Regular Article

Injury mechanisms of concussion in soccer among Japanese middle- and high-school students: a retrospective review of insurance registry data

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Tables and figures: 3 tables and 4 figures

Running title: Concussion mechanisms in Japanese school soccer

Abstract Concussions are a growing concern in youth soccer; yet, detailed information on their mechanisms and grade-specific characteristics remains limited. This study aimed to describe the epidemiological features and mechanisms of soccer-related concussions among middle-school and high-school students in Japan. A retrospective observational analysis was conducted using nationwide insurance data for sports injuries from 2012 to 2022. Concussion cases sustained during soccer were extracted, and their mechanisms were categorized. Sex- and grade-related differences were examined, and incidence rates per 1,000 club members were calculated to account for variations in player population size. Among 696,600 soccer-related injury claims, 3,343 concussion cases met the inclusion criteria. Boys accounted for 3,217 cases (96.2%) and girls for 126 cases (3.8%), with incidence proportion of 0.85 and 0.78 per 1,000 club members, respectively. The most frequent injury mechanism was playing surface-contact with player (40.2%), followed by collisions with other players. Most concussions occurred during competitions

rather than practice sessions. As school grade level increased, concussions more often resulted from player-to-player contact during games (middle school: 1st year, 49%; 2nd year, 54%; 3rd year, 63%; high school: 1st year, 57%; 2nd year, 60%; 3rd year, 69%). These findings indicate that most soccer-related concussions among middle- and high-school students occurred after contact and subsequent falls. Even when not directly caused by a collision, loss of balance leading to a fall frequently resulted in concussion. The grade-dependent variation in injury mechanisms highlights the need for tailored prevention strategies focusing on fall dynamics and safe contact techniques.

Keywords: soccer, concussion, adolescent, epidemiology

タイトル: 日本の中学・高校生サッカー競技における脳振盪の受傷機転：保険登録データを用いた後方視的検討

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抄録：近年，学齢期のサッカーにおける脳振盪の発生が懸念されているが，その詳細な受傷機転や学年別の特徴については十分に明らかにされていない．本研究は，日本の中学生および高校生を対象に，サッカー競技中に発生した脳振盪の疫学的特徴および受傷機転を明らかにすることを目的とした．2012 年から 2022 年における全国規模のスポーツ傷害保険データを用いて後方視的観察研究を実施した．サッカー競技中に発生した脳振盪症例を抽出し，その受傷機転を分類した．性別および学年による差を検討し，競技者人口の影響を補正するため，部員 1,000 人あたりの発生率を算出した．サッカー関連の傷害申請 696,600 件のうち，3,343 件が脳振盪として解析対象に該当した．男子は 3,217 件（96.2%），女子は 126 件（3.8%）であり，部員 1,000 人あたりの発生率はそれぞれ 0.85 および 0.78 であった．最も多かった受傷機転は「(他選手と接触後の)地面との接触」(40.2%)であり，次いで「他選手との衝突」であった．脳振盪の大部分は練習よりも試合中に発生していた．学年が上がるにつれて，試合中の選手間接触による脳振盪の割合が増加した（中学 1 年：49%，2 年：54%，3 年：63%，高校 1 年：57%，2

年：60%，3 年：69%）．これらの結果から，中高生サッカーにおける脳振盪の多くは接触およびその後の転倒によって発生していることが示された．直接的な衝突ではなく，バランスを崩した転倒による脳振盪も少なくないことが示唆された．学年による受傷機転の違いは，転倒動作および安全な接触技術に着目した学年特性に応じた予防対策の必要性を示している．

Introduction

Soccer is a popular sport with a large number of participants globally. Players often use their heads to pass the ball, making head contact a routine part of play. Due to these characteristics, greater attention has been directed toward concussions in soccer.[1] Several rule changes have been implemented in soccer to prevent concussions. The first was introduced before the 2006 Fédération Internationale de Football Association World Cup, granting referees the authority to issue red cards for intentional elbow strikes to the head.[1] The effectiveness of this change has been demonstrated by a reduction in the incidence of head injuries.[2,3] A second measure requires referees to stop the game for up to 3 minutes if a concussion is suspected, allowing the injured player to be assessed by the team doctor. Third, an additional permanent concussion substitution, which does not count as one of the 'normal' permitted substitutions when a player who has an actual or suspected concussion is substituted and takes no further part in the match, was approved at an international conference in 2024.[4] The effectiveness of this change is currently under evaluation.[5] To implement such measures, systematic analysis and identification of risk factors and injury mechanisms are essential.[6]

Several studies have reported on the mechanisms involved in concussion in soccer, with a high proportion of cases involving contact or collisions with other players.[7,8,9] The nature and distribution of injury mechanisms vary depending on factors such as age,[8,10,11,12,13,14] competition level,[15] and whether the injury occurred during a match or practice session.[11,12] Most of these studies originate from the United States of America or Europe, with limited data available from Asia, especially Japan.

Middle-school and high-school soccer players are an important group for studying sports-related concussion (SRC) in Japan. This is because these players, who span an age range of only 6 years, account for about half of all soccer players in Japan.[16] Moreover, most players participate in extracurricular club activities, and identifying epidemiological characteristics of this group could lead to the development of effective countermeasures. Extracurricular activities in Japan have characteristics that differ from those in other countries. First, participation in extracurricular activities in Japan is 'voluntary' but could be semi-mandatory due to the relationships within club activities significantly influencing school life itself and friendships.[17] Second, excessive practice in extracurricular activities as well as long working hours in Japanese workplaces

reflect the influence of Japanese culture.[18] Activities in Japan are typically conducted not only during the school term on weekdays but also on weekends, whereas many Organisation for Economic Co-operation and Development member countries offer extracurricular activities during the school term on weekdays only.[19] Third, in the United States of America and other countries, professional coaches—often hired separately from school staff—are responsible for athletic training. In contrast, Japanese schools often assign teachers with limited interest or experience in the sport as coaches, with an emphasis on character development as the primary educational goal. As noted above, extracurricular activities in Japan are viewed as a form of 'general educational activity', which differs from the perception in the United States of America and Europe.[20]

The mechanisms by which concussions occur among Japanese middle- and high-school soccer players in this particular environment remain unclear. This study aimed to systematically investigate the soccer concussion injury mechanisms in Japan using nationwide insurance claims data and to describe the characteristics of players who experience different types of SRC according to sex and grade level.

