

# Study on the Risk Factors of Injuries Resulting in Hospitalization in Primary School Students

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**Objective:** To develop effective prevention measures against serious injuries in primary school students, the involved factors of serious injuries inside school were surveyed.

**Methods:** Our study examined the data from primary schools of 7 prefectures in Japan. The study period was one year, from April 2007 to March 2008, and the 70,701 cases of school injuries which required medical treatment in medical institution were examined. The involved factors that influence hospitalization were investigated by logistic regression analysis.

**Results:** 1) Among the total number of injuries (70,701), 882 (1.2%) cases required hospitalization. 2) The injuries that needed hospitalization occurred the most frequently during recess. 3) Among the 207 cases of hospitalization-required injuries that occurred when the lower grade students were outside the school building in the school area during recess, 134cases (64.7%) happened while they were using playground equipment. The incidence of hospitalization was significantly higher (3.30 fold) than when no playground equipment was in use.

**Conclusion:** The results of this study indicate the importance to implement safety measures related with the use of playground equipment during recess time to prevent serious injuries of students, especially when they are not under the supervision of teachers. Furthermore, it is necessary to guide the lower grade students concerning the risk of fall from playground equipment such as monkey bar and climber.

**Keywords:** Primary school students, Playground equipment, Hospitalization, Serious injuries, Safety measure

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## 1. Introduction

In recent years, the increased number of accidents and incidents involving primary school students has induced growing concern about school safety (Uchida, 2007). Cases such as the fatal fall through the skylight of the school roof in June 2008 (Chunichi Newspaper, 2008.06.19), falls from the window of the lavatory during recess time (Chunichi Newspaper, 2010.02.24; Chunichi Newspaper, 2010.03.02), falls

from the second-floor window during school cleaning (Asahi Newspaper, 2010.10.16), and falls from playground equipment are the examples of accidents causing serious injuries or even death of primary school students (Asahi Newspaper, 2010.10.15; Chunichi Newspaper, 2011.06.21). Therefore, with the aim of preventing accidents, schools have been required to implement specific countermeasures in their installations and to educate students on safety issues (Saito, 2003; Minami, 2007; Japanese

Ministry of Education, Culture, Sports, Science and Technology, 2008).

In its 2008 report, the Central Council for Education, Japan has pointed out that “beyond the preparation of a safe school environment, it is important to institutionalize both safety management and safety education in schools for accident prevention”; the Council also stipulated that these countermeasures should be implemented together with the education for promoting awareness of safety. In 2009, based on the contents of the mentioned report, the School Health and Safety Act was enforced and the maintenance of safe school environment has become obligation in all schools by law.

Injuries at school range from negligible incidences that do not need medical care to severe accidents that require long-term treatment through hospitalization. Additionally, some of these cases need operations.

Although minor injuries can cause temporary pain, they do not significantly influence the life of the children and are expected to promote awareness of safety. However, besides physical pain and long-term recovery, hospitalization after severe injuries results in social and mental anguish. Additionally, the consequences of prolonged withdrawal from school life, such as learning delay and absence from extracurricular activities, may have an adverse influence on the school life of the students after return. Furthermore, various factors such as hospitalization-related limitation of activity, pain caused by medical treatment and examination and anxiety due to the separation from their families and friends may augment mental distress (Kitano et al., 2008; Hasegawa et al., 2009; Matsuo et al., 2009). Moreover, as subsequent complications, serious injuries may permanently affect their lives.

Based on the abovementioned reasons, serious injuries that require hospitalization represent a major hindrance in the development of primary school students. Accordingly, it is important to take preventive measures by identifying the factors that bring about serious injuries and eliminating them from school environment. Thus, the objective of this study was to elucidate the involved factors of serious injuries in primary school sites; the findings of this study are expected to contribute to the development of effective prevention measures against serious injuries in primary school students.

