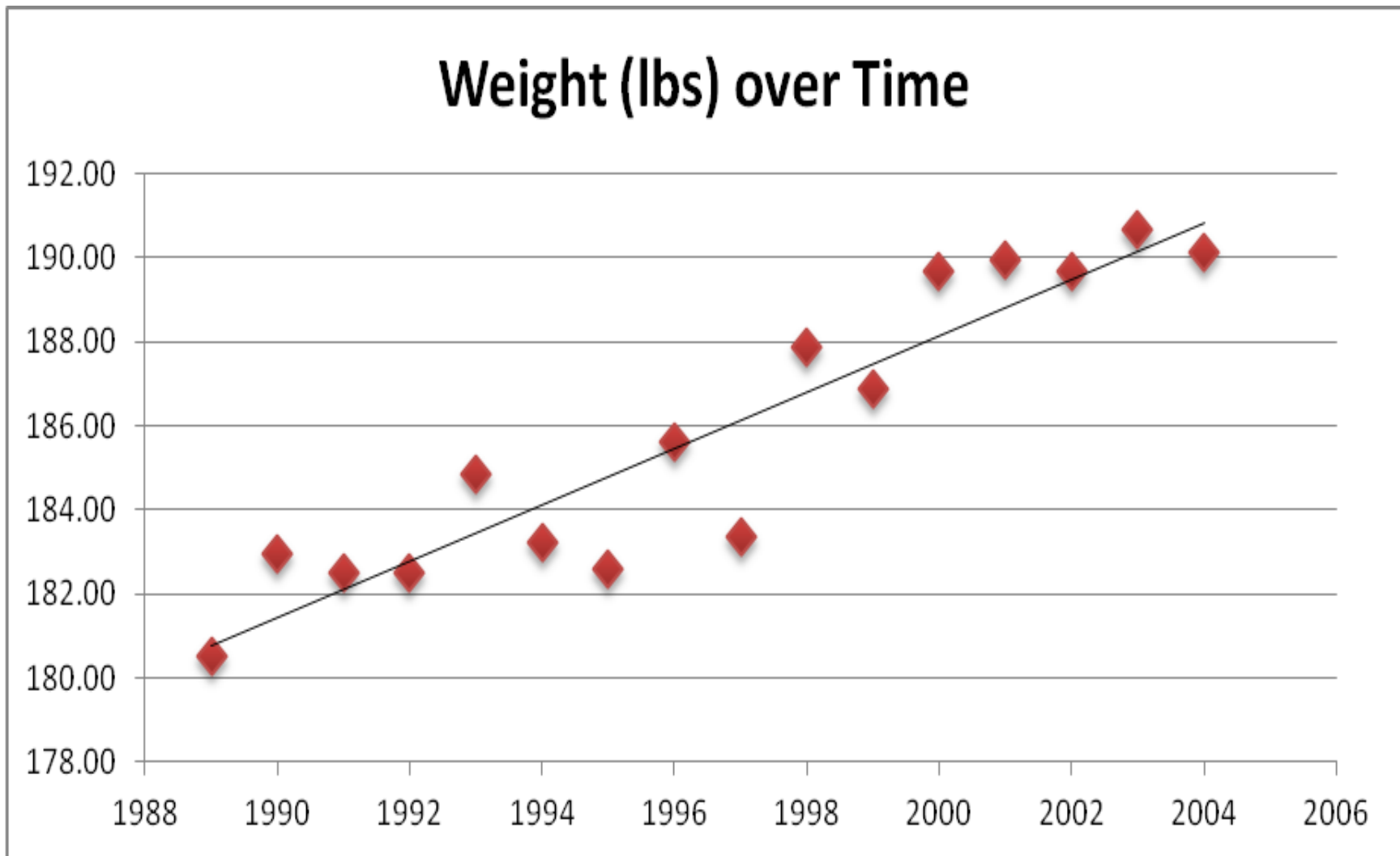




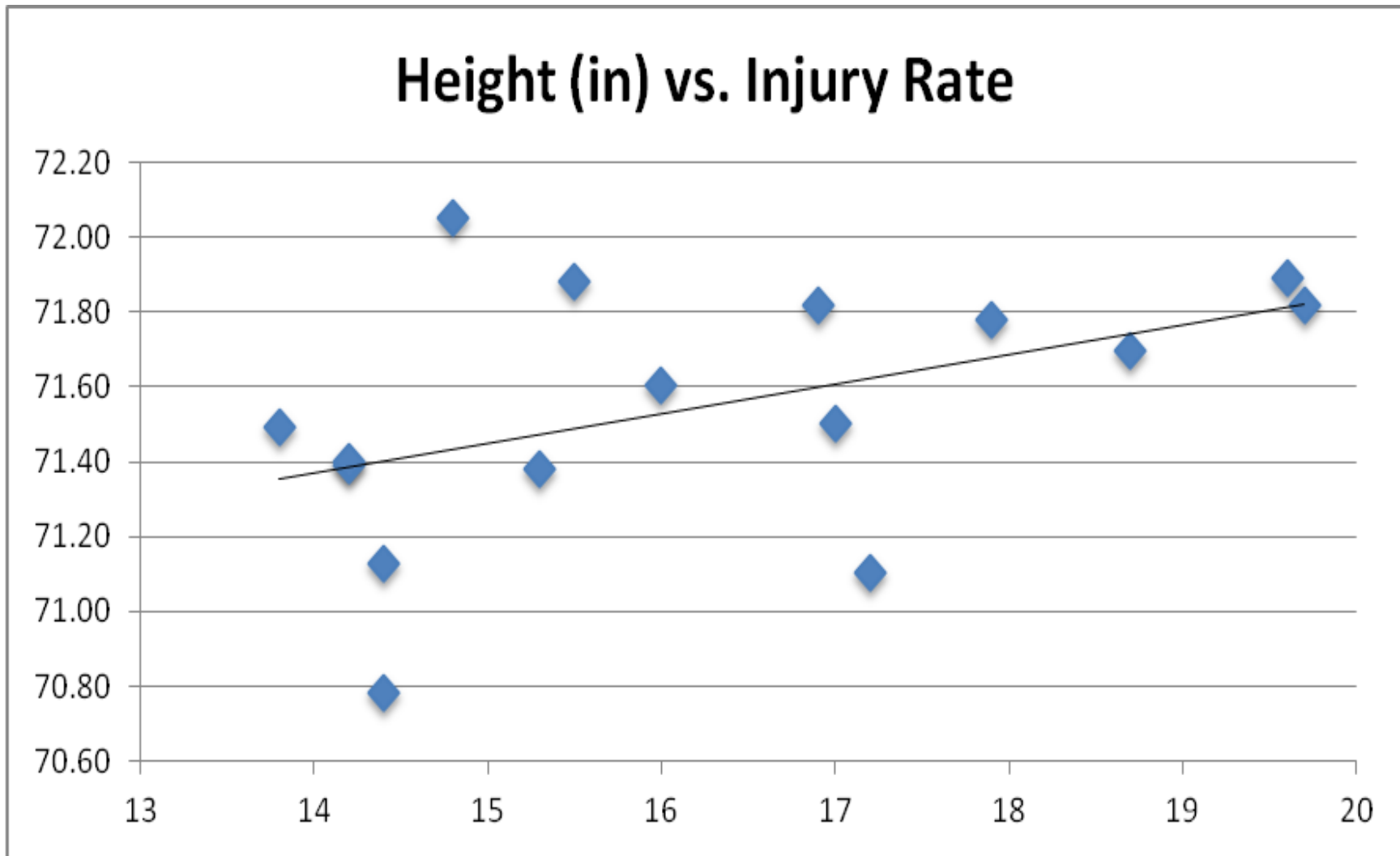
**Figure 1.** Average annual height, in inches, and respective trend line.