Methods

Study design, setting, and period. This retrospective observational study was conducted from April 2012 to March 2022. Data were extracted from the nationwide insurance registry of the Injury and Accident Mutual Aid Benefit System (IAMABS), a program administered by the Japan Sports Council to provide benefits (including medical expenses and compensation for injury or death) for accidents resulting in injury, illness, disability, or death that occur while students are under school supervision. Premiums for this system are jointly funded by the national government, school operators, and parents or guardians. Approximately 800,000 injury-related cases are reported annually, with total payments reaching 14.1 billion JPY. The IAMABS enrolment rates for middle and high schools are 99.9% and 97.8%, respectively.

Study population and eligibility criteria. The study population comprised Japanese middle- and high-school students who had been injured while participating in soccer and were registered in the IAMABS database. The inclusion criteria were being a middle- or

high-school student; having an injury that occurred between April 2012 and March 2020 during extracurricular sports club activities; and a diagnosis of SRC. Extracurricular sports club activities were defined as 'sports and exercise activities conducted under the guidance of the supervising teachers and other related parties, with the voluntary and independent participation of students who share an interest in sport, as part of their school education'.

Study procedures. Data were extracted from the IAMABS database by filtering according to 'date of injury', 'type of school', 'type of activity', and 'injury or illness'. As benefits cannot be claimed more than 2 years after visiting a medical institution, participants were accurately identified by selecting those who came within a 2-year window prior to the end of the benefit period. This approach ensured that all eligible participants within the target period were considered.

Data collection. The variables collected from the database included the date of injury, injury mechanism, school type, grade level, sex, sport, and diagnosis. For information on

the circumstances before and after the injury, information is provided in the 'Setting' section.

Data analysis. Based on the injury mechanism information, a three-step classification was performed. In Step 1 (before incidence), cases were categorised into three groups: 'contact with player (teammate or opponent)', 'no contact', and 'unknown', regardless of whether the contact was the direct cause of the injury. In Step 2 (incident mechanism), the main causes of concussions were divided into two categories: those caused by being hit by another player and those caused by contact with the playing surface. If there was 'no contact with a player' in Step 1, the cause of concussion was further classified as 'contact with playing surface', 'contact with playing apparatus', or 'others'. In Step 3 (detailed information), if there was 'contact with player' in Step 1 and the main mechanism involved 'hit by other player' in Step 2, the body part of the other player involved was classified as 'head-head', 'upper limb-head', 'lower limb-head', 'other-head', or 'unknown'. If there was 'no contact with player' in step 1 but 'contact with playing apparatus' in Step 2, the equipment was classified as 'ball', 'goalpost', or 'other'.

Specifically, 'other' refers to benches, fences, and training equipment not classified as the ball or goalpost.

Statistical analysis. The number of SRCs depends on the size of the athlete population; therefore, to calculate the incidence, the number of athletes was obtained from data provided by the Nippon Middle-School Physical Association, [21] and the All Japan High-School Athletic Federation.[22] The incidence was calculated using the following formula:

$$Incidence = \frac{Number\ of\ SRC\ cases}{Number\ of\ Club\ members} \times 1000$$

Descriptive statistics summarised the characteristics of students with SRC. The numbers of SRC cases by sex and grade level are expressed as percentages. Cross-tabulation was performed for multiple-category variables. To examine whether sex was associated with the occurrence of SRC, the chi-squared tests were performed separately for middle-school and high-school students. To evaluate whether the proportion of each injury mechanism or incident setting changed across school grades, trend tests for proportions (Cochran–Armitage trend tests) were conducted. These tests were applied to assess linear trends in the proportions of specific mechanisms (e.g., player-to-player contact, playing surface

contact, playing apparatus contact) and activity settings (competition, practice, and unknown) across six school grades. In addition, to compare the distribution of injury mechanisms between competition and practice, a Pearson's chi-squared test was performed using a 2 × 3 contingency table. All statistical analyses were conducted using R statistical software (version 4.5.2; R Foundation for Statistical Computing, Vienna, Austria). A two-sided p-value < 0.05 was considered statistically significant.

Ethical considerations. This study was reviewed and approved by the Ethics Committee of the Japan Institute of Sports Sciences (authorisation number: 013, 2023). The research used anonymised data, ensuring that individuals cannot be identified reversibly.

Results

Participant selection. Of the 696,600 cases that middle-school and high-school students received benefits because of injuries during soccer between April 2012 and March 2022, 3,343 met the eligibility criteria, including injury period, type of activity when injured,

and diagnosis.

Sex and grade level. Concussions in soccer were markedly more common in boys, a trend observed in both middle and high school. By school type, concussions occurred more frequently in high school, and by grade level, the second year was the most common in both school types (Table 1). The number of concussions per 1,000 club members was higher among boys in both school types, with high schools showing higher rates than middle schools (Table 2). To examine whether the occurrence of SRC differed by sex, the chi-squared test was performed separately for middle-school and high-school students. Among middle-school students, the occurrence of SRC differed significantly by sex ($\chi^2[1] = 4.89$, $p = 0.027$), with boys demonstrating a slightly higher proportion of SRC than girls. In contrast, no significant sex difference in SRC occurrence was observed among high school students ($\chi^2[1] = 3.28$, $p = 0.070$). When both school types were combined, no significant association between sex and SRC occurrence was found ($p = 0.345$).

Table 1

Table 2

Injury mechanism. Prior to injury (Step 1), 69.5% of cases involved 'contact with player'. As the incident mechanism (Step 2), the most common type of injury was 'contact with playing surface' (40.2%), followed by 'hit by another player' (29.3%) and 'contact with playing apparatus' (22.0%). As detailed information, within the hit by another player' (Step 2) category, 'head-head' contact was the most frequent (13.5%), followed by 'lower limb-head' (6.4%). Injuries caused by playing apparatus were most commonly due to 'ball' (20.3%) (Fig. 1).

Fig. 1

Changes in injury mechanisms by school level and grade (Fig. 2) showed distinct grade-related patterns in the relative contribution of each mechanism. The proportion of concussions caused by playing surface-no contact with player and by playing apparatus

showed significant decreasing trends with increasing school grade (chi-squared trend test, $\chi^2[1] = 43.25$, $p < 0.001$; $\chi^2[1] = 34.23$, $p < 0.001$, respectively). In contrast, the proportion of concussions caused by being hit by another player significantly increased with increasing school grade (chi-squared trend test, $\chi^2[1] = 126.95$, $p < 0.001$). There was no significant trend in the proportion of concussions caused by playing surface-contact with player across school grades (test for trend in proportions, $\chi^2[1] = 2.95$, $p = 0.086$). To examine whether the observed differences in injury mechanisms were influenced by competition frequency, we separated Figure 2 into practice and competition settings and reanalyzed the distribution of mechanisms by grade level. Grade-related differences were present in both practice and competition (Fig. 2B–C), indicating that similar trends were observed regardless of event type.