## 2. Methods

The subjects of this study were the students' injuries which occurred in primary schools of 7 prefectures (Toyama, Ishikawa, Fukui, Gifu, Shizuoka, Aichi and Mie) under jurisdiction of the Nagoya branch of the National Agency for the Advancement of Sports and Health (NAASH). The study period was one year, from April 2007 to March 2008, and 70,701 cases of injuries with the reception of the benefit from the Mutual Aid Disaster Insurance of the NAASH (the “benefit”), were examined. The benefit is a mutual aid system (NAASH Ordinance for Enforcement, Article 5, Paragraph 1, No. 1) which guarantees the right of receiving part of the medical expenses when an injury occurs under school responsibility. This mutual aid system covers more than 99% of the primary, middle and high school students in Japan and, in 2007, 99.9% of the primary school students (1,066,102 students) were registered in the Nagoya branch.

The expression “under school responsibility” indicates a state where students participate in educational activities under the management and instruction of school. In concrete terms, it involves the following five activities and/or periods of time: 1) while receiving lessons based on the curriculum of school, 2) while receiving extracurricular teaching that is performed based on the education plan of school, 3) during recess inside the school, 4) while commuting to and from school using the usual course and method, 5) when it applies to the previous items and is established by the Ordinance of the Japanese Ministry of Education, Culture, Sports, Science & Technology (Article 5, Paragraph 2 of the same Ordinance). In addition, the term “injury” indicates a state in which the body suffers from external or internal trauma by unexpected accidents.

Physical abnormalities originated from long-term distorted lifestyle or load accumulation (defined as “diseases” by the NAASH) were not considered injuries. In addition, the number of injuries expresses their occurrence number without counting repeated visits to the hospital to treat the injury.

Part of the contents of web-based applications made by schools to claim reimbursement of medical expenses to NAASH are used as collected data in this study. The contents of applications from schools essentially include the situation at the time of injury occurrence and information about the student. Specifically, the time and place in which

injury occurred, the use or the no use of playground equipment and its type, injured body part, type of injury, school grades, and the need of hospitalization are required to be recorded in the applications.

Activities during which injuries occurred are divided into five types: “curriculum activities” during regular classes; “special activities” of school events performed during class hours such as club and homeroom activities, cultural and athletic festivals, and excursions; “extracurricular activities” performed after school such as club activities, camp school, and swimming instruction; “recess” before, after or between classes and during lunchtime break; “commute to and from school” except for traffic accidents. Locations where injuries occurred are divided into “in the school building” (classroom, special classroom and gymnasium), “outside the school building in the school area” (playground, schoolyard and swimming pool), and “outside the school area” (streets and playgrounds outside the school site). In addition, playground equipment installed outside the school building in the school area is classified into horizontal bar, monkey bar, climber, jungle gym, slide, swing, seesaw, half buried tire, sandbox and others. Injured body parts are categorized into head, face, trunk, upper limb, and lower limb. The types of injuries are categorized into fracture, sprain, dislocation, contusion with intact skin surface, and other injuries.

The school grades are divided into the two groups; the lower grades (the grade from 1st to 3rd) of less than or equal 8 years old, and the higher grades (the grade from 4th to 6th) of more than 8 years old.

In this classification, the age of the students are unified to the age on April 1st of the year.

Among the 70,701 injuries occurred in the school year of 2007, the cases which required hospitalization for one or more times were classified as “hospitalized”, and the remaining cases were classified as “not hospitalized”. Cross tabulation and incidence ratio were calculated with respect to each injury time and location, the use or the no use of playground equipment at the time of injury, and the equipment type. Statistically significant differences were analyzed by  $\chi^2$  test. Also, the number of injuries which occurred while using playground equipment was calculated by type of injury and by injured body part.

In addition, with the aim of making clear the magnitude of the involved factors that influence

hospitalization (their odds ratio and 95% confidence interval), logistic regression analysis was performed, in which the necessity of hospitalization was used as the dependent variable while the activity at the time of injury, activity location and type of playground equipment were used as independent variables. The forced entry method was used to select independent variables. Statistical analysis was performed by using the SPSS Statistics version 18 software for Windows.

### **Ethical considerations**

As part of a research and analysis project carried out in collaboration with the NAASH, called “A survey to analyze the cause of hospitalization due to injury in school”, this study received permission to handle the collected data (National Agency for the Advancement of Sports and Health, 2010). This study was carried out under approval of the Ethics Committee of Aichi Gakuin University, School of Dentistry (authorization number 208).

