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**Incidence and Outcomes of Emergency self-harms among Adolescents:
A Descriptive Epidemiological Study in Osaka City, Japan**

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Abstract

Objectives: To evaluate the incidence and outcomes of them from ambulance records.

Design: A retrospective, observational study.

Setting: Osaka city

Participants: 365 adolescents aged 10-19 with emergency self-harms contacted by emergency-medical-service personnel such as poisoning, cutting skin, jumping, hanging, gassing, and drowning from January 2010 through December 2012.

Primary outcome measurements: Incidence per 100,000 persons and outcome at the scene or hospital arrival by age and gender. Poisson regression models for incidence evaluation were used; relative risks (RRs) and their 95% confidence intervals (CIs).

Results: During the study period, a total of 425 self-harms were documented in 365 adolescents. The incidence of self-harms per 100,000 persons significantly increased from 6.3 at the age of 11 to 81 at the age of 19 among boys and from 6.3 to 228.5 among girls (both P for trend< 0.001). Although there was no incidence difference between girls and boys in the group aged 11-14 years old (RR, 1.20; 95% CI, 0.59-2.47), the incidence was significantly higher among girls than among boys in the group aged 15-19 years old (RR, 4.18; 95% CI, 3.20-5.45). The proportion of death by self-harms was 4.9%. The proportion of hospital admission and death by self-harms was higher among boys than among girls (38.6% versus 25.2%, P=0.016 and 14.8% versus 2.4%, P<0.001).

Conclusions: From ambulance records in Osaka, the incidence of emergency self-harms among adolescents increased as the age increased, and was higher among girls than

49 boys in the group ≥ 15 years old. However, the proportion of hospital admission and
50 death was greater among boys than among girls.

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For peer review only

52 **Strengths and limitations of this study**

- 53 ■ This study showed that the incidence of emergency self-harms among adolescents
54 increased as the age increased, and was higher among girls than boys in the group
55 ≥ 15 years old. However, the proportion of hospital admission and death was
56 greater among boys than among girls.
- 57 ■ This study included only emergency patients contacted by
58 emergency-medical-service personnel, and we could not grasp the actual situations
59 about walk-in patients with self-harms or those who did not visit hospitals.

60

61 Introduction

62 World Health Organization (WHO) reported that approximately more than eight
63 hundred thousand people commit suicide all over the world, that is a suicide occurred
64 every 40 seconds.¹ The annual incidence of suicide decreased from 12.5 to 10.4 per
65 100,000 persons in the 1990s, but the incidence has been increasing since 2000.² Suicide
66 is one of the major causes of death especially for adolescents. It was the third-leading
67 cause of death for those aged 10-14 years and the leading cause of death for those aged
68 15-19 years in Japan.³ It was also the second-leading cause of death for those aged 15-24
69 years in the United States.⁴

70 Self-harms are the strongest risk factor for future suicide.⁵⁻⁶ There were a lot of
71 studies regarding pediatric self-harms. The incidence of self-harms was higher among
72 adolescents than among adults,^{2,7} but the rates of lifetime experience of self-harms varied
73 between countries.⁸ Some studies reported that females were more likely to have a
74 self-harm experience than males among adolescents, whereas others did not find any
75 significant gender disparities among adolescents.⁹⁻¹¹ Importantly, most of reports on
76 adolescent self-harms have collected data using interviews of theoretical sampling or
77 from single-center medical records, and little is known about population-based incidence
78 of self-harms and their outcomes.

79 Osaka City is the largest metropolitan community in western Japan, and ambulances
80 dispatched over two hundred thousand times every year. Using the ambulance records
81 by the Osaka City emergency-medical-service (EMS) personnel, we conducted a
82 population-based epidemiological study to provide fundamental information for the

83 prevention of adolescent self-harms.

84

85 **Methods**

86 **Study design, population, and settings**

87 We reviewed the ambulance records of Osaka Municipal Fire Department during the
88 period of January 2010 through December 2012. All adolescents who attempted
89 self-harms and for whom an ambulance was called in Osaka City were enrolled. An
90 adolescent was defined as those aged 10-19 years in this study. If two or more
91 self-harms were confirmed from one adolescent, each event was treated as an
92 independent case. In this study, self-harms were classified as the following: poisoning,
93 cutting skin, jumping from the height, hanging, gassing, and drowning according to
94 previous studies.¹²⁻¹³ When transported to a hospital, the diagnosis of self-harms was
95 clinically made by the physicians caring for the patient after hospital arrival in
96 collaboration with EMS personnel. When not transported to any hospital, the
97 classification of self-harms was made by the EMS personnel based on the EMS
98 interview with the patient him/herself or bystander at the scene. This study was
99 approved by the Ethics Committee of Kyoto University Graduate School of Medicine
100 and the Ethics Committee of Kyoto Prefectural University of Medicine. Since the
101 personal identifiers were already removed from the database by the EMS personnel, the
102 requirement of informed consent of patients was waived by the Personal Information
103 Protection Law and the national research ethics guidelines of Japan.

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EMS system and emergency hospitals in Osaka City

Osaka City has an area of 222 km², and a population is approximately 2.7 million in 2010 (population density, about 12,000 persons/km²).¹⁴ The EMS system of Osaka City is operated by the Osaka Municipal Fire Department and is activated by dialing the emergency number “119” on a telephone.¹⁵ In 2010, Osaka City had 25 fire stations (60 ambulances in total) and one dispatch center in Osaka City. Life support is provided 24 h a day. Usually, each ambulance typically operates with a crew of three emergency care providers including at least one emergency life-saving technician, a highly-trained prehospital emergency care provider. Osaka City had 186 hospitals (32,922 beds) in 2012, 94 of which—including six critical care centers—were equipped to treat patients with life-threatening emergencies.¹⁶ During the study period, emergency dispatchers in Osaka City EMS did not call a hospital for acceptance, leaving ambulances crews to select an appropriate hospital for emergency care.¹⁶

Data collection and quality control

The following data were uniformly collected via special forms including age, gender, location of call, type of self-harms, chronological factors, and the time-course of transportation, type of transported hospitals and departments, and patient outcomes. The forms were completed by EMS personnel in cooperation with the physicians caring for the patient, transferred to the EMS Information Center of Osaka Municipal Fire Department, and then checked by the investigators. If any data were missing, the investigators returned the form to the relevant EMS personnel for data completion.

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128 **Endpoints**

129 The endpoint of this study was the incidence per 100,000 adolescents and their clinical
130 outcomes of emergency self-harms at the scene or on hospital arrival. Outcomes were
131 classified as follows: transportation rejection by patients, only prehospital treatments,
132 no hospital admission after transportation, hospital admission, or death (death
133 confirmed at the scene or death confirmed at the hospital arrival).