Fig. 2-A

Fig. 2-B

Fig. 2-C

Incident setting. Overall, approximately 60% of SRC cases occurred during competitions. When analysed by school type and grade level, competition-related SRCs (Fig. 3) showed a significant increasing trend with increasing grade (chi-squared trend test, $\chi^2[1] = 27.68$, $p < 0.001$), whereas practice-related SRCs demonstrated a significant decreasing trend ($\chi^2[1] = 22.4$, $p < 0.001$). In contrast, SRCs attributed to unknown activity settings did not show a significant linear trend across grades ($\chi^2[1] = 2.08$, $p = 0.149$). Cross-tabulation by sex and event type showed that 'contact with playing surface' (Step 2) after 'contact with player' (Step 1) during competitions accounted for more than 40% of SRC cases in both sexes (Table 3). In addition, the distribution of concussion mechanisms differed significantly between competition and practice ($\chi^2[2] = 218.56$, $p < 0.001$). Regarding the injury mechanisms observed during competitions and practice, contact with another player was more frequent during competitions and occurred less often during practice (Figure 4).

Table 3

Fig. 3

Fig. 4

DISCUSSION

This nationwide investigation of concussions sustained during middle- and high-school soccer activities in Japan indicated that the most common cause of concussion was falling and striking the playing surface after colliding with another player. Furthermore, the proportion of injuries during competition increased with school type (middle or high school) and grade level, with most of these injuries resulting from contact with other players. By incorporating pre-injury contact information and detailed information regarding the objects involved in the contact, we were able to comprehensively evaluate the mechanisms underlying concussion injuries.

Sex and grade levels. Although SRCs were numerically more common in boys than in girls across both school types, the difference was statistically significant only in middle

school and not in high school or in the overall sample. Even when evaluated by the number of injuries per 1,000 club members, boys showed slightly higher rates; however, these differences were not statistically significant at the high school level or when both school types were combined (Table 2).

Previous studies in soccer have reported that girls have a higher risk of concussion than boys, based on injury rates calculated using athlete exposures.[8,11,12,23] In contrast, our study did not incorporate exposure time, and the number of SRCs per 1,000 club members reflects membership-based counts rather than true incidence rates. Therefore, direct comparisons with previous exposure-based studies should be made with caution. Cross-tabulation analysis showed that contact with the playing surface—following contact with another player during competition—accounted for a high proportion of SRC mechanisms in both boys and girls (Table 3). Soccer is widely popular among middle- and high-school students in Japan, with far more boys participating than girls. In some regions, limited numbers of female players result in combined teams across schools, potentially reducing opportunities for regular training and matches. Consequently, differences in concussion opportunities and exposure may partly explain the limited sex-based differences observed

in this study. Future research incorporating standardised exposure metrics will be necessary for accurate sex comparisons and international benchmarking.

Injury mechanism. Using this classification method, the most common injury mechanism was 'contact with another player' at Step 1 and 'contact with the playing surface' at Step 2. Previous studies have reported various classification schemes for SRC mechanisms in soccer, with considerable variation across studies. Limited studies have explicitly indicated whether 'contact with the playing surface' occurred as a result of prior 'contact with a player'.[24] In this study, both types of 'contact with playing surface,' with and without prior player contact, were identified. Among these, injuries occurring from contact with the ground following prior player contact were the most common across all injury mechanisms. Previous reports have identified direct external force from contact with other players[25] as the most common cause of concussion; however, our findings suggest that even player contact insufficient to directly cause a concussion may disrupt balance, leading to concussions in middle- and high-school level athletes.

Moreover, injuries that did not involve contact with another player (Step 1) also accounted for a certain number of cases, suggesting opportunities for prevention targeting

accident factors. Specific examples of injuries included ‘a player impacted in the head by a ball kicked by another player during shooting practice because they did not see it’, or ‘being hit by a ball from a different sport club practicing nearby’. These findings suggest that the narrow grounds unique to Japan, where multiple sports are practiced in the same area, may contribute to such injuries.

Another cause of concussions without contact is poor playing technique. Examples include ‘falling after stepping on the ball while dribbling’, ‘losing balance while kicking the ball’, and ‘hitting one’s head on the ground after landing poorly while jumping sideways as a goalkeeper’. As observed in the present study, these cases are thought to decrease with improved skills and become less common among older students. These age-related differences in injury mechanisms are further supported by findings from studies involving adult-level players in Japan. In Japan, a study of university male soccer players[24] demonstrated that head-to-head collisions accounted for the largest proportion of concussions sustained during matches, while head-to-ball contact was the predominant mechanism during practice. This match–practice discrepancy highlights the influence of competitive demands on injury patterns. Compared with the present results in middle-

and high-school athletes, the relatively higher frequency of head-to-head contact in adult players may be attributed to increased speed, strength, and aerial challenges at higher competitive levels. In contrast, the greater contribution of ball-related impacts during practice suggests that training formats and technical skill requirements differ substantially across developmental stages.

Incident setting. The results showed that concussions occurred more frequently during 'competitions' than 'practice', consistent with previous findings.[11,12] Furthermore, the finding that concussion incidence during competitions increased with grade level had not been reported previously. This aligns with the assumption that, as students progress through middle and high school, improvements in skill and physical development lead to higher performance levels and increased opportunities to participate in games.

Furthermore, an important finding of this study is that the proportion of injury mechanisms varies between competitions and practice. 'Contact with players' was more common during competitions and less frequent in practice (Fig. 4)—a trend not previously reported. Possible contributing factors include the unpredictable nature of game situations, where players may engage in contact play without sufficient preparation,

leading to injuries due to contact or falls caused by loss of balance. In fact, one study reported that during matches, which are more aggressive and competitive than practice, player-to-player contact increases, resulting in an increase in injuries.[26] Athletes have also reported that they 'avoid unnecessary contact during practice' to reduce risk of head injuries,[24] suggesting that during competitive matches, where winning or losing is at stake, changes in judgment criteria may lead to contact that would not occur during practice.