## **3. Results**

### **3.1. Overall trend of injury**

Among 1,066,102 primary school students, in the period of one year there were a total of 70,701 injury cases under school responsibility with the reception of the benefit from the NAASH, which represents an incidence of 66 cases per 1,000 students (**Table 1**). The number of injuries was approximately 20% greater in the higher grade students (41,796 cases, 59.1%) than in the lower grade students (28,905 cases, 40.9%).

From the 70,701 injuries, 882 cases required hospitalization, which represents an incidence of 0.8 cases per 1,000 students. Hospitalization ratio was 1.2% of the total number of injuries. It was significantly higher in the lower grade students (445cases, 1.5%) than in the higher grade students (437cases, 1.0%).

### **3.2. The temporal situation of the occurrence of injuries and the incidence of hospitalization**

**Table 2** shows the results of the analysis of the time when injuries occurred in the 70,701 cases. Among the lower grade students, there were 15,988 cases (55.3%) of injuries during recess, 5,724 cases (19.8%) during curriculum activities, and 3,678

cases (12.7%) during commute to and from school. Among the higher grade students, there were 18,685 cases (44.7%) of injuries during recess, 11,927 cases (28.5%) during curriculum activities, and 5,874 cases (14.1%) during special activities.

When we look only at the injuries that required hospitalization, among the lower grade students, 284 cases (63.8%) occurred during recess and 68 cases (15.3%) occurred during commute to and from school. On the other hand, among the higher grade students, 208 cases (47.6%) occurred during recess and 114 cases (26.1%) occurred during curriculum activities.

Compared with curriculum activities, the incidence of hospitalization due to injuries which occurred among the lower grade students were 1.91 fold (95% confidence interval: 1.34-2.72) during commute to and from school and 1.83 fold (1.37-2.44)

during recess. Among the higher grade students, the same comparison showed that the incidence of hospitalization was 1.92 fold (1.28-2.88) during commute to and from school. Among the lower grade students, the injuries, including those which required hospitalization, occurred the most frequently during recess, and the incidence of hospitalization was significantly higher than the injuries which occurred during curriculum activities.

### 3.3. The locational situation of the occurrence of injuries and the incidence of hospitalization

The 70,701 cases of injuries were analyzed by activity location (**Table 3**).

Among the lower grade students, there were 12,788 cases (44.2%) of injuries in the school building, 12,167 cases (42.1%) outside the school building in

**Table 1** Injury number and ratio by school grade and severity

	Hospitalized		Not hospitalized		Total		Hospitalization ratio (%)
	Number	%	Number	%	Number	%	
Lower grades; Students aged ≤8 years	445	50.5	28,460	40.8	28,905	40.9	1.5
Higher grades; Students aged >8 years	437	49.5	41,359	59.2	41,796	59.1	1.0
Total	882	100.0	69,819	100.0	70,701	100.0	1.2
Injured cases per 1,000 students	0.8		65.5		66.3		

$\chi^2$  test    df=1     $\chi^2=33.8$      $p < 0.001$

**Table 2** Injury number and hospitalization incidence by time of the day

		Hospitalized		Not hospitalized		Total		Odds ratio	95% CI
Age	Time	Number	%	Number	%	Number	%		
Lower grades; ≤8 years old	Curriculum activities	56	12.6	5,668	19.9	5,724	19.8	1.00	
	Special activities	34	7.6	3,334	11.7	3,368	11.7	1.03	0.67-1.58
	Extracurricular activities	3	0.7	144	0.5	147	0.5	2.11	0.65-6.82
	Recess	284	63.8	15,704	55.2	15,988	55.3	1.83	1.37-2.44
	Commute to and from school	68	15.3	3,610	12.7	3,678	12.7	1.91	1.34-2.72
	Total	445	100.0	28,460	100.0	28,905	100.0		
Higher grades; >8 years old	Curriculum activities	114	26.1	11,813	28.6	11,927	28.5	1.00	
	Special activities	53	12.1	5,821	14.1	5,874	14.1	0.94	0.68-1.31
	Extracurricular activities	32	7.3	3,630	8.8	3,662	8.8	0.91	0.62-1.35
	Recess	208	47.6	18,477	44.7	18,685	44.7	1.17	0.93-1.47
	Commute to and from school	30	6.9	1,618	3.9	1,648	3.9	1.92	1.28-2.88
	Total	437	100.0	41,359	100.0	41,796	100.0		

the school area, and 3,950 cases (13.7%) outside the school area. Among the higher grade students, there were 21,306 cases (51.0%) of injuries in the school building, 17,395 cases (41.6%) outside the school building in the school area, and 3,095 cases (7.4%) outside the school area.