134

135 **Statistical analysis**

136 Incidence and outcomes of self-harms were compared by the background characteristics
137 and chronological factors using either chi-square test or Fisher’s exact test. In addition,
138 outcomes were compared by sex. Incidence of self-harms per 100,000 adolescents by
139 age and gender was calculated with the 2010 Osaka census data.¹⁴ Poisson regression
140 models were applied for incidence trends by age and gender with risk ratios (RRs) and
141 their 95% confidence intervals (CIs) were calculated. Time of day was divided into the
142 4 groups by 6-hour interval. As for season, the period from April to June was defined as
143 spring: 1st quarter (1Q), July to September summer: 2nd quarter (2Q), October to
144 December autumn: 3rd quarter (3Q), and January to March winter: 4th quarter (4Q),
145 respectively. All statistical analyses were performed using SPSS statistical package
146 version 22.0J (IBM Corp. Armonk, NY). All tests were two-tailed, and P-values of
147 <0.05 were considered statistically significant.

148

149 Results

150 Population

151 During the study period, a total of 633,359 emergency cases including 18,516
152 adolescent cases were documented in Osaka City. Among them, 425 self-harms were
153 documented in 365 adolescents. The youngest boy and girl were 11 and 12 years old,
154 respectively. The incidence per 100,000 persons by age and gender was shown in Figure
155 1. The incidence of self-harms significantly increased from 6.3 at age 11 years to 81 at
156 age 19 years among boys and from 6.3 to 228.5 among girls (both P for trend < 0.001).
157 Although there was no incidence difference between girls and boys in the group aged
158 11-14 years old (RR, 1.20; 95% CI, 0.59-2.47), the incidence was significantly higher
159 among girls than among boys in the group aged 15-19 years old (RR, 4.18; 95% CI,
160 3.20-5.45).

162 Chronological factors

163 The number of self-harms by chronological factors was noted in Figure 2. The number
164 of cases by time of day was the lowest at the period of 6-12h, and the number was
165 doubled during the period of 18-24h (RR, 2.12; 95% CI, 1.59-2.98). Regarding day of
166 the week, the number did not differ between each day. As for season, the number was
167 1.36-times (95% CI, 1.02-1.82) greater in spring: 1Q (Apr-Jun) than in winter: 4Q
168 (Oct-Dec).

170 Characteristics

Table 1 shows the patient characteristics by type of self-harms. There were 88 (20.7%) self-harms among boys and 337 (79.3%) self-harms among girls. The mean age was 17.3 years. The most frequent type was poisoning (210, 49.4%), followed by cutting skin (158, 37.2%), jumping from the height (26, 6.1%), hanging (22, 5.2%), gassing (6, 1.4%), and drowning (3, 0.7%). The place where self-harms occurred was home (344, 80.9%), followed by road (52, 12.2%), building (23, 5.4%), school (3, 1.0%), and health care facility (3, 1.0%), respectively. The mean time from call to EMS contact and to hospital arrival was 6.5 mins and 48.6 mins, respectively. A total of 54 (12.7%) self-harms were transported to critical care medical centers and 289 (68.0%) to non-critical care medical centers, but 82 (19.3%) were not transported. Among transported self-harms cases, the type of departments consisted of surgery (168, 39.5%), internal medicine (162, 38.1%), pediatrics (8, 1.9%), and psychiatry (5, 1.2%).

Outcomes

Table 2 shows the patient outcomes by type of self-harms. A total of 73 (17.2%) patients (7.1% transportation rejection by patients and 10.1% only pre-hospital treatment) were not transported to hospitals. About 50% of patients transported to hospitals were only treated at the emergency room but were not admitted to hospitals. Hospital admission was more frequent among boys than among girls (38.6% versus 25.2%, $P=0.016$). The case fatality of self-harms was 4.9% and was higher for boys than for girls (14.8% versus 2.4%, $P<0.001$). As for type of self-harms, 41.9% of patients with poisoning were admitted to hospitals. Most of adolescents with cutting skin (70.9%) were not

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6 193 admitted to hospitals. A total of 15 (57.7%) adolescents with jumping were admitted to
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8 194 hospitals and five (19.2%) died. The case fatality of hanging reached 59.1%. As for
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10 195 gassing, two patients were admitted to hospitals and two died (33.3%, respectively).
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15 197 **Discussion**

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18 198 By assessing the ambulance records in Osaka City, Japan, the largest metropolitan
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20 199 community in western Japan, we conducted a community-based study about adolescents
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22 200 with self-harms contacted by EMS personnel. The incidence and outcomes of
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24 201 emergency self-harms among adolescents differed by age and sex. Although there were
25
26 202 a lot of studies regarding adolescent self-harms, their community-based evaluation based
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28 203 on ambulance records has never been conducted. To our knowledge, this is the first to
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30 204 assess EMS-related adolescent self-harms and provides some important clues for the
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32 205 prevention of adolescent self-harms and subsequent deaths.
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37 206 Some reports showed that the incidence of self-harms varied between communities.⁸
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39 207 In this study, the proportion of adolescent death by self-harms in this study accounted for
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41 208 about 5% of total self-harms. Although the study design varied between reports, this
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43 209 result was similar to a previous report from WHO.¹ Among self-harms poisoning or
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45 210 cutting skin were the most common manners in this study, and this findings were also
46
47 211 similar to a preceding report from the United States.¹⁷ However, in the United States, the
48
49 212 most frequent manner of death by self-harms was the use of firearm,² and this was
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51 213 different from this study in Japan where firearms are strictly restricted. Importantly, it is
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214 well-known that self-harms are important risk factors for future suicide,⁵⁻⁶ and it is,
215 therefore, essential to prevent self-harms irrespective of type.

216 In this study, the youngest cases were children aged 11 years who were still
217 elementary school pupils. The incidence increased with increasing age for both sexes,
218 which was consistent with the preceding studies in western countries.^{2,7} This age
219 dependency might be attributed to various factors such as increasing chance to access to
220 drugs and alcohols, increasing prevalence of psychiatric disorders, and development of
221 cognitive function.^{9,18-21} Especially, the prevalence of psychiatric disorders, main cause
222 of self-harms, dramatically increased during adolescence,¹⁸⁻¹⁹ and adolescent cognitive
223 development let them perceive to be negative or hopeless for the present and future and
224 may result in suicide.²⁰⁻²¹ Therefore, wide measures based on the adolescent
225 environment and their developmental stage are needed to prevent suicides.

226 Although the incidence was similar between girls and boys in the group aged 11-14
227 years, it was significantly higher among girls than among boys in the group aged ≥ 15
228 years old. On the other hand, mild cases were more frequent among girls than among
229 boys, whereas moderate or severe cases with hospital admission or death by self-harms
230 were more frequent among boys than among girls. Although definitive reasons for the
231 severity among boys were unclear like previous studies, this trend was also consistent
232 with ones in the United States.²²⁻²³ The reason of high incidence of girls with self-harms
233 may be partially explained by the high incidence of psychiatric disorders among girls.¹⁹
234 Puberty is another plausible reason for high incidence of self-harms among girls. For
235 example, puberty might cause lack of synchrony between age and cognitive development

236 and be at risk of self-harms.²⁴⁻²⁵ Since the effectiveness of suicide prevention was
237 different between the two genders,²⁶ we should provide gender-specific preventive
238 interventions to adolescents even in Japan.