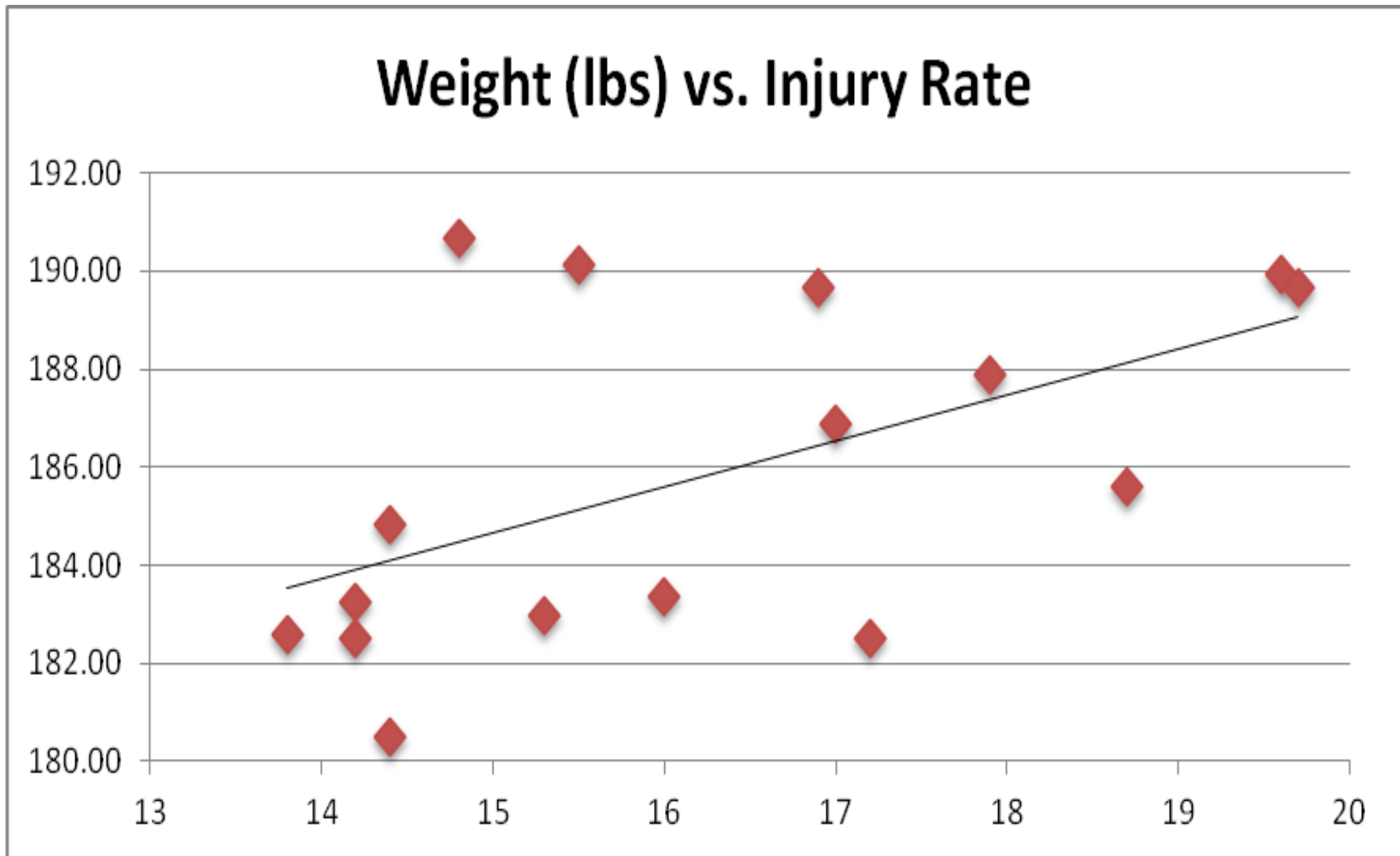
**Figure 2.** Average annual BMI, and respective trend line.



