

Cross-Sectional Study

Etiologic Factors of Ice Hockey Injuries in Korean High School Players

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Background: Ice hockey is a competitive sport and ice hockey injuries can be influenced by many physical and psychological factors. Young ice hockey players are especially vulnerable to injury due to their relative lack of experience and rapid physical growth during their juvenile years. Up to now there has been no survey of the physical, psychological, and environmental etiological factors based on the Korean high school ice hockey players population.

Purpose: The purpose of our study was to evaluate, through a comprehensive survey, the incidence of ice hockey injuries according to age and the relationship between etiological factors and injuries in high school students.

Study Design: A cross-sectional study.

Methods: One hundred nineteen ice hockey players in Korean high schools were recruited for this study. The study was conducted by a self-administered questionnaire survey. The researcher explained the purpose of the survey and how to fill it out. Individual questionnaires were distributed to participants. Chi-squared tests were used to evaluate the relationship between the independent and dependent values. There was a significant difference between a player's age and injury incidence ($P = .018$). The injury level of each position showed a significant tendency ($P = .055$). Age was highly correlated with the number of total injuries ($P = .019$).

Results: The average demographic characteristics of those surveyed were age (16.7 years), play line (2.2), height (174.8 cm), weight (69.6 kg), and body mass index (23.4). The shoulder was the most frequent injury area and the knee was the most common cause of hospital visits. There was a higher injury incidence in older groups; however, there was no correlation with body mass index, position, and play line. The causative factors were divided into physical factors, psychological factors, and environmental factors. Generally, 3 factors were not closely regarded as etiologic factors of ice hockey injury. However, deficiency of fitness in the physical factor, aggressiveness in the psychological factor, and injury by other players in the environmental factor showed a high etiological correlation for ice hockey injury.

Conclusion: The multiple aspects of this etiological factor analysis showed modest results. However, based on our results, in order to reduce the long-term implications of youth ice hockey injuries and associated public health costs, comprehensive efforts, including psychological and environmental factor modification, should be put in place.

Key terms: Ice hockey, etiologic factor, high school player

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The number of ice hockey players is increasing worldwide and despite the advantages of sport participation, there is increasing concern regarding the frequency of ice hockey injuries in youths (1). Unlike adult ice hockey players, youth players are vulnerable to injury and show high disease incidence and a long duration of morbidity (2). High injury prevalence in youth players is attributed to relative physical immaturity and a lack of skills and inexperience with the game (2).

One previous study reported that risk factors for female youth ice hockey players include: a policy allowing body checking, higher divisions of play, older age group, lower body weight, fatigue, higher levels of aggression, and lower levels of empathy (1,3). Other previous studies have reported various injury prevalences (3). However, due to inconsistent injury reports and definitions, clear injury causation in youth ice hockey players has not been reported.

High school players who are eligible for participation in competitive and vigorous sports games such as ice hockey are between 15 and 18 years of age. As they are growing and exercising exponentially in this youthful period, the relative age and experience levels would have a significant influence on game ability and injury incidence (1,4-8). However, some authors did not report significant differences between younger and older age groups (8,9). Because all data were collected merely from the physical factors of the players, mixed results were reported. More than estimating the individual physical factors of each player, other etiologic factors such as psychological factors and environmental factors of the players should also be considered.

Aggressiveness and hostile acts could be the primary etiological factors of ice hockey injuries (10). Brain and spinal cord injuries are highly correlated with player aggressiveness and account for 15% of the injuries between 9 and 16 years of age (1,11). Behavior modification and reducing aggressiveness might reduce ice hockey injuries, especially in youth. Therefore, the emotional burden and individual emotional status should be considered as an important etiology in youth ice hockey players. Environmental factors could also be major etiological factors. Limiting body checking, wearing safety equipment, and maintaining physical fitness can prevent many injuries (12).

To date, several studies on the incidence and prevalence of ice hockey injuries have been reported.

However, few studies of ice hockey injuries in Korean youth ice hockey players have been reported. In addition, to date, no survey in terms of individual, psychological, and environmental etiological factors based on the entire population of Korean high school ice hockey players has been reported. The purpose of our study was to evaluate, through a comprehensive survey, the incidence of ice hockey injuries according to age and the relation between etiological factors and injuries in high school students.

METHODS

Sample Survey

A total of 119 ice hockey players from 8 high schools registered in the Korean Ice Hockey Association were recruited for the study. All of the players had participated as team members in the Korean Ice Hockey League from the first grade. The study was conducted using a self-administered questionnaire survey of high school students in Kangreung during a Korea Ice Hockey League tournament from July 20, 2012 through July 25, 2012.