239 To our knowledge, there were no other preceding studies investigating adolescent
240 self-harms regarding chronological factors. As for season, previous studies on adult
241 self-harms reported that the incidence of suicides increased from spring to summer and
242 decreased in winter,²⁷⁻²⁸ and the number of self-harm in this study was similarly higher in
243 the warmer seasons. As for time of day, the number of self-harms was lowest at 6-12h and
244 this result was consistent with a prior study for adult self-harms.¹³ On the other hand, as
245 for day of week, although a previous study regarding adult self-harms showed the highest
246 incidence on Monday, we found no significant differences by the day of week in this
247 study. Thus, chronological patterns of adolescent self-harm occurrence seemed to be
248 basically similar to those of adult one, but their numbers were too small to detect the
249 relationship properly.

250 Self-harms are the greatest risk factors for future suicide.¹⁶⁻¹⁷ Recently, a
251 meta-analysis showed that active interventions to adolescents who attempted self-harms
252 could prevent repeating self-harms or completing suicides.²⁹ Our study provides
253 fundamental information about adolescent self-harms contacted by EMS personnel, and
254 we consider that our findings are helpful to promote school-, community-, and
255 hospital-based preventive interventions against adolescent self-harms.

256 However, this study has several inherent limitations. First, the data used in this study
257 were based on ambulance records by EMS personnel, and we did not obtain information

258 on adolescents' comorbidity and history of suicide or self-harm attempt, or outcomes
259 after hospital admissions. At present, we are prospectively collecting data on emergency
260 patients with these data in Osaka Prefecture since 2015 and will address them in future.
261 Second, this study included only emergency patients contacted by EMS personnel, and
262 we could not grasp the actual situations about walk-in patients with self-harms or those
263 who did not visit hospitals. The last important limitation was that we could not detect
264 repeating self-harms in an adolescent, because lifetime experience of self-harms might
265 be overestimated from our study.

266

267 **CONCLUSION**

268 The incidence of emergency adolescents with self-harms increased as the age increased,
269 and was higher among girls than boys in the group ≥ 15 years old. However, the
270 proportion of hospital admission and death was greater among boys than among girls. It
271 will be necessary to establish age- and gender-specific prevention and intervention
272 strategies for adolescent self-harms and subsequent deaths.

273

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276 Department and concerned physicians in Osaka City for their indispensable cooperation
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278

279 Contributions

280 Conceived and designed the study: TM, T Kitamura, SH, MN, TI Analyzed the data:
281 TM, T Kitamura, KK, T Kawamura Wrote the paper: TM, T Kitamura, BO

282

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284 None.

285

286 Competing interests

287 None.

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289 Ethics approval

290 This study was approved by the Ethics Committee of Kyoto University Graduate School
291 of Medicine and the Ethics Committee of Kyoto Prefectural University of Medicine.
292 Since the personal identifiers were already removed from the database by the EMS
293 personnel, the requirement of informed consent of patients was waived by the Personal
294 Information Protection Law and the national research ethics guidelines of Japan.

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297 Not commissioned; externally peer reviewed.

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299 **Data sharing statement**

300 No additional data available

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302 **Open Access**

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390

391 **Figure legends**

392 **Figure 1:** Incidence per 100,000 persons of emergency adolescents with self-harms by
393 age and gender

394 **Figure 2:** Number of emergency self-harms among adolescents by chronological factor
395 such as (A) hour, (B) week, and (C) season

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Table 1. Characteristics of emergency self-harms among adolescents in Osaka City.

	Total	Poisoning	Cutting skin	Jumping	Hanging	Gassing	Drowning	P Values
	(n=425)	(n=210)	(n=158)	(n=26)	(n=22)	(n=6)	(n=3)	†
Boy, n, (%)	88 (20.7)	40 (19.0)	20 (12.7)	9 (34.6)	13 (59.0)	5 (83.3)	1 (33.3)	<0.001
Girl, n, (%)	337 (79.3)	170 (81.0)	138 (87.3)	17 (65.4)	9 (41.0)	1 (16.7)	2 (66.7)	
Age, year, n, (%)								<0.001
11	2 (0.5)	1 (0.5)	0 (0.0)	1 (3.8)	0 (0.0)	0 (0.0)	0 (0.0)	
12	6 (1.5)	1 (0.5)	2 (1.3)	1 (3.8)	2 (9.1)	0 (0.0)	0 (0.0)	
13	6 (1.5)	5 (2.4)	0 (0.0)	0 (0.0)	1 (4.5)	0 (0.0)	0 (0.0)	
14	16 (4.2)	7 (3.3)	2 (1.3)	7 (26.9)	1 (4.5)	0 (0.0)	0 (0.0)	
15	20 (5.2)	12 (5.7)	7 (4.4)	1 (3.8)	2 (9.1)	1 (16.7)	0 (0.0)	
16	49 (12.9)	32 (15.2)	21 (13.3)	1 (3.8)	0 (0.0)	0 (0.0)	1 (33.3)	
17	65 (17.1)	37 (17.6)	24 (15.2)	7 (26.9)	2 (9.1)	1 (16.7)	2 (66.7)	

18	94 (24.7)	57 (27.1)	43 (27.2)	4 (15.4)	6 (27.3)	0 (0.0)	0 (0.0)	
19	117 (30.7)	58 (27.6)	59 (37.3)	4 (15.4)	8 (36.4)	4 (66.7)	0 (0.0)	
Place, n, (%)								<0.001
Home	344 (80.9)	183 (87.1)	124 (78.5)	11 (42.3)	22 (100.0)	4 (66.7)	0 (0.0)	
Road	52 (12.2)	12 (5.7)	22 (13.9)	14 (53.8)	0 (0.0)	1 (16.7)	3 (100)	
Building	23 (5.4)	10 (4.8)	12 (7.6)	0 (0.0)	0 (0.0)	1 (16.7)	0 (0.0)	
School	3 (1.0)	2 (1.0)	0 (0.0)	1 (3.8)	0 (0.0)	0 (0.0)	0 (0.0)	
Health care facility	3 (1.0)	3 (1.4)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Call to contact with a patient by EMS, min, mean (SD)	6.5 (5.0)	6.4 (3.1)	6.1 (3.1)	6.5 (3.0)	7 (2.2)	7.3 (4.0)	33.7 (42.0)	<0.001
Call to hospital arrival, min, mean (SD)*	48.6 (25.6)	55.7 (27.6)	43 (20.6)	43.2 (23.3)	41.8 (30.8)	43 (17.0)	99.0 (0.0)	<0.001
Type of hospitals, n (%)								<0.001
No transportation	82 (19.3)	30 (14.3)	38 (24.1)	0 (0.0)	9 (40.9)	3 (50.0)	2 (66.7)	
Non critical care medical center	289 (68.0)	154 (73.3)	117 (74.1)	9 (34.6)	7 (31.8)	1 (16.7)	1 (33.3)	
Critical care medical center	54 (12.7)	26 (12.4)	3 (1.9)	17 (65.4)	6 (27.3)	2 (33.3)	0 (0.0)	