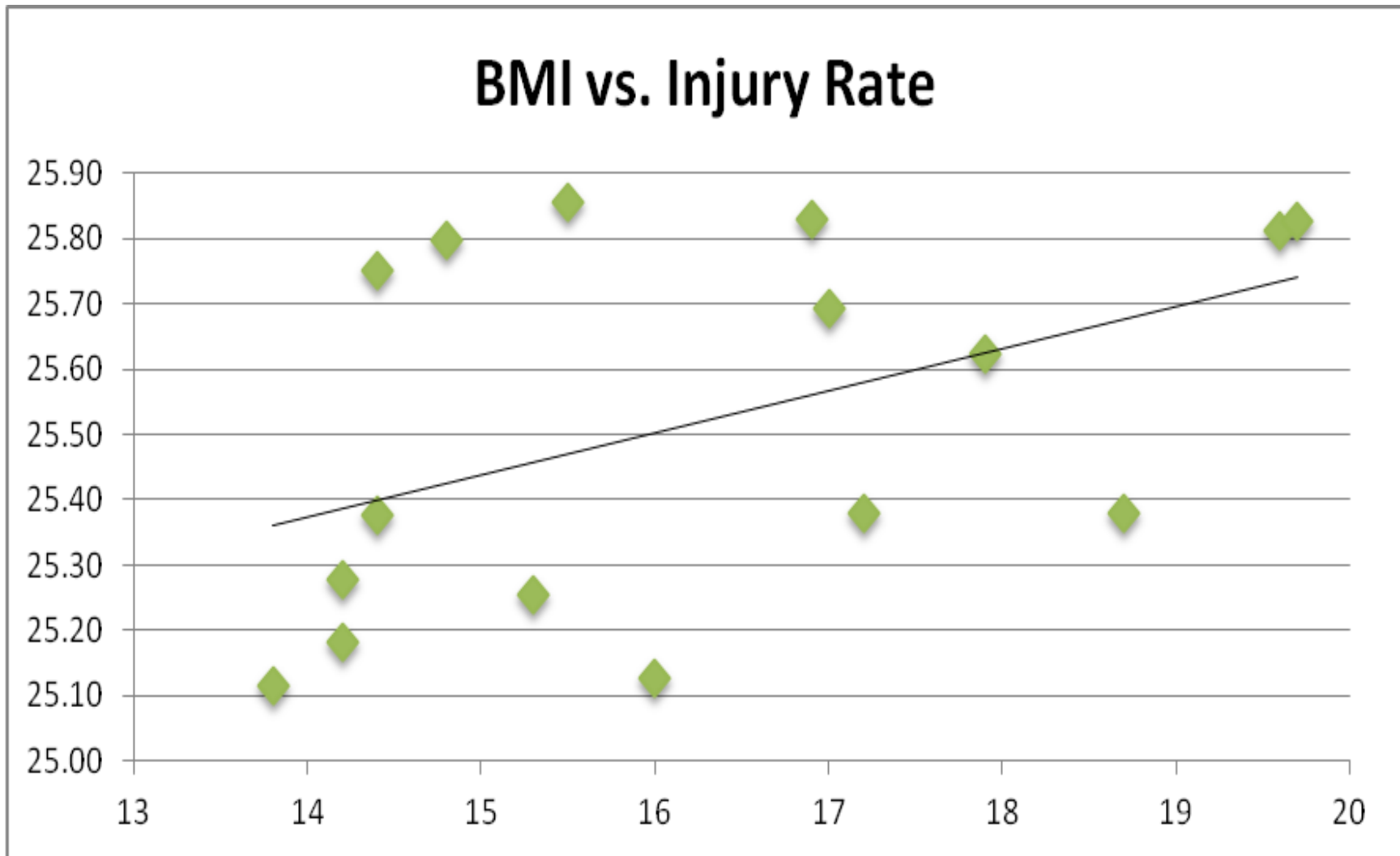
**Figure 3.** Average annual weight, in pounds, and respective trend line.