First, the researcher explained the purpose of the survey and how to fill it out. Individual questionnaires were distributed to participants. The self-administered questionnaire survey is a way of ensuring the participants read and answer the questions themselves. Informed consent was provided after an explanation of the study. The comprehensive survey included demographic characteristics of the players, hospital visit status, and injury patterns. Players who were unwilling to participate in the study or did not participate in the Korean Ice Hockey League were excluded from this study.

Assessment Variables and Statistical Methods

The dependent values were medical examination, health consultation frequency, and injury grade and status. The injury grade was divided by frequency of injuries in one year. The independent values were age, position, body mass index (BMI), and ice hockey playing ability on a team. Chi-squared tests were used for evaluation of the relationship between independent and dependent values.

To examine the measurement factors-basic characteristics, actual conditions of injury, cause of injury etc., a frequency analysis was performed using SPSS 18.0 (SPSS Inc., Chicago, IL) and Chi-squared test was performed for analyzing each level of injury.

RESULTS

Prevalence of Ice Hockey Injuries

Demographic characteristics including age, play line, position, height, weight, and BMI of the 119 high school ice hockey players are shown in Table 1. The International Classification of adult standard weight according to BMI is between 18.5 and 24.99 (13). The samples were divided into lower BMI (18.5 – 22.99) and higher BMI (23 – 24.99) groups.

The number of regional injuries occurring in one year is recorded in Table 2. Shoulder injuries (0.87 ± 1.29) were the most common, followed by knee (0.55 ± 0.82) and back (0.50 ± 0.99) injuries. The number of hospital visits is shown in Table 3. The most common causes of hospital visits were knee (1.85 ± 5.56), low back (1.54 ± 4.28), and foot (1.49 ± 4.63), followed by shoulder (1.45 ± 2.73) injuries.

Incidence of Ice Hockey Injuries by Age, Position, and Play Line

Incidence of ice hockey injuries by age, position, and play line is shown in Table 4. Play level was divided into 3 levels (high, middle, and low), depending on each participant's own ranking of the league. Injury prevalence was the sum of all injuries of each sample in one year. Fifteen year-old players showed the lowest injury prevalence (38.5%) and 18 year-old players showed the highest injury prevalence (60.9%). Injury level of each position showed a significant tendency for high risk of injury but not to a statistically significant degree ($= .055$). In the case of defense, it showed the highest response as high level at 44.4%, however the wing showed the highest response as low level at 29.8%. Besides the position, the level of each grade, line, ability, height, and weight did not show significant difference. As a result,

Table 1. Demographic data of the sample.

	Valid	Frequency (%)
Age	15	13 (10.9)
	16	44 (37.0)
	17	34 (28.6)
	18	28 (23.5)
	sum	119 (100.0)
Play line	1	51 (32.3)
	2	34 (21.5)
	3	14 (8.9)
	4	6 (3.8)
	sum	105 (100.0)
Position	C (center)	20 (12.7)
	LW, RW (wing)	47 (29.7)
	LD, RD (defense)	36 (22.8)
	G (goaltender)	15 (9.5)
	sum	118 (100.0)
Height	~170 cm	19 (12.0)
	171 – 175 cm	47 (29.7)
	176 – 180 cm	31 (19.6)
	181 cm~	22 (13.9)
	sum	119 (100.0)
Weight	~60 kg	11 (7.0)
	60 – 70 kg	63 (39.9)
	70 – 80 kg	34 (21.5)
	81 kg~	11 (7.0)
	sum	119 (100.0)
BMI	18~18.49 (mild thinness)	3 (2.5)
	18 – 24.99 (standard)	102 (85.7)
	18 – 22.99 (lower BMI)	70 (58.8)
	23 – 24.99 (upper BMI)	32 (26.9)
	25 – 30 (pre obese)	14 (11.8)
	sum	119 (100.0)

Table 2. Number of regional injuries per year.

Injury sites	N	Minimum	Maximum	Mean	Std. deviation
Head	119	0	2	.09	.368
Face and Neck	119	0	3	.14	.475
Shoulder, Elbow	119	0	5	.87	1.286
Back	119	0	7	.50	.99041
Knee	119	0	3	.55	.820
Foot and Ankle	119	0	4	.42	.786
Chest	119	0	3	.11	.407
Abdomen	119	0	4	.12	.524
Other region	119	0	5	.20	.754

Table 3. Number of hospital visits by injury sites per year.