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Type of transported department, n (%)*											<0.001			
Surgery	168	(39.5)	24	(11.4)	108	(68.4)	26	(100.0)	9	(40.9)	1	(16.7)	0	(0.0)
Internal medicine	162	(38.1)	145	(69.0)	11	(7.0)	0	(0.0)	3	(13.6)	2	(33.3)	1	(33.3)
Pediatrics	8	(1.9)	8	(3.8)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)
Psychiatry	5	(1.2)	3	(1.4)	1	(0.6)	0	(0.0)	1	(4.5)	0	(0.0)	0	(0.0)

EMS, Emergency Medical Services; SD, standard deviation.

*Calculated only for self-harms transported to institutions.

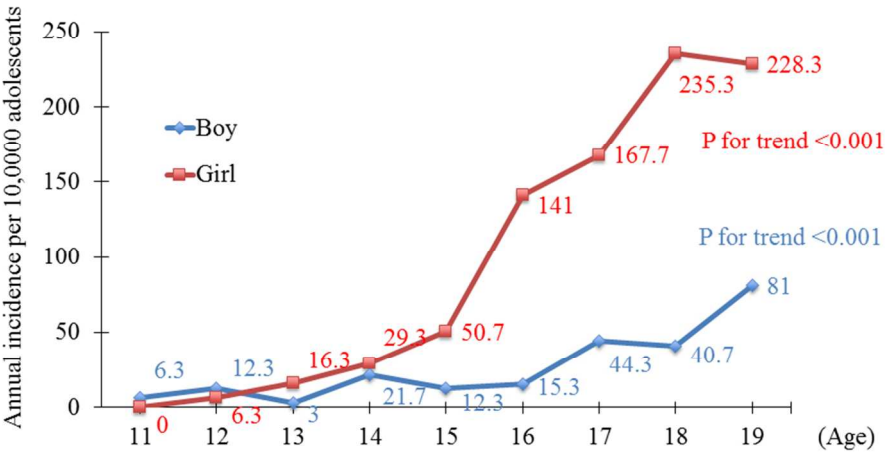
†Comparison between the 6 groups were evaluated with Fisher exact test.

Table 2. Outcomes of emergency self-harms among adolescents in Osaka City.

	Gender														
	Total						Poisoning	Cutting skin	Jumping	Hanging	Gassing	Drowning	P		
			Boy	Girl	P										
	(n=425)	(n=88)	(n=337)	values	(n=210)	(n=158)	(n=26)	(n=22)	(n=6)	(n=3)	Values*				
Transportation rejection by patients, n, (%)	30 (7.1)	7 (8.0)	23 (6.8)	0.647	24 (11.4)	4 (2.5)	0 (0.0)	2 (9.0)	0 (0.0)	0 (0.0)	0.017				
Only prehospital treatments, n, (%)	43 (10.1)	4 (4.5)	39 (11.6)	0.072	6 (2.9)	34 (21.5)	0 (0.0)	0 (0.0)	1 (16.7)	2 (66.7)	<0.001				
No hospital admission after transportation, n, (%)	212 (49.9)	30 (34.1)	182 (54.0)	0.001	92 (43.8)	112 (70.9)	6 (23.1)	1 (4.5)	1 (16.7)	0 (0.0)	<0.001				
Hospital admission, n, (%)	119 (28.0)	34 (38.6)	85 (25.2)	0.016	88 (41.9)	8 (5.0)	15 (57.7)	6 (27.3)	2 (33.3)	0 (0.0)	<0.001				
Death, n, (%)	21 (4.9)	13 (14.8)	8 (2.4)	<0.001	0 (0.0)	0 (0.0)	5 (19.2)	13 (59.1)	2 (33.3)	1 (33.3)	<0.001				
Death confirmed at the scene	9 (2.1)	7 (8.0)	2 (0.6)		0 (0.0)	0 (0.0)	0 (0.0)	7 (31.8)	2 (33.3)	0 (0.0)					
Death confirmed at the hospital admission	12 (2.8)	6 (6.8)	6 (1.8)		0 (0.0)	0 (0.0)	5 (19.2)	6 (27.3)	0 (0.0)	1 (33.3)					

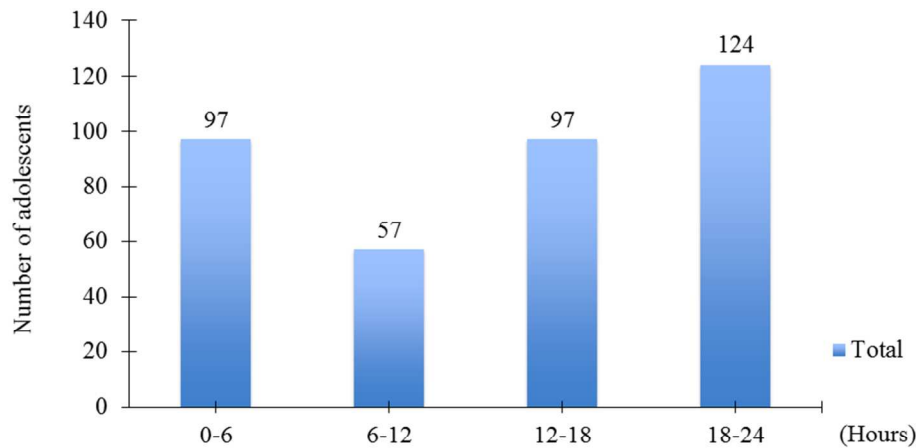
*Comparison between the 6 groups (type of self-harms) were evaluated with Fisher exact test.