When we look only at the injuries which required hospitalization, among the lower grade students 245 cases (55.1%) occurred outside the school building in the school area and 127 cases (28.5%) occurred in the school building. While among the higher grade students 210 cases (48.1%) occurred outside the school building in the school area and 173 cases (39.6%) occurred in the school building. Among all the grades the injuries which required hospitalization occurred the most frequently outside the school building in the school area.

Compared with injuries which occurred in the school building, the incidence of hospitalization

by location among the lower grade students was 2.05 fold (1.65-2.54) outside the school building in the school area and 1.88 fold (1.40-2.51) outside the school area. Among the higher grade students, the same comparison showed that the incidence of hospitalization was 2.17 fold (1.59-2.95) outside the school area and 1.49 fold (1.22-1.83) outside the school building in the school area.

### 3.4. The association of the use of playground equipment with the occurrence of injuries and the incidence of hospitalization

The injuries which happened outside the school building in the school area during recess were divided into two groups with or without the use of playground equipment. Among the 9,509 cases of injuries in the lower grade students, 3,441 (36.2%) occurred with the use of playground equipment (**Table 4**). In addition, 134 cases (64.7%) of the 207 cases of

**Table 3** Injury number and hospitalization incidence by location

		N=70,701						Odds ratio	95% CI
Age	Location	Hospitalized		Not hospitalized		Total			
		Number	%	Number	%	Number	%		
Lower grades; ≤8 years old	In the school building	127	28.5	12,661	44.5	12,788	44.2	1.00	
	Outside the school building in the school area	245	55.1	11,922	41.9	12,167	42.1	2.05	1.65-2.54
	Outside the school area	73	16.4	3,877	13.6	3,950	13.7	1.88	1.40-2.51
	Total	445	100.0	28,460	100.0	28,905	100.0		
Higher grades; >8 years old	In the school building	173	39.6	21,133	51.1	21,306	51.0	1.00	
	Outside the school building in the school area	210	48.1	17,185	41.6	17,395	41.6	1.49	1.22-1.83
	Outside the school area	54	12.4	3,041	7.4	3,095	7.4	2.17	1.59-2.95
	Total	437	100.0	41,359	100.0	41,796	100.0		

**Table 4** Playground equipment-related injury number and hospitalization incidence during recess

		N=19,593						Odds ratio	95% CI
Age	Playground equipment	Hospitalized		Not hospitalized		Total			
		Number	%	Number	%	Number	%		
Lower grades; ≤8 years old	Used	134	64.7	3,307	35.6	3,441	36.2	3.30	2.43-4.48
	Not used	73	35.3	5,995	64.4	6,068	63.8	1.00	
	Total	207	100.0	9,302	100.0	9,509	100.0		
Higher grades; >8 years old	Used	61	46.2	1,926	19.4	1,987	19.7	3.88	2.68-5.62
	Not used	71	53.8	8,026	80.6	8,097	80.3	1.00	
	Total	132	100.0	9,952	100.0	10,084	100.0		



injuries that required hospitalization occurred with the use of playground equipment. Compared with the injuries which occurred without the use of playground equipment, the incidence of hospitalization was significantly higher (3.30 fold; 2.43-4.48) in the case of injuries with the use of playground equipment. Among the 10,084 cases of injuries in the higher grade students, 1,987 (19.7%) occurred with the use of playground equipment. In addition, 61 cases (46.2%) of the 132 cases of injuries that required hospitalization occurred with the use of playground equipment.

Compared with the injuries which occurred without the use of playground equipment, the incidence of hospitalization was significantly higher (3.88 fold; 2.68-5.62) in the case of injuries with the use of playground equipment in the higher grade students as well as in the lower grade students. Comparison

of the number of hospitalization-required injuries which occurred with the use of playground equipment between in the lower grade students (134 cases, 64.7%) and in the higher grade students (61 cases, 46.2%) showed no significant difference ( $p>0.05$ ).