Injury sites	N	Minimum	Maximum	Mean	Std. Deviation
Head	119	0	2	.07	.338
Face and Neck	119	0	5	.13	.747
Shoulder, Elbow	119	0	14	1.45	2.730
Back	119	0	30.00	1.54	4.278
Knee	119	0	50	1.85	5.560
Foot and Ankle	119	0	32	1.49	4.632
Chest	119	0	10	.17	1.084
Abdomen	119	0	6	.09	.713
Other region	119	0	36	.83	3.956

Table 4. Injury incidence depending on the ability level regarding age and position factors.

		None	Low Level	Middle Level	High Level	Total
Age	15	5 (38.5%)	3 (23.1%)	2 (15.4%)	3 (23.1%)	13 (10.9%)
	16	9 (20.5%)	11 (25.0%)	13 (29.5%)	11 (25.0%)	44 (37.0%)
	17	2 (5.9%)	12 (35.3%)	11 (32.4%)	9 (26.5%)	34 (28.6%)
	18	1 (4.3%)	2 (8.7%)	6 (26.1%)	14 (60.9%)	23 (19.3%)
	Total	17 (16.0%)	28 (24.4%)	32 (26.9%)	37 (32.8%)	114 (100.0%)
Position	center	2 (10.0%)	5 (25.0%)	5 (25.0%)	8 (40.0%)	20 (16.9%)
	wing	12 (25.5%)	14 (29.8%)	9 (19.1%)	12 (25.5%)	47 (39.8%)
	defense	4 (11.1%)	7 (19.4%)	9 (25.0%)	16 (44.4%)	36 (30.5%)
	goaltender	1 (6.7%)	2 (13.3%)	9 (60.0%)	3 (20.0%)	23 (12.7%)
	Total	19 (16.1%)	28 (23.7%)	32 (27.1%)	39 (33.1%)	118 (100.0%)

injury prevalence increased in position, age, and grade; however no correlation was observed in weight, height, medical examination, ability, and line. That is, physical and psychological factors were not significant. Among age, position, and play line factors, significant correlation was observed between age and injury prevalence ($= .018$); however, although the player position shows a tendency for high risk of injury, no correlation was observed between position, play line, and injury prevalence ($= .215$).

Hospital Visiting Status by Injury Sites

Unlike the most common injuries in one year in Table 2, hospital visits by injury sites was different (Table 4). The most common hospital visit injury sites were knee (1.85 ± 5.56 times) followed by back (1.54 ± 4.27 times), foot and ankle (1.49 ± 4.63 times), and shoulder and elbow (1.45 ± 2.73 times).

Causative Factor Analysis: Physical Factors, Psychological Factors, and Environmental Factors

Causative factors were divided into physical factors, psychological factors, and environmental factors (Table 5). Physical factors include players' own carelessness, deficiency in warming-up, poor physical condition, and deficiency of fitness. Psychological factors include aggressiveness, weakened mental strength, and excessive demand by staff. The environmental factors include ice rink condition, protective equipment, and injury by other players. In general, physical, psychological, and environmental factors were not closely regarded as etiologic factors of ice hockey injury. Most participants strongly disagreed or disagreed on the relationship between etiologic factors and injury prevalence. Only injury by other players, poor physical condition, and players' own carelessness factors were regarded as

Table 5. *The causative factors of injury by participants' opinions.*

		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total
Physical Factors	own carelessness	7 (4.4%)	29 (18.4%)	26 (16.5%)	23 (14.6%)	23 (14.6%)	108 (100.0%)
	deficiency of warming-up	4 (2.5%)	18 (11.4%)	16 (10.1%)	32 (20.3%)	38 (24.1%)	108 (100.0%)
	poor physical condition	9 (5.7%)	22 (13.9%)	31 (19.6%)	19 (12.0%)	27 (17.1%)	108 (100.0%)
	deficiency of fitness	2 (1.3%)	9 (5.7%)	16 (10.1%)	36 (22.8%)	45 (28.5%)	108 (100.0%)
Psychological Factors	aggressiveness	10 (6.3%)	25 (15.8%)	26 (16.5%)	19 (12.0%)	28 (17.7%)	108 (100.0%)
	weakened mental strength	3 (1.9%)	12 (7.6%)	22 (13.9%)	32 (20.3%)	39 (24.7%)	108 (100.0%)
	excessive demand by staff	5 (3.2%)	10 (6.3%)	14 (8.9%)	36 (22.8%)	43 (27.2%)	108 (100.0%)
Environmental Factors	ice rink condition	6 (3.8%)	12 (7.6%)	22 (13.9%)	33 (20.9%)	35 (22.2%)	108 (100.0%)
	protective equipment	5 (3.2%)	10 (6.3%)	17 (10.8%)	33 (20.9%)	43 (27.2%)	108 (100.0%)
	injury by other players	21 (13.3%)	24 (15.2%)	29 (18.4%)	14 (8.9%)	20 (12.7%)	108 (100.0%)