Figure 1



Incidence per 100,000 persons of emergency adolescents with self-harms by age and gender
254x190mm (96 x 96 DPI)

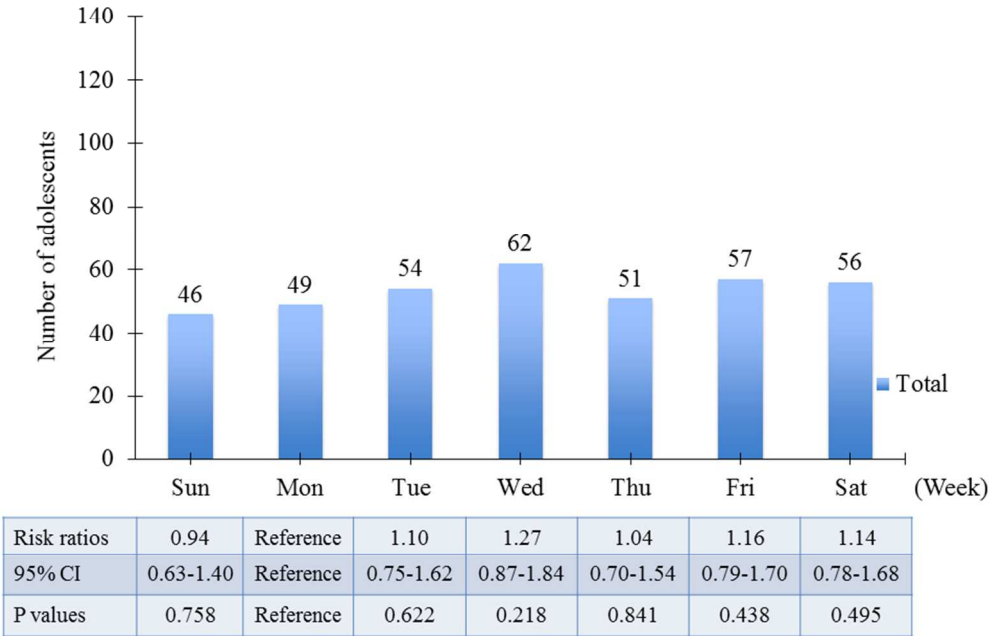
Figure 2A



Risk ratios	1.70	Reference	1.70	2.12
95% CI	1.23-2.36	Reference	1.23-2.36	1.59-2.98
P values	0.001	Reference	0.001	<0.001

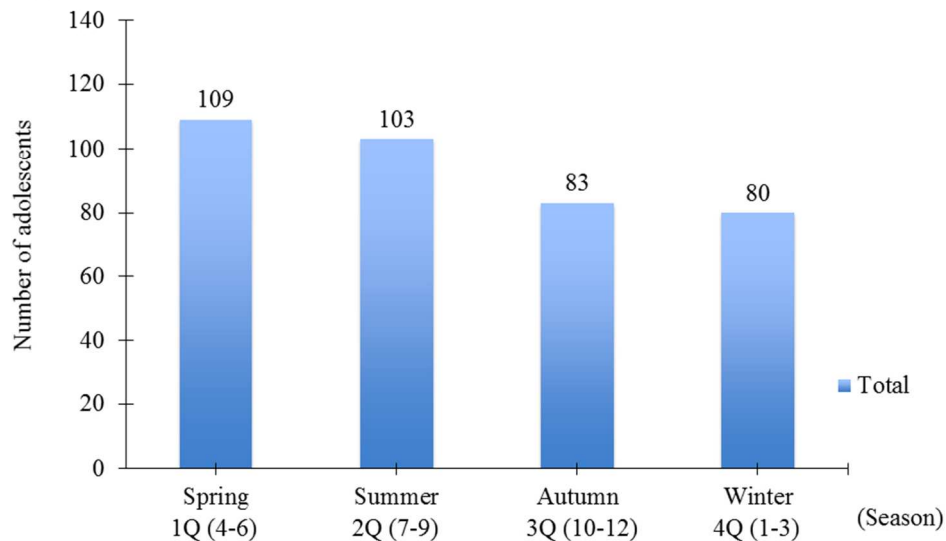
Number of emergency self-harms among adolescents by chronological factor such as hour
254x190mm (96 x 96 DPI)

Figure 2B



Number of emergency self-harms among adolescents by chronological factor such as week
254x190mm (96 x 96 DPI)

Figure 2C



Risk ratios	1.36	1.29	1.04	Reference
95% CI	1.02-1.82	0.96-1.72	0.76-1.41	Reference
P values	0.036	0.090	0.814	Reference

Number of emergency self-harms among adolescents by chronological factor such as season
254x190mm (96 x 96 DPI)

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of cohort studies

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract	3
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	3-4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	6
Objectives	3	State specific objectives, including any prespecified hypotheses	6-7
Methods			
Study design	4	Present key elements of study design early in the paper	7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	7-8
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	7-8
		(b) For matched studies, give matching criteria and number of exposed and unexposed	NA
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	9
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	NA
Bias	9	Describe any efforts to address potential sources of bias	NA
Study size	10	Explain how the study size was arrived at	8
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8-9
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	9
		(b) Describe any methods used to examine subgroups and interactions	NA
		(c) Explain how missing data were addressed	8
		(d) If applicable, explain how loss to follow-up was addressed	NA
		(e) Describe any sensitivity analyses	NA
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	10
		(b) Give reasons for non-participation at each stage	10
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	10-11, (Table 1)
		(b) Indicate number of participants with missing data for each variable of interest	NA
		(c) Summarise follow-up time (eg, average and total amount)	NA
Outcome data	15*	Report numbers of outcome events or summary measures over time	11-12, (Table 2)
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10-12 (Figure 1, Table 2)
		(b) Report category boundaries when continuous variables were categorized	Figure 2
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12-15
Generalisability	21	Discuss the generalisability (external validity) of the study results	14-15
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	NA

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Incidence and Outcomes of Emergency self-harm among Adolescents: A Descriptive Epidemiological Study in Osaka City, Japan

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**Incidence and Outcomes of Emergency self-harm among Adolescents:
A Descriptive Epidemiological Study in Osaka City, Japan**

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26

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27 **Abstract**

28 **Objectives:** To evaluate the incidence and outcomes of self-harm from ambulance
29 records.

30 **Design:** A retrospective, observational study.

31 **Setting:** Osaka city

32 **Participants:** 365 adolescents aged 10-19 with emergency self-harm treated by
33 emergency-medical-service personnel such as poisoning by drugs or gas, cutting skin,
34 jumping from heights, hanging, and drowning from January 2010 through December
35 2012.

36 **Primary outcome measurements:** Incidence per 100,000 persons and outcome at the
37 scene or hospital arrival by age and gender. Poisson regression models for incidence
38 evaluation were used; reporting relative risks (RRs) and their 95% confidence intervals
39 (CIs).

40 **Results:** During the study period, a total of 425 self-harm events were documented in
41 365 adolescents. The incidence of self-harm increased significantly between the ages of
42 11 and 19, from 6.3 to 81.0 among boys and the ages of 12 and 19 from 6.3 to 228.3
43 among girls, respectively (both P for trend< 0.001). Although there was no incidence
44 difference between girls and boys in the group aged 11-14 years (RR, 1.20; 95% CI,
45 0.59-2.47), the incidence was significantly higher among girls than boys in the group
46 aged 15-19 years (RR, 4.18; 95% CI, 3.20-5.45). The overall proportion of death by
47 self-harm was 4.9%. The proportion of hospital admission and death by self-harm was

48 higher among boys than among girls (38.6% versus 25.2%, $P=0.016$ and 14.8% versus
49 2.4%, $P<0.001$).