To further explore whether the trends observed in injury mechanisms could be attributed solely to the higher proportion of match participation among older students, we additionally separated Figure 2 into practice and competition settings and reassessed the distribution by grade level. Grade-related differences remained evident for several injury mechanisms in both settings, although not all mechanisms demonstrated significant linear trends. These findings suggest that the shift in concussion patterns across grades cannot be explained solely by match exposure. Rather, factors associated with age progression—such as increased technical proficiency, greater physicality, and changes in play intensity or tactical engagement—are likely contributing to these developmental differences. These findings emphasize the influence of age-specific characteristics on SRC risk and highlight

the importance of preventive measures tailored to different developmental stages.

Study strengths. To the best of our knowledge, this study represents the first nationwide investigation of concussions sustained during middle- and high-school soccer activities in Japan. The use of insurance registry data with very high enrolment rates—99.9% for middle schools and 97.8% for high schools—provides exceptionally comprehensive coverage of the target population. This high level of participation enhances the external validity of our findings and allows for a reliable assessment of concussion characteristics in Japanese school-aged soccer players.

Study limitations. There are no universally standardised criteria for the diagnosis of concussion by medical professionals; therefore, diagnoses may not be consistent. Since this study used insurance data, cases that did not lead to insurance claims may have been excluded.

Clinical implications. A notable proportion of concussions in soccer occurred as a result of accidents. Therefore, further investigation into the relationship between external factors and concussion incidence is necessary, along with the implementation of environmental improvements to support effective prevention. Moreover, conducting

longitudinal evaluations will allow for the assessment of the effectiveness of such preventive measures over time.

The high incidence of injuries during competitions highlights the need to establish medical support systems, even at the amateur level, for middle- and high-school students. Given that concussions share similar injury mechanisms with more severe head injuries,[27] the presence of appropriate medical teams is anticipated to reduce the risk of serious outcomes.

Among middle- and high-school students in Japan, concussions during soccer most commonly occur when players come in contact with other players and hit their heads upon falling. Even impacts not severe enough to cause a concussion can increase the risk of concussion onset by causing a loss of balance. In addition, a proportion of cases involving accident-related factors were also identified, suggesting that further detailed investigations could lead to effective countermeasures. Furthermore, the varying proportions of injury mechanisms across grade levels highlight the need for preventive measures tailored to each stage of development.

Acknowledgements

The authors thank the staff of the Department of Injury and Accident Mutual Aid Benefit at the Japan Institute of Sports Sciences for their assistance in extracting and organising the large volume of benefit data.

Conflicts of Interest

All authors declare that they have no financial or non-financial conflicts of interest related to this work.

Author Contributions

All authors contributed to the study conception, design, and data interpretation. KF analysed the data and drafted the manuscript. All authors revised and approved the final version of the manuscript.

Data availability statement

The data that support the findings of this study were obtained from the IAMABS.

Restrictions apply to the availability of these data, which are not publicly available.

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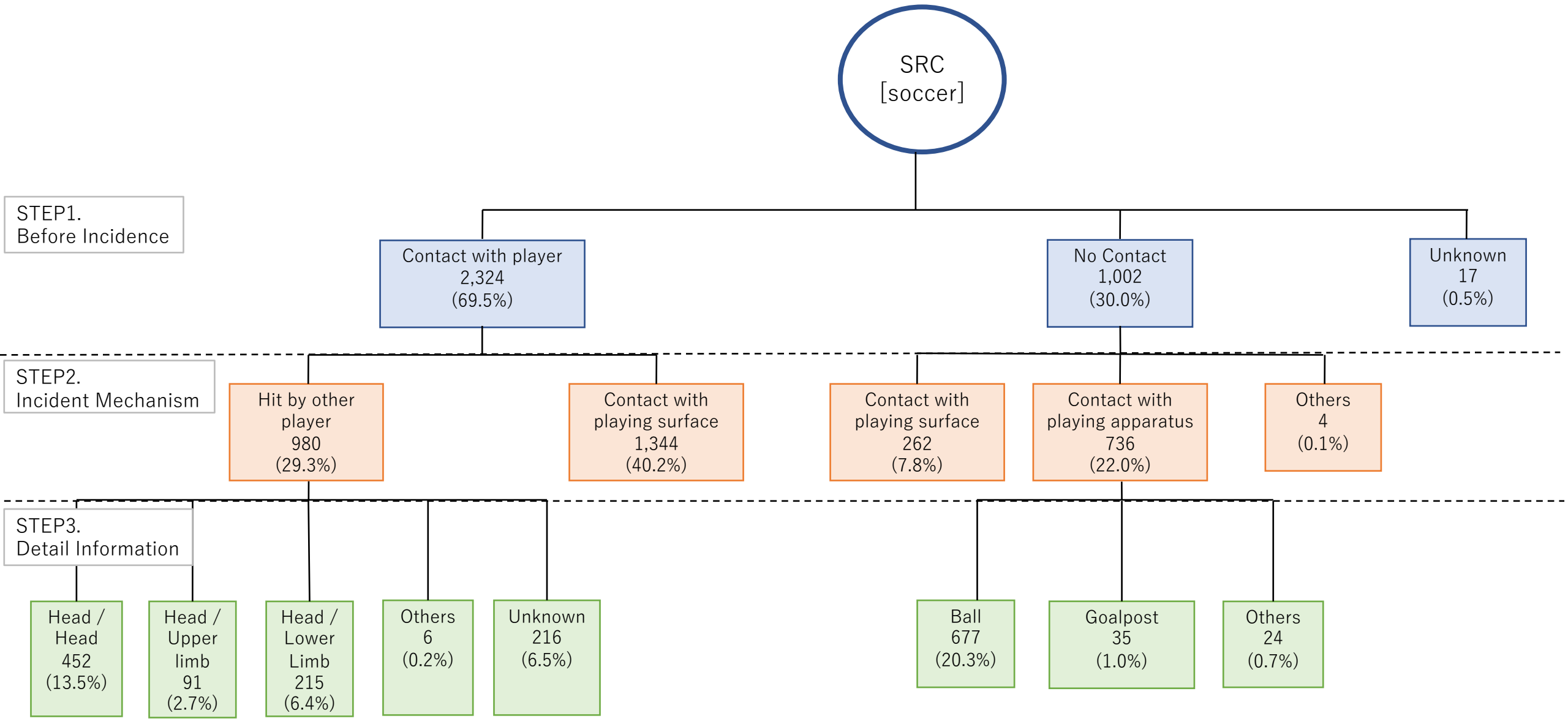
Figure legends