neutral or agreed correlating etiologic factors of injury. We also divided the standard BMI into upper BMI and lower BMI groups and compared the causative factors with ice hockey injuries.

The 3 related causative factors, injury by other players, poor physical condition, and players' own carelessness, were more closely analyzed by age (Table 6). The own carelessness factor was most closely correlated with the 15 year-old age group (41.7% of positive response). The injury by other players factor was most closely correlated with the 18 year-old age group (43.5% of positive response). There was no distinctive correlating age group with the poor physical condition factor. However, negative responses were also high in 15 year-old age group with the own carelessness factor (58.2%) and in the 18 year-old group with the injury by other players factor (34.8%). Therefore, no statistical correlation was noted between age and the 3 mentioned causative factors.

In addition, we also analyzed the 3 causative factors by play line. The own carelessness factor was most closely correlated with the fourth play line (100% of positive response and no negative response). The poor physical condition factor was most closely correlated with the fourth play line (75.0% of positive response and 29.4% of negative response). However, only 4 samples of fourth play line were recruited.

The injury by other players factor was most closely correlated with the third play line (46.2% of positive response and 36.8% of negative response).

Lastly, we analyzed the 3 causative factors by BMI (upper BMI and lower BMI in the standard BMI group). However, there was no statistical difference between 3 causative factors and injury development by BMI.

DISCUSSION

Youth ice hockey players have several characteristics including rapid physical growth, fewer skills, and less experience than adult ice hockey players. As ice hockey is a vigorous, physical contact sport, body checking is not allowed for very young players. However it depends on the rules of the league. Due to rapid physical growth, skill, and allowance of body checking, high school players can be easily injured. Despite mixed data on injury rates in youth hockey players due to varying sample sizes and inconsistent definitions of injury, previous studies have reported a higher incidence of severe injury compared to adult hockey players (1,4,6,14).

As ice hockey is a team sport and strongly controlled by staff, hospital visits might be limited unless a player suffers a debilitating and serious illness and cannot skate (especially knee and back injuries) (Table 5). Therefore, relatively less debilitating injuries, such as shoulder and upper extremity injuries, may not require

Table 6. *The 3 significant causative factor analysis by age.*

Age	Strongly Agree	Agree	*PR (%)	Neutral	Disagree	Strongly ** NR (%) Disagree	Total
Own carelessness							
15	2 (16.7%)	3 (25.0%)	41.7	0 (0.0%)	2 (16.7%)	5 (41.7) 58.2	12 (11.2%)
16	1 (2.6%)	11 (28.2%)	30.8	12 (30.8%)	8 (20.5%)	7 (17.9%) 38.4	39 (36.4%)
17	3 (9.4%)	9 (28.1%)	37.5	7 (21.9%)	8 (25.0%)	5 (15.6%) 40.6	32 (29.9%)
18	1 (4.2%)	5 (20.8%)	25.0	7 (29.2%)	5 (20.8%)	6 (24.0%) 44.8	24 (22.4%)
Total	7 (6.5%)	28(26.2%)	32.7	26 (24.3%)	23 (21.5%)	23 (21.5%) 43.0	107 (100.0%)
Poor physical condition							
15	2 (16.7%)	1 (8.3%)	25.0	4 (33.3%)	1 (8.3%)	4 (33.3%) 41.6	12 (11.1%)
16	3 (7.7%)	9 (23.1%)	30.8	12 (30.8%)	7 (17.9%)	8 (20.5%) 38.4	39 (36.1%)
17	2 (6.1%)	9 (27.3%)	33.4	8 (24.2%)	4 (12.1%)	9 (27.3%) 39.4	33 (30.6%)
18	2 (8.3%)	4 (16.7%)	25.0	7 (29.2%)	6 (25.0%)	5 (20.8%) 45.8	24 (22.2%)
Total	9 (8.3%)	23 (21.3%)	29.6	31 (28.7%)	18 (16.7%)	26 (24.1%) 40.8	108 (100.0%)
Injury by other players							
15	2 (16.7%)	5 (20.8%)	37.5	2 (16.7%)	1 (8.3%)	2 (16.7%) 27.0	12 (11.3%)
16	9 (23.1%)	6 (15.4%)	38.5	10 (25.6%)	6 (15.4%)	8 (20.5%) 35.9	39 (36.8%)
17	6 (18.8%)	7 (21.9%)	40.7	10 (31.3%)	3 (9.4%)	6 (18.8%) 28.2	32 (30.2%)
18	4 (17.4%)	6 (26.1%)	43.5	5 (21.7%)	4 (17.4%)	4 (17.4%) 34.8	23 (21.7%)
Total	21 (19.8%)	24 (22.6%)	42.4	27 (25.5%)	14 (13.2%)	20 (18.9%) 32.1	106 (100.0%)