50 **Conclusions:** Based on ambulance records in Osaka, the incidence of emergency
51 self-harm among adolescents increased with age, and was higher among girls than boys
52 in the group aged ≥ 15 years. However, the proportion of hospital admission and death
53 due to self-harm was greater among boys than girls.

54

55 **Strengths and limitations of this study**

- 56 ■ The incidence of emergency treatment for self-harm by adolescents increased with
57 age and our findings also demonstrated the gender paradox that whereas the
58 incidence was higher among girls than boys, particularly in the group aged ≥ 15
59 years, the proportions of deaths were greater among boys.
- 60 ■ To our knowledge, this is the first to assess EMS-related adolescent self-harm and
61 provides important epidemiological information which may help prevent incidents
62 of self-harm among adolescents in Asia
- 63 ■ No other such large-scale evaluations have been conducted using ambulance
64 records in Asia.
- 65 ■ This study included only emergency patients treated by emergency-medical-service
66 personnel, and we therefore have no information on walk-ins with self-harm or
67 patients who did not request emergency services
- 68 ■ We did not obtain information on the purpose/motivation of self-harm such as
69 suicidal intention.

70

71 Introduction

72 World Health Organization (WHO) reported that upwards of 800,000 people commit
73 suicide all over the world, with one death by suicide every 40 seconds.¹ While annual
74 suicide incidence decreased from 12.5 to 10.4 per 100,000 persons in the 1990s,
75 incidence has been rising again since the 2000.² Suicide is one of the major causes of
76 death in a number of populations, particularly adolescents, and the third-leading cause of
77 death among those aged 10-14 years and the leading cause of death among those aged
78 15-19 years in Japan,³ as well as the second-leading cause of death among those aged
79 15-24 years in the United States.⁴

80 Self-harm is the strongest risk factor for future suicide.⁵⁻⁶ A number of studies have
81 been conducted on the topic of pediatric self-harm. While incidence of self-harm has
82 been shown to be higher among adolescents than adults,^{2,7} rates of lifetime experience of
83 self-harm vary by community, producing conflict findings.⁸ For example, where some
84 studies found that adolescent females were more likely to have had a self-harm
85 experience than males among adolescents, others noted no significant gender disparities
86 among adolescents.⁹⁻¹¹ Of note, most of reports on adolescent self-harm have collected
87 data using interviews of theoretical sampling or from single-center medical records, but
88 relatively few population-based studies have evaluated incidence of emergency
89 self-harm and their outcomes treated by emergency medical service (EMS) personnel.

90 Osaka City is the largest metropolitan community in western Japan, and ambulances
91 are dispatched over 200,000 times every year. Using the ambulance records in Osaka
92 City, we conducted a population-based epidemiological study to provide fundamental

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93 information for the prevention of adolescent self-harm.
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95 **Methods**

96 **Study design, population, and settings**

97 Our descriptive study retrospectively observed the ambulance records of Osaka
98 Municipal Fire Department from January 2010 through December 2012. All adolescents
99 (aged 10-19 years) treated by EMS personnel for self-harm in Osaka City were included.
100 If two or more incidents of self-harm were confirmed from one adolescent (e.g., both
101 cutting skin and poisoning were confirmed simultaneously from one adolescent), each
102 event was treated as an independent case. In this study, self-harm was classified by the
103 EMS/physicians as the following: poisoning by drugs, poisoning by gas, cutting skin,
104 jumping from heights, hanging, and drowning according to previous studies.¹²⁻¹³ For
105 patients transported to a hospital, the diagnosis of self-harm was clinically confirmed by
106 the physicians caring for the patient after hospital arrival in collaboration with EMS
107 personnel. For patients not transported to any hospital, the diagnosis was made by EMS
108 personnel based on on-site observations and the EMS interview with the patient. This
109 study was approved by the Ethics Committee of Kyoto University Graduate School of
110 Medicine and the Ethics Committee of Kyoto Prefectural University of Medicine. Since
111 the personal identifiers were already removed from the database by the EMS personnel,
112 the requirement of informed consent of patients was waived by the Personal Information
113 Protection Law and the national research ethics guidelines of Japan.

114

115 **EMS system and emergency hospitals in Osaka City**

Osaka City has an area of 222 km², and a population is approximately 2.7 million in 2010 (population density, about 12,000 persons/km²).¹⁴ The municipal EMS system of Osaka City is similar to that used in other areas of Osaka Prefecture, as previously described.¹⁵ The system is operated by the Osaka Municipal Fire Department and is activated by dialing the emergency number “119” on a telephone.¹⁶ In 2010, Osaka City had 25 fire stations (60 ambulances in total) and one dispatch center. Usually, each ambulance typically operates with a crew of three emergency care providers including at least one emergency life-saving technician, a highly-trained in providing prehospital emergency care. Osaka City had 186 hospitals (32,922 beds) in 2012, 94 of which—including six critical care centers—were equipped to treat patients with life-threatening emergencies.¹⁶ Basically, all patients who requested emergency services were transported to one of these 184 hospitals. During the study period, emergency dispatchers in Osaka City EMS did not call a hospital for acceptance, leaving ambulances crews to select an appropriate hospital for emergency care.¹⁶

130

131 **Data collection and quality control**

132 The following data were uniformly collected via regular forms including age, gender, 133 location of call, type of self-harm, temporal patterns, and the time-course of 134 transportation, destination hospital/department type, and patient outcomes. The forms 135 were completed by EMS personnel in cooperation with the physicians caring for the 136 patient, transferred to the EMS Information Center of Osaka Municipal Fire Department,

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6 137 and then checked by the investigators. If any data were missing, the investigators
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8 138 returned the form to the relevant EMS personnel for data completion.
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11 12 13 140 **Incidence and Outcomes**

14 141 The study was to evaluate the incidence per 100,000 adolescents and their clinical
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16 142 outcomes of emergency self-harm at the scene or on hospital arrival. Outcomes were
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18 143 classified as follows: refusal of transport by patients,, only prehospital treatments at the
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20 144 scene, no hospital admission after transportation, hospital admission, or death (death
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22 145 confirmed at the scene or death confirmed at the hospital arrival).
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28 29 147 **Statistical analysis**