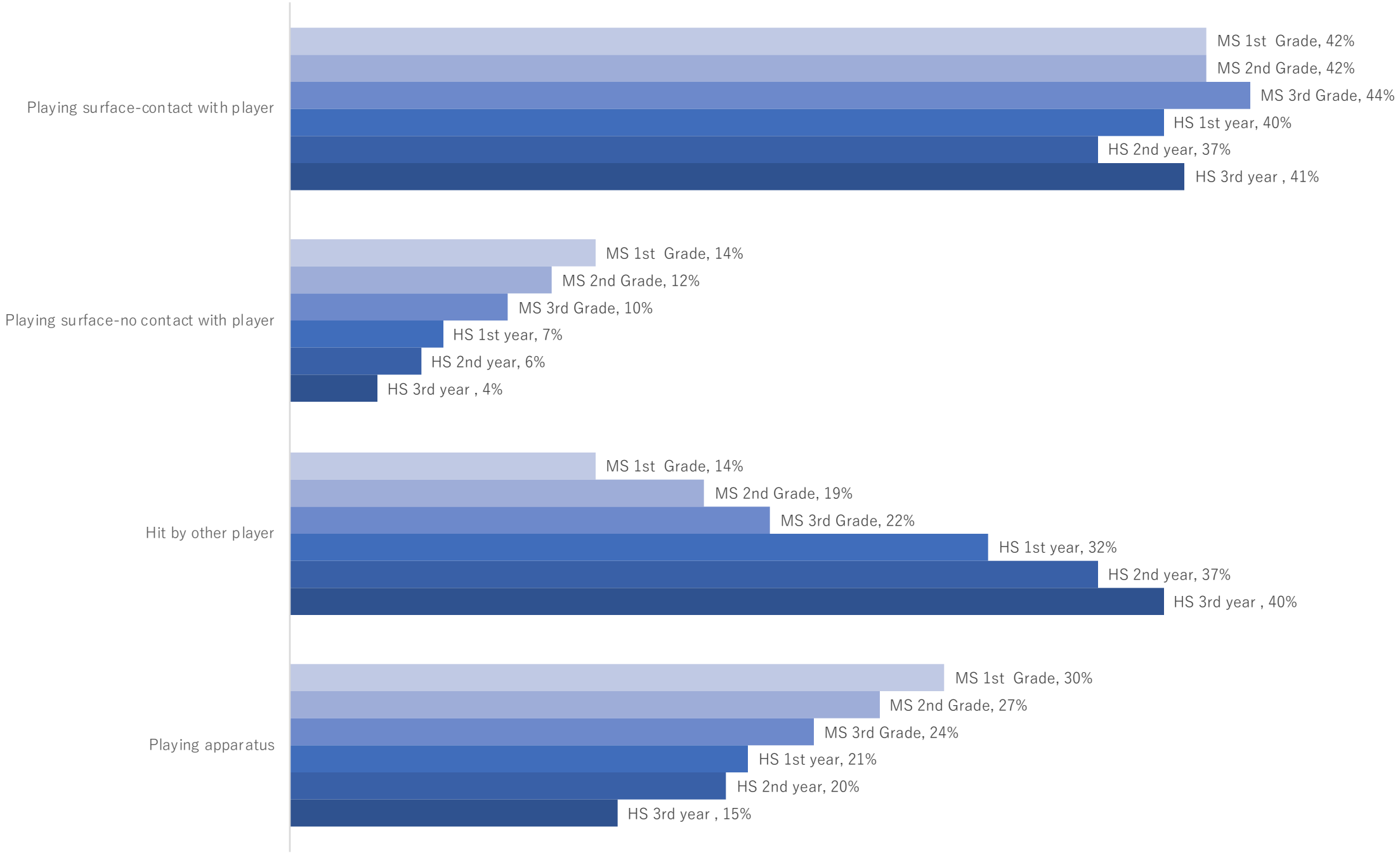
Fig. 1 Tree diagram of the SRC injury mechanism summarizes the mechanisms of SRC sustained during soccer among middle- and high-school students. The figure illustrates a stepwise categorization: Step 1 shows whether contact occurred; Step 2 specifies the incident mechanism (e.g., hit by other player, contact with playing surface, or equipment); and Step 3 details the specific type of contact. SRC: sports-related concussion

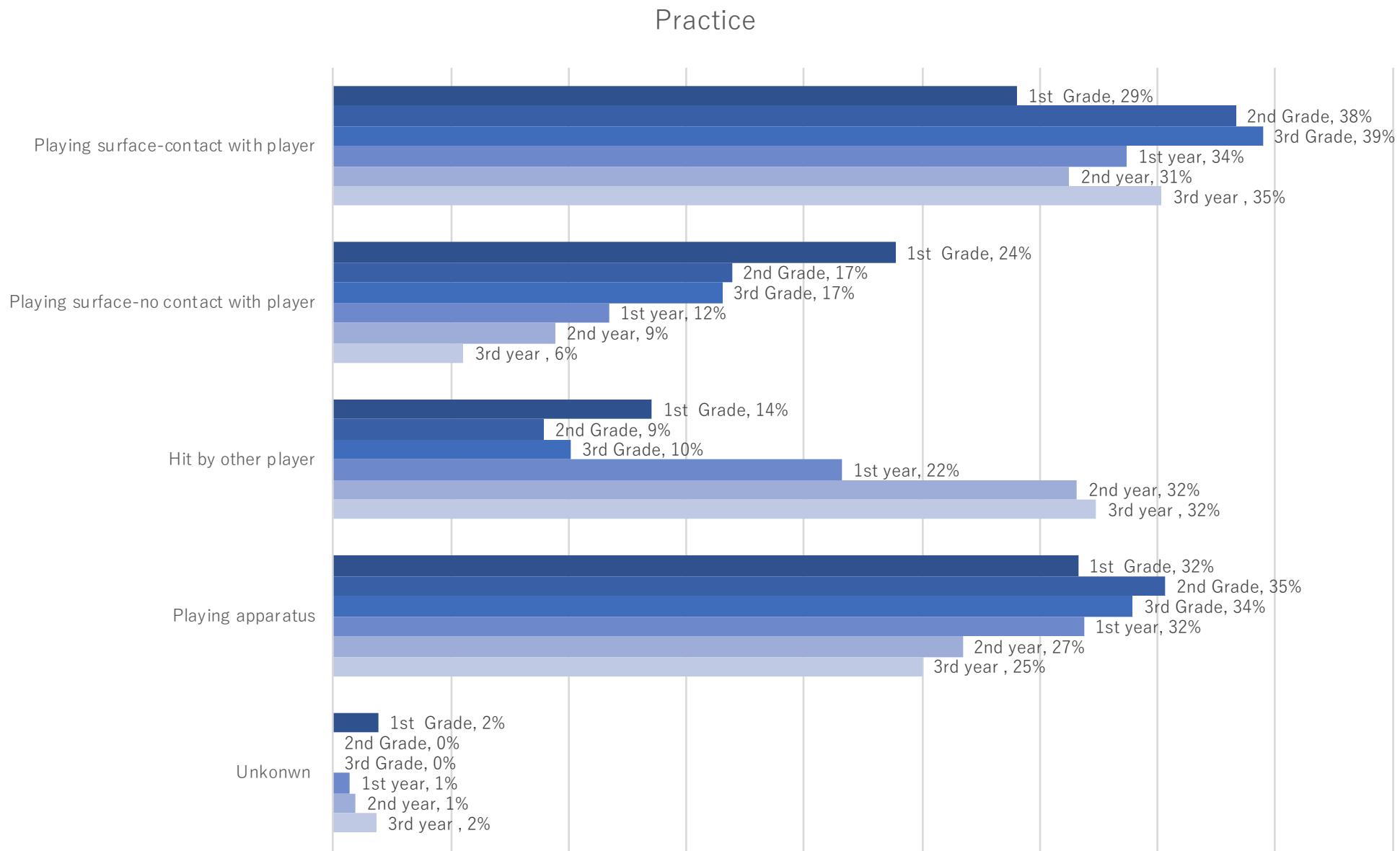
Fig. 2 Percentage of objects that injured the student by grade level. Proportions of each mechanism are shown separately for each grade. HS: high school, MS: middle school