Among the lower grade students, the analysis with respect to the types of playground equipment which involved in the injuries revealed that the monkey bar had the highest incidence of hospitalization-required injuries (33 cases, 24.6%); followed by horizontal bar (15 cases, 11.2%), swing & half buried tire (13 cases, 9.7%), slide (11 cases, 8.2%), jungle gym (10 cases, 7.5%) and seesaw (4 cases, 3.0%) (Table 5). Compared with the injuries which occurred without the use of playground equipment, the incidence of hospitalization was significantly high in the cases of injuries with the use of playground equipment according to the types of playground equipment as

**Table 5** Injury number and hospitalization incidence by playground equipment type

		N=5,428						Odds ratio	95% CI
Age	Playground equipment type	Hospitalized		Not hospitalized		Total			
		Number	%	Number	%	Number	%		
Lower grades; ≤8 years old	Not used							1.00	
	Monkey bar	33	24.6	394	11.9	427	12.4	6.88	4.50-10.51
	Horizontal bar	15	11.2	573	17.3	588	17.1	2.15	1.23- 3.77
	Swing	13	9.7	466	14.1	479	13.9	2.29	1.26- 4.16
	Half buried tire	13	9.7	200	6.0	213	6.2	5.34	2.91- 9.79
	Slide	11	8.2	359	10.9	370	10.8	2.52	1.32- 4.79
	Jungle gym	10	7.5	291	8.8	301	8.8	2.82	1.44- 5.52
	Seesaw	4	3.0	68	2.1	72	2.1	4.83	1.72-13.59
	Climber	1	0.7	114	3.4	115	3.3	0.72	0.10- 5.23
	Sandbox	1	0.7	21	0.6	22	0.6	3.91	0.52-29.46
	Other	33	24.6	821	24.9	854	24.8	3.30	2.17- 5.01
	Total	134	100.0	3,307	100.0	3,441	100.0		
Higher grades; >8 years old	Not used							1.00	
	Horizontal bar	19	31.2	411	21.3	430	21.6	5.23	3.12- 8.75
	Monkey bar	12	19.7	146	7.6	158	8.6	9.29	4.93-17.50
	Jungle gym	6	9.8	196	10.2	202	10.2	3.46	1.49- 8.06
	Climber	4	6.6	62	3.2	66	8.0	7.29	2.58-20.59
	Swing	4	6.6	233	12.1	237	11.9	1.94	0.70- 5.36
	Seesaw	1	1.6	25	1.3	26	1.3	4.52	0.60-33.83
	Half buried tire	1	1.6	100	5.2	101	5.1	1.13	0.16- 8.22
	Slide	0	0.0	165	8.6	165	8.3		
	Sandbox	0	0.0	23	1.2	23	1.2		
	Other	14	23.0	565	29.3	579	29.1	2.80	1.60- 5.00
	Total	61	100.0	1,926	100.0	1,987	100.0		

follows: monkey bar (6.88 fold; 4.50-10.51), half buried tire (5.34 fold; 2.91-9.79), seesaw (4.83 fold; 1.72-13.59), jungle gym (2.82 fold; 1.44-5.52), slide (2.52 fold; 1.32-4.79), swing (2.29 fold; 1.26-4.16), and horizontal bar (2.15 fold; 1.23-3.77). In these top-seven playground equipment types, 99 cases of injuries required hospitalization. Among them, there were 78 fractures (78.8%) and 14 contusions with intact skin surface (14.2%), 2 sprains (2.0%), 2 dislocations (2.0%) and 3 others (3.0%). In the 78 fractures, 67 cases (85.9%) were the fractures of the upper limbs.

Among the higher grade students, the analysis with respect to the types of playground equipment which involved in the injuries revealed that the horizontal bar had the highest incidence of hospitalization-required injuries (19 cases, 31.2%); followed by monkey bar (12 cases, 19.7%), jungle gym (6 cases, 9.8%), and climber & swing (4 cases, 6.6%). Compared with the injuries which occurred without the use of playground equipment, the incidence of hospitalization was significantly high in the cases of injuries with the use of playground equipment according to the types of playground equipment as follows: monkey bar (9.29 fold; 4.93-17.50), climber (7.29 fold; 2.58-20.59), horizontal bar (5.23 fold; 3.12-8.75), and jungle gym (3.46 fold; 1.49-8.06).