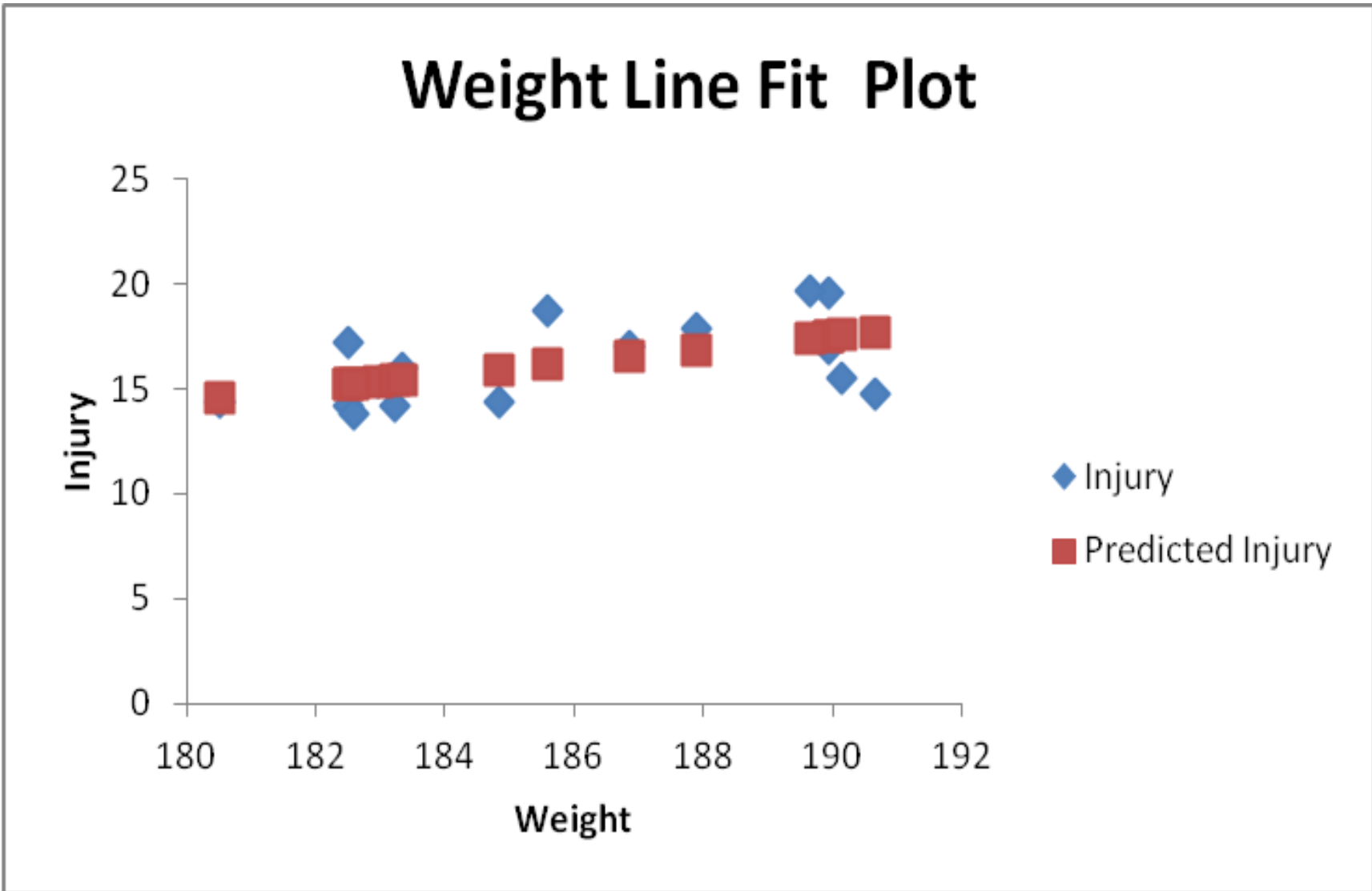
**Figure 4.** Scatter Plot showing the variability of injury rate as a function of height (inches) and regression line for injury rate and height.