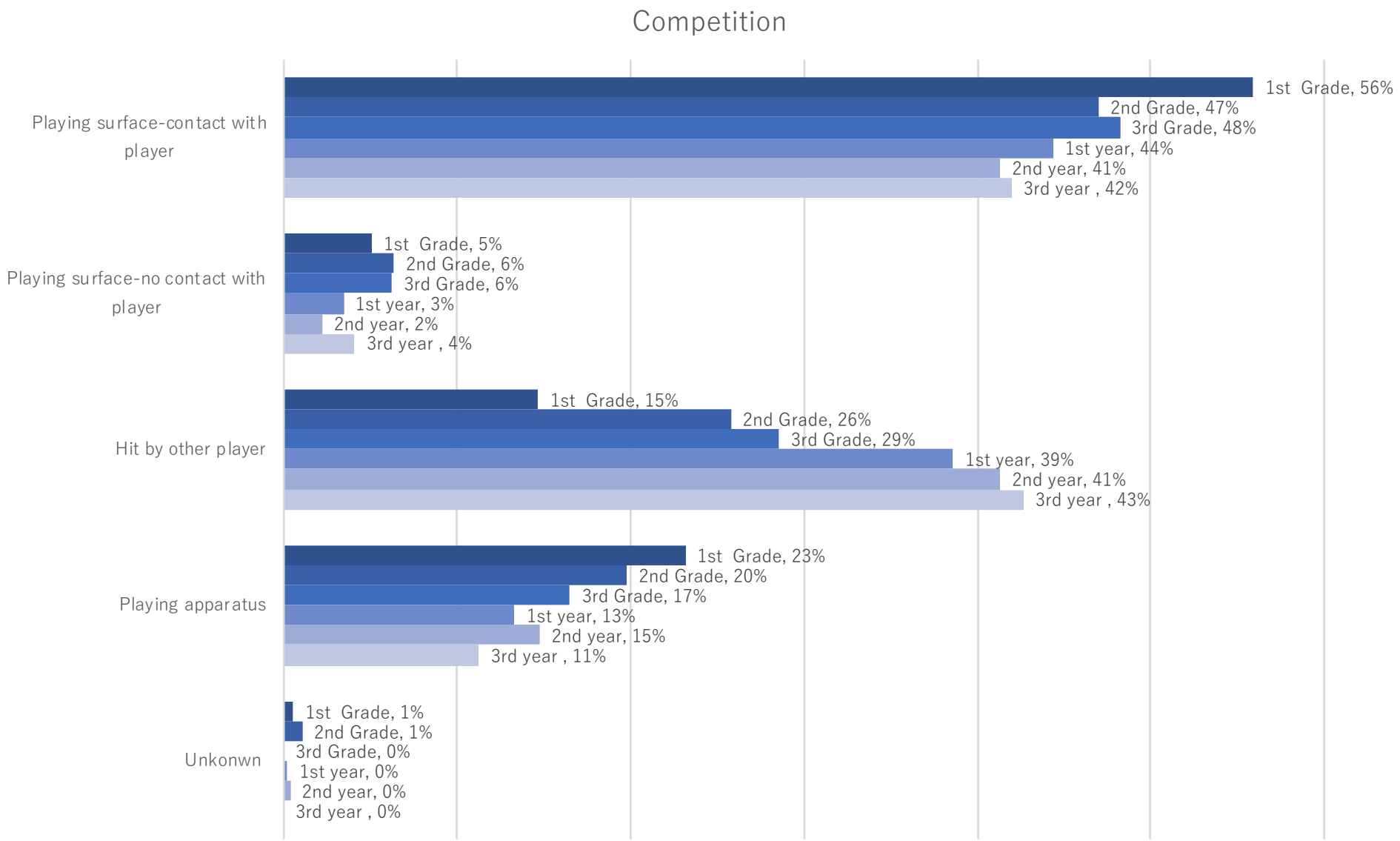
Fig. 3 Distribution of concussion events by school grade and event type among middle- and high-school soccer players. The figure shows the proportions of concussions occurring during competition, practice, and unknown situations for each grade level in middle-school (MS) and high-school (HS).