In these top-four playground equipment types, 41 cases of injuries required hospitalization. Among them, there were 31 fractures (75.6%), 8 contusions with intact skin surface (19.5%), 1 sprain (2.4%) and 1 other (2.4%). In the 31 fractures, 27 cases (87.1%) were the fractures of the upper limbs.

Both in the lower grade students and in the higher grade students, most of the injuries that required hospitalization were the fractures of the upper limbs due to falls from playground equipment.

## 4. Discussion

### 4.1. The rate of the occurrence of injuries that required hospitalization

The analysis of the occurrence of injuries that required medical treatment in primary schools of seven prefectures of the Tokai/Hokuriku area in Japan, with a total enrollment of 1,066,102 students, revealed that in the period of the one year 70,701 cases of injuries occurred under school responsibility. Among the injury cases, 882 severe cases required

hospitalization, which represents approximately 1.2% of the total number of treatment-required injuries. As the age of primary school students ranges from 6 to 12 years, the characteristics of the occurrence of injuries that required hospitalization were investigated by taking their developmental stage into consideration, and the students were divided into two groups; the lower grade group (the grade from 1st to 3rd) and the higher grade group (the grade from 4th to 6th)

In the 70,701 cases of injuries that required medical treatment, 40% were the lower grade students and 60% were the higher grade students (approximately 1.5 fold the number of cases for the lower grade students). However, the ratio of the hospitalization of the lower grade students was significantly higher than that of the higher grade students, because the number of cases which required hospitalization was almost the same between the two groups (445 and 437 cases, respectively).

There are a number of research reports concerning the factors that lead to the occurrence of injuries among students in Japan and in other countries.

Nevertheless, the subjects of most of the studies carried out in other countries were the cases of hospital consultation, in which medical diagnosis at the hospital was only investigated (Chalmers et al., 1990; Lillis and Jaffe, 1997; Graham et al., 2005). As they do not cover all the injuries which occurred inside school, these studies are insufficient to obtain information on safety measures that should be taken by schools. In Japan, when students of primary, junior high and high schools suffer injuries under school responsibility, the NAASH provides reimbursement of medical expenses. Thus, the database stored by the NAASH provides us with very valuable information to improve school safety measures; and several studies explored details of the causes of the occurrence of injuries (Ishigure, 1996; Ishigure et al., 2002; Ishigure, 2007). On the other hand, serious injuries that required hospitalization do not often occur among students, making it difficult to gather enough number of cases to analyze their characteristics. In fact, there are very few data or reports in Japan and overseas on the occurrence of injuries that require hospitalization when students are under school responsibility.

In this study, in the period of one year there were only 882 cases of hospitalization among more than one million of primary school students, an incidence

of 0.8 cases per 1,000 students. According to the School Basic Survey, 97.8% of the primary schools in Japan have less than 900 students (Japanese Ministry of Education, Culture, Sports, Science and Technology, 2007). This indicates that the number of hospitalization-required injuries is less than one in a year in most primary schools. Therefore, as it was impossible to collect enough injury data from isolated schools for the purpose of analysis, it was difficult to find out the causes of severe injuries. Results of our study indicated that it is important to collect severe injury-related data of a wide area.

#### **4.2. The situation of the occurrence of injuries that required hospitalization**

This study revealed that the incidence of hospitalization among primary school students increased when they suffered injuries during recess, outside the school building in the school area (i.e., in the playground).

Concerning primary school students, Nakahara et al. (2004) showed that the injuries inside schools occurred the most frequently during recess. In our study, similar tendency was found in severe injuries that required hospitalization. Especially, among the lower grade students, more than 60% of the injuries that required hospitalization happened during recess, showing odds ratio of 1.83 when compared with those which occurred during classes.

Concerning the injuries that occurred except those during recess, although the involved factors of hospitalization increased 1.91 fold when they occurred during commute to and from school, the number of injury cases was under 1/4 (68 cases) of those occurred during recess.

In addition, the incidence of hospitalization also increased among the higher grade students during commute to and from school, but the number of cases was only 30. These results suggest that a large proportion of fall-derived fractures of upper limbs happened when using playground equipment outside the school building in the school area during recess, with high incidence of hospitalization.