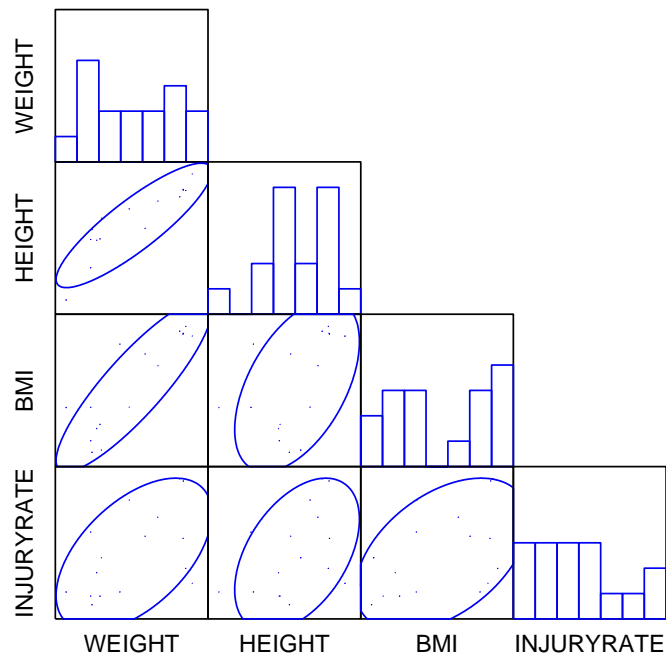
**Figure 5.** Scatter Plot showing the variability of injury rate as a function of weight (lbs) and regression line for injury rate and Weight



**Figure 6.** Scatter Plot showing the variability of injury rate as a function of BMI and regression line for injury rate and BMI.



**Figure 7.** Scatter Plot showing the variability of injury rate as a function of weight (lbs), and calculated predicted injury rates.



	WEIGHT	HEIGHT	BMI	INJURYRATE
WEIGHT	1.000			
HEIGHT	0.868	1.000		
BMI	0.871	0.512	1.000	
INJURYRATE	0.537	0.461	0.455	1.000

**Figure 8.** Pearson Correlation Matrix and Pearson r coefficient table. This shows graphs for each correlation as depicted by the SYSTAT 11 software, as well as correlation outputs. For example, one can see that weight and height are highly correlated (.868), but height and BMI to a lesser degree (.512).



## **Analysis/Discussion**

It is clear that being a larger hockey player does present its advantages. A taller player will be able to execute a faster and longer swing to make the puck go faster. A heavier player will be able to put more force and inertia behind the play, due to just simple physics (Deits et al, 2010). More muscle mass can lead to more strength, and taller players will be more able to perform at the same level as their opponents. Taller players are also able to generate more speed because their stride length for each skate is longer.

A statistically significant correlation was found between weight trends and injury trends for 1988-2004. Height and BMI, although positively correlated with injury rates, did not make the cut off to be significant, but came rather close. In fact, 29% of the variance seen with injury trends was due to changes in weight alone. That is, a little less than one-third of the change in injury rates seen from 1988-2004 can be accounted for by changes in player weight. This statistic has huge implications for the sport. Of course, the rise seen with injury rates is due to many other factors as well as this. Equipment changes, rule changes, increased competitiveness of the sport, more regimented training programs, and other factors all are likely contributors to this rise in injury rates.

Weaknesses of this study are primarily in the amount of injury data available. Data from the Injury Surveillance System (ISS) is available to researchers with permission to analyze it. However, due to the preliminary nature of this study, it was decided to use just the data that had been analyzed by previous researchers to gather information about the growing injury rate- namely, 1988-2004. Given more time, more recent years could have been analyzed to see if the

trend has continued to the present date. With even more data from the ISS, data about injuries from specific player positions, team divisions, and more could have been explored and extrapolated.