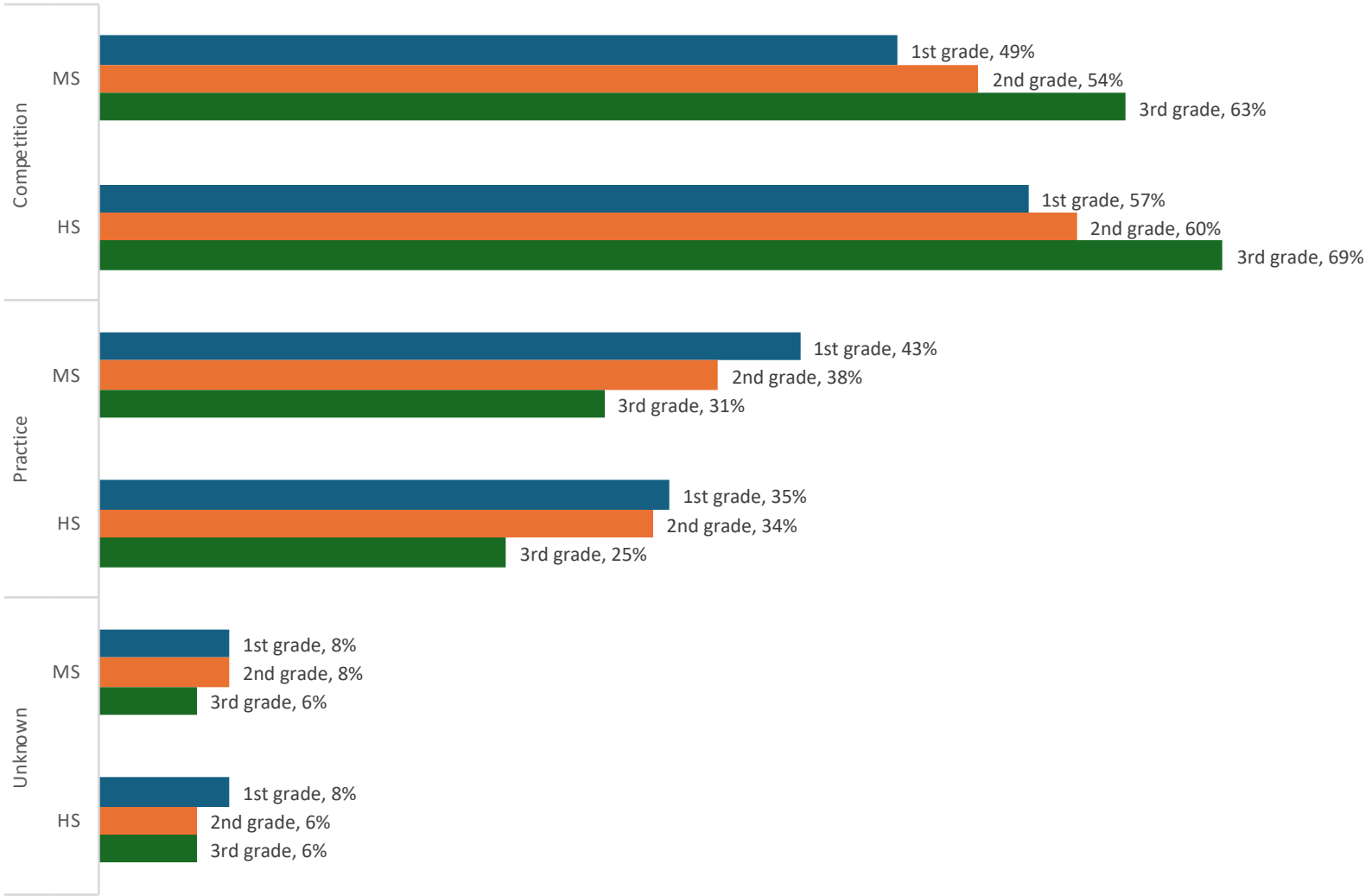
Fig. 4 Proportion of contact with other players during practice and competition. The figure illustrates the proportions of concussions resulting from contact with another player, no contact, and unknown causes during competition, practice, and overall.