* PR (Positive response) is summation of strongly agree and agree opinions.

* NR (Negative response) is summation of disagree and strongly disagree opinions.

hospital visits, even though shoulder injuries were the most common injury in our study (Table 2).

Although some studies did not report significant differences (8,9), many studies have reported an increasing injury prevalence in older adolescent players (1,4-7). Usually the longer the exposure time to the exercise, the higher the injury prevalence in adult ice hockey players. The increased injury prevalence in older groups does not mean that older groups have more skating time. All players on the same team and same age groups have equal skating time. Even with the same exposure time, the older group showed a higher injury prevalence, which might be due to the unique features of high school players: relatively less experience and skill cannot catch up with a rapidly growing physical condition.

In addition, previous studies have reported mixed results regarding injury prevalence according to the level of play (8,14,15). In our study, only age showed the positive correlation with injury prevalence; BMI and play line did not. The standard BMI group in our study may not be sufficient to show a correlation between BMI and injury prevalence. In addition, play line might

not be an exact parameter to judge the play level of the players.

We also analyzed the possible etiologic factors of the cause of injuries. More than analyzing the physical factors in previous studies, psychological factors and environmental factors were also included.

Unlike physical factor analysis of each player, little attention has been paid to psychological and environmental factors which might also be a very important cause of risk taking in youth ice hockey. Emery et al (16) reported a positive correlation between level of empathy and level of aggression and injury prevalence, although the study was limited by a low sample size.

As a result, more than physical factors such as a player's own carelessness, poor condition, and injury by other players were also regarded as agreed correlating etiologic factors of injury. However, there was no significant correlation between physical, psychological, and environmental factors with injury. In addition, the 3 related causative factors, injury by other players, poor physical condition, and own carelessness, were not considered as the cause of injury even after re-analyzing by age, play line, and BMI.

Even though most etiologic factors in our study showed low correlating factors with injury, injury by other player and poor condition showed a relatively high correlation. Most players considered their injuries to be their fault. However several other etiologic factors could play an important role as a causative factor. Therefore, other preventable etiologic factors except their own fault should be cautiously considered and prevented.

Although, there was no significant difference between the 3 etiologic factors with cause of injury, there were some positive and negative tendencies in each etiologic factor.

There are several strengths of our study. First, a comprehensive survey for high school players was conducted which can remove the sampling error and it might reflect all characteristics of those surveyed. Second, the injury prevalence was analyzed through different points of factor analysis. Unlike the previous studies, physical, psychological, and environmental factors could be contributing etiologic factors. Although no strong correlation was observed between all etiologic factors and cause of injury, none of the factors should be overlooked in order to prevent future injuries. As all of the etiologic factors could cause serious injuries, either separately or together especially in the young. However, our results from samples of Korean high

school ice hockey players should be cautiously considered as evidence for injury factor analysis. This may be of particular concern with regard to how data are collected in a specific time situation such as before or after league and whether the participants feel pressured to provide biased responses when revealing their personal information. In addition, from our findings, we cannot generalize to all ice hockey injuries.

However, our results could provide the general tendency of all ice hockey injuries with much greater reliability compared to the previous selected survey.

CONCLUSIONS

Age appears to be the only correlating etiologic factor and player position showed a tendency to a greater risk of injuries in South Korean high school ice hockey players. There was no correlation between physical, psychological, and environmental factors and the risk of injury. Further investigation with a different methodology might be necessary to determine whether or not these risk factors truly have an impact on the risk of injury in Korean hockey players.

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