With the increased emphasis on player size and level of competition, however, comes an increase in the amount of force a player will exert when colliding with the wall, floor, net, or even upon player contact. As was discussed previously, the vast majority of injuries related to hockey are amongst males (Deits et al 2010). This statistic makes sense upon further examination of the differences between men's and women's hockey rules. Women are allowed no form of player contact, while their male counterparts are allowed to body check. Male hockey players are constantly subject to running into other players-- athletes that are, as determined in this study, getting taller and larger each year. Effective measures need to be implemented to reduce player contact with other players and objects if injuries are to be prevented. Weight is clearly not the only factor involved with the increase seen in injury rates, as it only accounts for a little less than 1/3 of the increase. Therefore, there are other ways and factors that researchers could look at to slow down the trend, as it is unlikely that hockey players will stop getting larger as the years go by.

Another less obvious factor that contributes to injury rates is the level of experience a player has. In a recent study conducted by Atif Kukaswadia (2010), researchers examined a rule change in Ontario minor hockey, where children were introduced to body-checking at a younger age, 9-10 years old, versus the previous 12-13 years old. It was hypothesized that this would result in a higher amount of injuries to minor hockey players in this location. While the

overall injury rates actually declined for 7-14 year-olds in the years after the rule change, injuries due to body checking alone remained the same (Kukaswadia et al, 2010). This study brings up an important point that the level of experience a player has had with body checking can mean a decrease in overall injuries, but does not matter when it comes to body checking injuries alone.

Protective equipment is meant to defend an athlete from trauma, injury, strain, bumps, and bruises. According to Daniel Daneshvar et al. (2011), in the game of ice hockey, players are at extreme risk for concussion, mild, and even severe brain injuries. Several studies have proven helmets to be effective at reducing the number of severe head injuries, including injuries that could result in death (Mueller, 2009). However, this same statistic is paralleled by the fact that concussion rates are on the rise (Daneshvar et al, 2011). Writing about the potential impact of larger players, Daneshvar et al (2011) comments, "The importance of understanding and preventing these impacts is increasing because athletes have been getting bigger, faster, and stronger, leading to more forceful collisions, which are more likely to cause concussions" (pg. 146). The smaller, seemingly minor hits to the head can also add up and leave the athlete with lifelong symptoms. Though a helmet and mouth guard's intentions are surely good, they are only effective if worn properly. Part of the reasons injuries such as concussions are increasing might be due to players not wearing their equipment the right way. Even then, sometimes protective equipment can give an athlete a false sense of security.

The feeling of invincibility that players feel when wearing protective equipment is not unique to hockey. Football players, donning armor-like equipment, feel safeguarded by the gear

that they wear. Gone are the days of leather helmets, in which players would be less apt to go at another player head-on. Players perceive that they are safer than they really are, and often play more aggressively because of this.

Future researchers should focus on other factors leading to injury within hockey. Player size, it seems, will inevitably rise due to training methods, general growth in the population, and a larger player pool to choose from. The answer to preventing injuries may lie in rule changes that limit player contact to each other (thus limiting the amount of forceful blows players experience with increasingly larger opponents). However, these rule changes would have to accomplish this task without taking away from the competitiveness or overall spirit of the game in order to satisfy hockey fans. Equipment changes to helmets, padding, and so forth could also prove quite useful to injury prevention, if the proper research is done and players wear the equipment properly. As mentioned above, often times equipment and protective gear can make a player feel invincible, as if nothing can hurt them no matter how hard they ram into each other. Perhaps the answer lies not in changing the rules of the game or the standard equipment, but in changing the technique and style of the athletes and educating players about the real risk for injury they have during every game.

It is clear that size, as defined and accompanied largely by weight, does have an effect on the amount of injuries players sustain during game play. These injuries are largely the result of player contact with other players, the floor, walls, or net. The larger the hockey player, the more force they exert on the object they come into at a given speed. More impact inescapably means more injuries, as emphasized in this research. Size, indeed, does matter, and can have

both positive and negative implications for a player. The question is, which outweighs the other?

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