30 148 Incidence and outcomes of self-harm were compared by the background characteristics
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32 149 and temporal patterns using either chi-square test or Fisher's exact test, outcomes were
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34 150 additionally compared by gender. Incidence of self-harm per 100,000 adolescents by
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36 151 age and gender was calculated with the 2010 Osaka census data.¹⁴ Poisson regression
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38 152 models were applied for incidence trends by age and gender with risk ratios (RRs) and
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40 153 their 95% confidence intervals (CIs) were calculated. Time of day was divided into the
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42 154 4 groups by 6-hour interval. As for season, the period from April to June was defined as
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44 155 spring: 1st quarter (1Q), July to September summer: 2nd quarter (2Q), October to
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46 156 December autumn: 3rd quarter (3Q), and January to March winter: 4th quarter (4Q),
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48 157 respectively. All statistical analyses were performed using SPSS statistical package
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158 version 22.0J (IBM Corp. Armonk, NY). All tests were two-tailed, and P-values of
159 <0.05 were considered statistically significant.
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Results

Population

During the study period, a total of 633,359 emergency patients including 18,516 adolescents were documented in Osaka City. Of 18,516, a total of 365 adolescents with 425 incidents of self-harm were identified. The youngest boy and girl were 11 and 12 years old, respectively. The incidence per 100,000 persons by age and gender was shown in Figure 1. The incidence of self-harm increased significantly between the ages of 11 and 19, from 6.3 to 81.0 among boys and the ages of 12 and 19 from 6.3 to 228.3 among girls, respectively (both P for trend < 0.001). The incidence was highest in 19 years old. Although no marked difference in incidence was noted between girls and boys in the group aged 11-14 years (RR, 1.20; 95% CI, 0.59-2.47), the incidence was significantly higher among girls than boys in the group aged 15-19 years (RR, 4.18; 95% CI, 3.20-5.45).

Temporal patterns

Temporal patterns were described in Figure 2. The number of cases by time of day was the lowest at the period of 6-12h, and the number was doubled during the period of 18-24h (RR, 2.12; 95% CI, 1.59-2.98). The number was the same between the period of 0-6h and 12-18h (Figure 2A). Regarding influence of day of the week, the number did not markedly differ by day (Figure 2B). As for seasons, the number was 1.36-times (95% CI, 1.02-1.82) greater in spring: 1Q (Apr-Jun) than in winter: 4Q (Jan-Mar) (Figure 2C).

183

184 **Characteristics**

185 Population characteristics by type of self-harm are shown in Table 1. A total of 88
186 (20.7%) incidents of self-harm were reported among boys, versus 337 (79.3%) among
187 girls, with an overall mean age of 17.3 years. Proportions of types of self-harm were as
188 follows: 210 (49.4%) cases of poisoning by drugs, 158 (37.2%) cases of cutting skin, 26
189 (6.1%) cases of jumping from heights, 22 (5.2%) cases of hanging, 6 (1.4%) cases of
190 poisoning by gas, and 3 (0.7%) cases of drowning. There was no self-harm by firearms
191 in this area. Locations where self-harm occurred were home (80.9%), road (12.2%),
192 building (5.4%), school (1.0%), and health care facility (1.0%), respectively. The mean
193 time from call to EMS contact and to hospital arrival was 6.5 mins and 48.6 mins,
194 respectively. A total of 54 (12.7%) self-harm were transported to critical care medical
195 centers and 289 (68.0%) to non-critical care medical centers, whereas the number of
196 non-transported patients including cases with refusal of transport by themselves, only
197 prehospital treatments, or death confirmed at the scene was 82 (19.3%). Patients
198 transported to medical centers were treated at the following departments: 168 (39.5%)
199 in surgery, 162 (38.1%) in internal medicine, 8 (1.9%) in pediatrics, and 5 (1.2%) in
200 psychiatry.

201

202 **Outcomes**

203 Outcomes by type of self-harm are shown in Table 2. A total of 73 (17.2%) patients
204 (7.1% transportation rejection by patients and 10.1% only pre-hospital treatment) were

not transported to hospitals. About 50% of adolescents transported to hospitals were only treated at the emergency room but were not admitted to hospitals. Hospital admission was more frequent among boys than among girls (38.6% versus 25.2%, $P=0.016$). The proportion of death by self-harm was 4.9% and was higher for boys than for girls (14.8% versus 2.4%, $P<0.001$). As for type of self-harm, 41.9% of patients with poisoning by drugs were admitted to hospitals. Most of adolescents with cutting skin (70.9%) were not admitted to hospitals. A total of 15 (57.7%) adolescents who harmed themselves by jumping from heights were admitted to hospitals and five (19.2%) died. The proportion who died by hanging reached 59.1%. As for poisoning by gas, two patients were admitted to hospitals and two died (33.3%, respectively).

216 **Discussion**

217 Here, we conducted a population-based study on adolescents treated for self-harm by
218 EMS personnel by assessing ambulance records in Osaka City, Japan. The incidence of
219 emergency treatment for self-harm by adolescents increased with age and our findings
220 also demonstrated the gender paradox that whereas the incidence was higher among
221 girls than boys, particularly in the group aged ≥ 15 years, the proportions of deaths were
222 greater among boys. The overall proportion of deaths due to self-harm was
223 approximately 5%, with values differing by type of self-harm. Although a number of
224 studies have been conducted on the topic of adolescent self-harm, no other such
225 large-scale evaluations have been conducted using ambulance records in Japan. In
226 addition, to our knowledge, this is the first to assess EMS-related adolescent self-harm
227 and provides important epidemiological information which may help prevent incidents
228 of self-harm among adolescents in Asia.

229 Some reports showed that the incidence of self-harm varied between communities
230 and/or countries.⁸ In the present study, approximately 5% of total self-harm incidents
231 resulted in death, a value similar to that reported by the WHO in another study¹ Most
232 incidents of self-harm manifested as poisoning by drugs or cutting skin in our study, a
233 finding similar to that in a previous report from the United States.¹⁷ However, some
234 discrepancies were noted in our present findings and those in other similar studies; for
235 example, in the United States, the most frequent manner of death by self-harm is reported
236 to be by firearm,² a finding which would never be reported in Japan, where firearms are
237 strictly restricted. Self-harm—even that performed outside of a suicide attempt—is

238 well-known to be a major risk factor for future suicide attempts; as such, ardent efforts
239 should be made to reduce or prevent incidents of self-harm, irrespective of type.⁵⁻⁶

240 The youngest participants in the present study were aged 11 years, and incidence
241 increased with age among both genders, a result consistent with findings from preceding
242 studies in western countries.^{2,7} This shift in incidence with age may be due to a range of
243 factors, such as increasing chance to access to drugs and alcohols, increasing prevalence
244 of psychiatric disorders, and development of cognitive function.^{9,18-21} In particular, the
245 prevalence of psychiatric disorders—the main cause of self-harm—,dramatically
246 increased during adolescence,¹⁸⁻¹⁹ and adolescent cognitive development let them
247 perceive to be negative or hopeless for the present and future and may result in
248 suicide.²⁰⁻²¹ Therefore, wide measures with consideration for situations surrounding
249 adolescents and their developmental stage are therefore needed to prevent suicides.