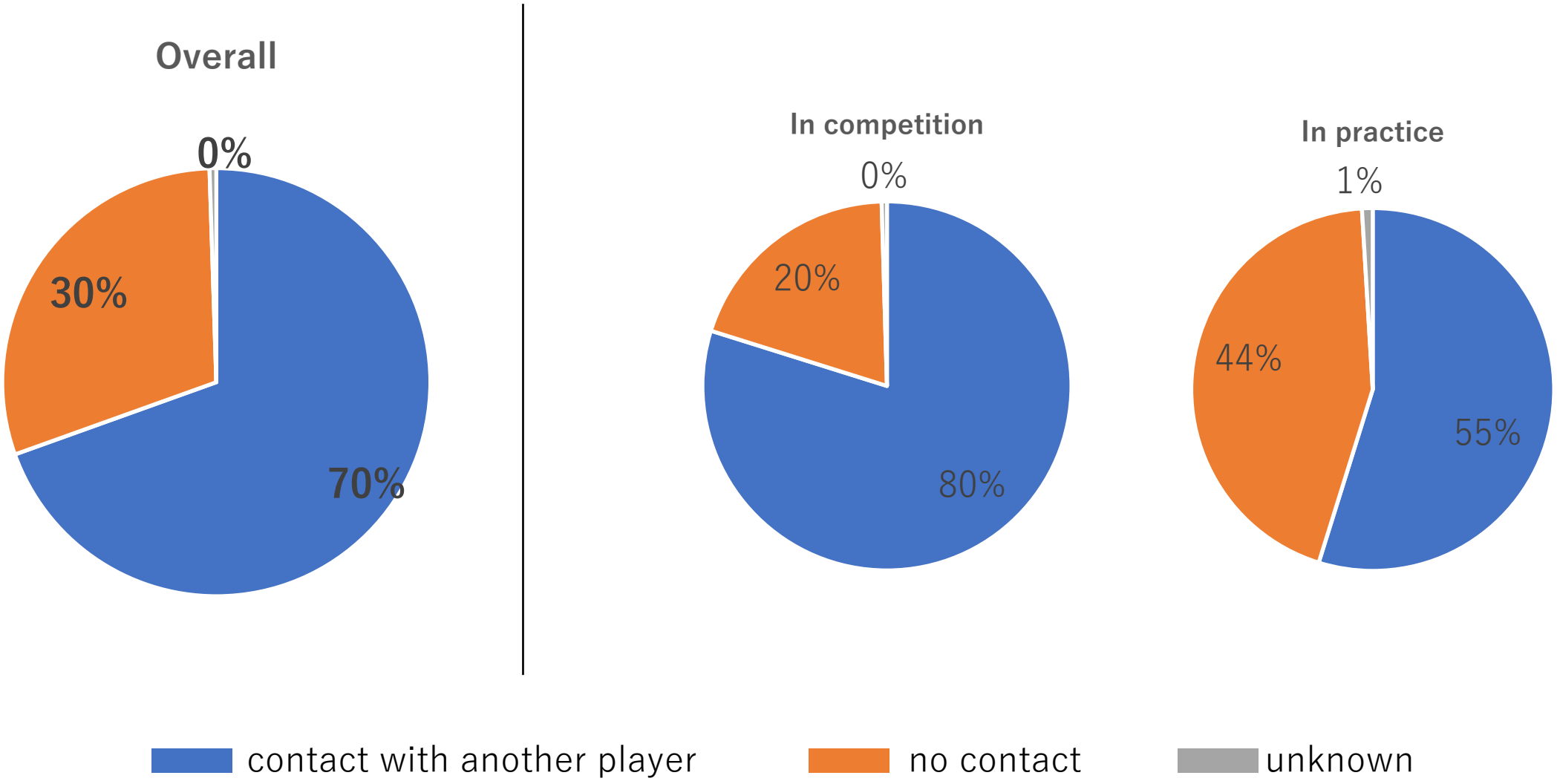

SRC
[soccer]
STEP1.
Before Incidence
Contact with player
2,324
(69.5%)
No Contact
1,002
(30.0%)
Unknown
17
(0.5%)
STEP2.
Incident Mechanism
Hit by other player
980
(29.3%)
Contact with playing surface
1,344
(40.2%)
Contact with playing surface
262
(7.8%)
Contact with playing apparatus
736
(22.0%)
Others
4
(0.1%)
STEP3.
Detail Information
Head / Head
452
(13.5%)
Head / Upper limb
91
(2.7%)
Head / Lower Limb
215
(6.4%)
Others
6
(0.2%)
Unknown
216
(6.5%)
Ball
677
(20.3%)
Goalpost
35
(1.0%)
Others
24
(0.7%)


Playing surface-contact with player
MS 1st Grade, 42%
MS 2nd Grade, 42%
MS 3rd Grade, 44%
HS 1st year, 40%
HS 2nd year, 37%
HS 3rd year , 41%
Playing surface-no contact with player
MS 1st Grade, 14%
MS 2nd Grade, 12%
MS 3rd Grade, 10%
HS 1st year, 7%
HS 2nd year, 6%
HS 3rd year , 4%
Hit by other player
MS 1st Grade, 14%
MS 2nd Grade, 19%
MS 3rd Grade, 22%
HS 1st year, 32%
HS 2nd year, 37%
HS 3rd year , 40%
Playing apparatus
MS 1st Grade, 30%
MS 2nd Grade, 27%
MS 3rd Grade, 24%
HS 1st year, 21%
HS 2nd year, 20%
HS 3rd year , 15%


Practice
Playing surface-contact with player
1st Grade, 29%
2nd Grade, 38%
3rd Grade, 39%
1st year, 34%
2nd year, 31%
3rd year , 35%
Playing surface-no contact with player
1st Grade, 24%
2nd Grade, 17%
3rd Grade, 17%
1st year, 12%
2nd year, 9%
3rd year , 6%
Hit by other player
1st Grade, 14%
2nd Grade, 9%
3rd Grade, 10%
1st year, 22%
2nd year, 32%
3rd year , 32%
Playing apparatus
1st Grade, 32%
2nd Grade, 35%
3rd Grade, 34%
1st year, 32%
2nd year, 27%
3rd year , 25%
Unkonwn
1st Grade, 2%
2nd Grade, 0%
3rd Grade, 0%
1st year, 1%
2nd year, 1%
3rd year , 2%


Competition
Playing surface-contact with player
1st Grade, 56%
2nd Grade, 47%
3rd Grade, 48%
1st year, 44%
2nd year, 41%
3rd year , 42%
Playing surface-no contact with player
1st Grade, 5%
2nd Grade, 6%
3rd Grade, 6%
1st year, 3%
2nd year, 2%
3rd year , 4%
Hit by other player
1st Grade, 15%
2nd Grade, 26%
3rd Grade, 29%
1st year, 39%
2nd year, 41%
3rd year , 43%
Playing apparatus
1st Grade, 23%
2nd Grade, 20%
3rd Grade, 17%
1st year, 13%
2nd year, 15%
3rd year , 11%
Unkonwn
1st Grade, 1%
2nd Grade, 1%
3rd Grade, 0%
1st year, 0%
2nd year, 0%
3rd year , 0%


Competition
MS
1st grade, 49%
2nd grade, 54%
3rd grade, 63%
HS
1st grade, 57%
2nd grade, 60%
3rd grade, 69%
Practice
MS
1st grade, 43%
2nd grade, 38%
3rd grade, 31%
HS
1st grade, 35%
2nd grade, 34%
3rd grade, 25%
Unknown
MS
1st grade, 8%
2nd grade, 8%
3rd grade, 6%
HS
1st grade, 8%
2nd grade, 6%
3rd grade, 6%


Overall
0%
30%
70%
In competition
0%
20%
80%
In practice
1%
44%
55%
contact with another player
no contact
unknown

TABLE

Table 1. Number of SRC by sex and grade

		All (n=3,343) n (%)	Middle school (n=1,241) n (%)	High school (n=2,102) n (%)
Sex				
	Boys	3,217 (96.2)	1,222 (98.5)	1,995 (94.9)
	Girls	126 (3.8)	19 (1.5)	107 (5.1)
Grade				
	1st	1,132 (33.9)	363 (29.3)	769 (36.6)
	2nd	1,430 (42.8)	523 (42.1)	907 (43.1)
	3rd	781 (23.4)	355 (28.6)	426 (20.3)

Data are presented as numbers (%).

Table 2. Number of SRC cases, club members, and cases per 1,000 club members in soccer

	ALL		Middle school		High school	
	Boys	Girls	Boys	Girls	Boys	Girls
No. of SRCs	3,217	126	1,222	19	1,995	107
No. of club members	3,770,422	160,881	2,152,797	56,614	1,617,625	104,267
SRC/1,000 members	0.85	0.78	0.57	0.34	1.23	1.03

Data are presented as numbers and calculated incidence per 1,000 club members.

SRC: sports-related concussion

Table 3. Cross-tabulation by sex and event type

		Competition		Practice	
STEP 1.	STEP 2.	Boys, n (%)	Girls, n (%)	Boys, n (%)	Girls, n (%)
Contact with player	Hit by other player	659 (34.9)	21 (32.3)	230 (20.8)	11 (22.9)
	Contact with playing surface	852 (45.1)	28 (43.1)	377 (34.1)	14 (29.2)
No Contact	Contact with playing surface	78 (4.1)	2 (3.1)	143 (12.9)	13 (27.1)
	Contact with playing apparatus	291 (15.4)	14 (21.5)	343 (31.0)	10 (20.8)
	Others	2 (0.1)	0 (0.0)	2 (0.2)	0 (0.0)
Unknown		7 (0.4)	0 (0.0)	10 (0.9)	0 (0.0)

Data are presented as numbers (%).