Although the types of playground equipment with elevated incidence of hospitalization were different between in the lower grade students and in the higher grade students, this difference is considered to reflect diverse playing ways and interest according to their developmental stages. Yamamoto et al. (2009)

reported that the frequency of the use of playground equipment was higher in the lower age children than in higher age children; they also found that the lower age children used the swing, jungle gym and slide with more frequency, while the higher age children preferred the horizontal bar and climber. The findings by Yamamoto et al. (2009) support the results of our study.

More frequent use of playground equipment among the lower grade students is supposed to inevitably bring about the increased incidence of injury. It was reported that about 24% of 311 cases of injuries which occurred in kindergartens and nursery schools were related with the use of playground equipment, and that the rate of injury was higher among the lower age children (Kuwabara et al., 1997). Overseas, many reports described that the use of climbing playground equipment, especially the monkey bar and jungle gym, resulted in high incidence of serious injuries among children. In 1975, Illingworth et al. (1975) examined 200 injury cases which happened during the use of playground equipment and found that the swing, climber and slide accounted for 3/4 of the cases and were related with the severity of the injuries. Furthermore, in the study that analyzed the cases of the injuries which were associated with playground equipment between 1990 and 1994, Mack et al. (1997) observed that each year there were roughly 211,000 preschool or elementary school children in the United States who received emergency department care for those injuries, and that approximately 35% of them were classified as severe (that is, concussions, dislocations, fractures, etc.) and about 3% required hospitalization. Swing, climber and slide were the pieces of playground equipment associated with 88% of the injuries.

Moreover, Lillis and Jaffe (1997) reported that the use of playground equipment such as the monkey bar and climber comprised more than 40% of the injury cases in the children examined by the emergency room of hospitals in Canada from 1990 to 1991. Additionally, they found that 84% of the injuries that required hospitalization occurred by the use of equipment such as the monkey bar, climber, jungle gym and slide. These results by Lillis and Jaffe (1997) support the findings of our study.

Thus, falls from playground equipment such as the monkey bar and jungle gym are the main cause of upper limbs fractures and consequent increased incidence of hospitalization in injuries of primary



school students under school responsibility. Previous studies pointed out that falls were the main cause of playground equipment-related injuries (Chalmers et al., 1990; Mack et al., 1997; Vollman et al., 2009), suggesting that factors such as the shock by falls and fall-induced collisions with other children further increased the incidence of severe injuries. It was reported that 70% of the injuries which occurred during the use of playground equipment by infants and children younger than primary school students were caused by falls (Mack et al., 1997), and 75% of the playground equipment-related injuries among students under 18 years of age were also derived from falls (Vollman et al., 2009). In addition, a study of 1,125 cases of hospitalization-required injuries which occurred among students less than 15 years of age showed that 93% were derived from falls (Chalmers et al., 1990). Although these reports included locations outside the school area, such as public parks and athletic facilities, our school playground equipment-restricted study showed the same trend with these studies. Thus, we can deduce that the impact on the ground and the collision with other children caused by falls from playground equipment are associated with the severity of the injuries.

It was shown that the incidence of fractures in the upper limbs was high among the children who suffered injuries during the use of playground equipment (Sherker et al., 2003; Sherker et al., 2005). Fractures which occurred during the use of playground equipment, especially those of the upper limbs, were found in approximately 80% of the hospitalized children (Lillis and Jaffe, 1997), and the ratio of hospitalization after injuries which occurred during the use of playground equipment was reported to be increasing because of fractures in the upper limbs (Mitchell et al., 2007). In addition, Waltzman et al. (1999) reported that 60% of the injuries which occurred in playground equipment such as the monkey bar and jungle gym included some sort of fracture, and 90% of them were supracondylar fractures of the humerus. Other reports also showed that the danger of fracture in the upper limbs was high among young children who fell from playground equipment (Sherker et al., 2003; Sherker et al., 2005; Tanaka et al., 2005).

In this way, most of the fractures of upper limbs due to falls from playground equipment such as the monkey bar and jungle gym, especially among young children with insufficient bone growth,

lead to hospitalization for repositioning treatment. Similar to this study, which focused its investigation on accidents occurred inside school, another study showed that 23% of the accidents involved playground equipment and that 1/4 of them resulted in serious injuries such as fracture or cerebral concussion (Thomas et al., 1984).

In schools, fixed playground equipment such as the monkey bar and horizontal bar is used to improve arm strength and grip through long-term, continuous stimulation of actions such as holding, hanging and grasping. The use of fixed playground equipment with the aim of providing students with the opportunity to climb and come down, suspend themselves, traverse and jump down is also specified in the Official Guidelines for Primary School Teaching (Japanese Ministry of Education, Culture, Sports, Science and Technology, 1998a). It is said that playground equipment is not intended just to provide students with the opportunity for various kinds of play, but to continuously and intentionally afford the opportunity of movement and consequent improvement of basic physical fitness qualities such as agility, power, balance ability, and muscular strength (Komata, 2006). In addition, playground equipment promotes group play and physical, mental and social development of the students (Japanese Ministry of Land, Infrastructure, Transport and Tourism, 2008). However, considering the high risk of severe accidents in parks (where there is no limit of time for using the equipment) even under supervision of guardians, the risk of falls and collisions during the short-time recess at school, especially when many students use the equipment at the same time, will be high as well. In primary schools, the length of recess varies according to schools (Japanese Ministry of Education, Culture, Sports, Science and Technology, 1998b), but in most schools there are 10 min between classes and 20-30 min during lunch or before and after the classes. We hypothesize that the risk of falls and collisions increases because, without supervision of teachers, a large number of students simultaneously use playground equipment during the limited recess time. Since it was reported that the number of playground equipment-related injuries increased especially in the schools with a large number of students (Ishigure, 2007), measures such as safety guidance to the students who use the playground equipment, limitation of the number of users and supervision by teachers are necessary.

Thus, to reduce the incidence of serious injuries that require hospitalization, it is important to be alert when playground equipment with high risk of falls (monkey bar, jungle gym, etc.) is used in the schoolyard. Above all, it is necessary to repeatedly provide the lower grade students with concrete and detailed knowledge on the ways to avoid accidents in playground equipment such as the monkey bar and jungle gym; for example, “falls have a high risk to result in serious injuries”, “impish acts are prohibited during the use of playground equipment”, “observe the established rules when using playground equipment”, “do not enter the area where other students can fall from playground equipment”, etc. Enhancement of the knowledge of students on how to protect themselves and promotion of their consciousness for hazard prevention are expected to be effective for continuously preventing serious injuries.

In recent years, large-scale playground apparatuses that combine multiple elements such as the monkey bar, jungle gym and slide have been installed in schoolyards. Safe design of playground equipment is insufficient to prevent serious injuries when their correct use is not followed by students and when the sense of danger is deficient. It is important to frequently guide the lower grade students on the safe use of playground equipment during recess. In addition, both human and material preventive measures such as restriction of the number of students using the same playground equipment at a time and installation of fences to prevent falls over other students need to be carried out as soon as possible.

### 4.3. Limitations of the study

Although our study statistically clarified the magnitude of the involved factors of injuries that required hospitalization, detailed analysis of the circumstances of all injuries that required hospitalization was not performed. In future studies, it will be necessary to examine the detailed context of the occurrence of injuries that required hospitalization.

## 5. Conclusion

This study made clear that the incidence of hospitalization among the lower grade students, aged less than or equal 8 years, was high when the

injuries which occurred during recess with the use of playground equipment. Compared with the injuries which occurred without the use of playground equipment, the incidence of hospitalization increased 3-7 fold in the injuries with the use of climbing playground equipment such as the monkey bar, horizontal bar and jungle gym in the lower grade students. And it also increased 3-9 fold in the higher grade students, by the use of equipment such as the monkey bar, climber, horizontal bar and jungle gym.

Overall, the results of this study revealed that the serious injuries in primary schools that required hospitalization occurred the most frequently during recess, outside of the school building in the school area, during the use of playground equipment; in particular, the incidence of hospitalization increased due to fractures of upper limbs caused by falls from the monkey bar or jungle gym. Accordingly, with the aim of reducing the incidence of hospitalization in schools, it is important to enhance teaching practices that aim to prevent falls from playground equipment.

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