250 Although no marked difference in incidence was noted between girls and boys aged
251 11-14 years, incidence was significantly higher among girls than boys aged ≥ 15 years,
252 possibly due to the high incidence of psychiatric disorders among girls compared with
253 boys.¹⁹ Puberty of girls is another plausible reason for high incidence of self-harm.²² For
254 example, puberty might cause lack of synchrony between age and cognitive development
255 and be at risk of self-harm. Although boys also go through puberty, female hormones
256 may lead to the increased prevalence of self-harm among girls.²³ However, while
257 incidence of self-harm was higher in girls than in boys, self-harm by boys more often
258 resulted in hospital admission or death. Although the cause of the increased severity of
259 incidents among boys is unclear, our findings here are consistent with those in the United

260 States.^{24,25} Given these present findings and reports of gender differences in effectiveness
261 of suicide prevention efforts,²⁶ gender-specific preventions and interventions should be
262 developed for adolescents who engage in self-harm even in Japan.

263 To our knowledge, no other studies have investigated rates of self-harm among
264 adolescents by temporal patterns. In the present study, we found that the rate of self-harm
265 was higher in spring months than in winter ones, a finding which concurred with results
266 in previous studies.²⁷⁻²⁸ With regard to time of day, incidents of self-harm were fewest
267 from 6-12h, a result consistent with those of a prior study conducted in adults.¹³ However,
268 while a previous study in adults found that numbers of self-harm incidents were highest
269 on Mondays, we found no significant differences by the day of week in this study. Given
270 these present and previous findings, temporal patterns of self-harm in adolescents seem
271 to be basically similar to those in adults, although our population was too small to draw a
272 definitive conclusion on a relationship.

273 Adolescent self-harm is the greatest risk factors for future suicide.¹⁶⁻¹⁷ A recent
274 meta-analysis showed that active interventions among adolescents following an instance
275 of self-harm helped prevent future self-harm and suicide.²⁹ Given the effectiveness of
276 active and gender-specific interventions in preceding studies,^{26,29} comprehensive
277 measures of self-harm prevention for adolescents, especially girls should be taken even
278 in Japan as with the suicide prevention³⁰ in cooperation with various organizations.

279 However, this study has several inherent limitations. First, the data used in this study
280 were based on ambulance records by EMS personnel, and we did not obtain information
281 on the purpose/motivation of self-harm such as suicidal intention, adolescents'

comorbidities or history of suicide or self-harm attempt, or outcomes after hospital admissions. At present, we are prospectively collecting data on emergency patients with these data in Osaka Prefecture since 2015 and will address these concerns in future. Second, our study included only emergency patients treated by EMS personnel, and we therefore have no information on walk-ins with self-harm or patients who did not request emergency services, although a previous study demonstrated that the number of patients with self-harm who did not request emergency services is about eight times as large as those who did.³¹. The last important limitation was that we could not detect repeating self-harm in an adolescent, thereby lifetime experience of self-harm might lead to being overestimated from our study.

292

293 CONCLUSION

The incidence of emergency adolescents with self-harm increased with age, and was higher among girls than boys in the group aged ≥ 15 years. However, the proportion of hospital admissions and death due to self-harm was greater among boys than among girls. It would be necessary to establish active, gender-specific, and comprehensive prevention strategies for adolescent self-harm, based on our findings showing the age-and gender-differences of self-harm among adolescents.

300

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303 Department and concerned physicians in Osaka City for their indispensable cooperation
304 and support.

306 **Contributions**

307 Conceived and designed the study: TM, T Kitamura, SH, MN, TI Analyzed the data:
308 TM, T Kitamura, KK, T Kawamura Wrote the paper: TM, T Kitamura, BO

310 **Funding**

311 None.

313 **Competing interests**

314 None.

316 **Ethics approval**

317 This study was approved by the Ethics Committee of Kyoto University Graduate School
318 of Medicine and the Ethics Committee of Kyoto Prefectural University of Medicine.
319 Since the personal identifiers were already removed from the database by the EMS
320 personnel, the requirement of informed consent of patients was waived by the Personal
321 Information Protection Law and the national research ethics guidelines of Japan.

322

323 **Provenance and peer review**

324 Not commissioned; externally peer reviewed.

325

326 **Data sharing statement**

327 TM and TK had full access to all of the data in the study and takes responsibility for the
328 integrity of the data and the accuracy of the data analysis.

329

330 **Open Access**

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For peer review only

426 **Figure legends**

427 **Figure 1:** Incidence per 100,000 persons of emergency adolescents with self-harm by
428 age and gender

429 **Figure 2:** Number of emergency self-harm cases among adolescents by temporal
430 patterns such as (A) hour, (B) week, and (C) season

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Table 1. Characteristics of emergency self-harm among adolescents in Osaka City.

	Total		Poisoning by drugs		Poisoning by Gas		Cutting skin		Jumping from heights		Hanging		Drowning		P Values
	(n=425)		(n=210)		(n=6)		(n=158)		(n=26)		(n=22)		(n=3)		†
Boy, n, (%)	88	(20.7)	40	(19.0)	5	(83.3)	20	(12.7)	9	(34.6)	13	(59.0)	1	(33.3)	<0.001
Girl, n, (%)	337	(79.3)	170	(81.0)	1	(16.7)	138	(87.3)	17	(65.4)	9	(41.0)	2	(66.7)	
Age, year, n, (%)															<0.001
11	2	(0.5)	1	(0.5)	0	(0.0)	0	(0.0)	1	(3.8)	0	(0.0)	0	(0.0)	
12	6	(1.5)	1	(0.5)	0	(0.0)	2	(1.3)	1	(3.8)	2	(9.1)	0	(0.0)	
13	6	(1.5)	5	(2.4)	0	(0.0)	0	(0.0)	0	(0.0)	1	(4.5)	0	(0.0)	
14	16	(4.2)	7	(3.3)	0	(0.0)	2	(1.3)	7	(26.9)	1	(4.5)	0	(0.0)	
15	20	(5.2)	12	(5.7)	1	(16.7)	7	(4.4)	1	(3.8)	2	(9.1)	0	(0.0)	
16	49	(12.9)	32	(15.2)	0	(0.0)	21	(13.3)	1	(3.8)	0	(0.0)	1	(33.3)	
17	65	(17.1)	37	(17.6)	1	(16.7)	24	(15.2)	7	(26.9)	2	(9.1)	2	(66.7)	
18	94	(24.7)	57	(27.1)	0	(0.0)	43	(27.2)	4	(15.4)	6	(27.3)	0	(0.0)	
19	117	(30.7)	58	(27.6)	4	(66.7)	59	(37.3)	4	(15.4)	8	(36.4)	0	(0.0)	
Place, n, (%)															<0.001
Home	344	(80.9)	183	(87.1)	4	(66.7)	124	(78.5)	11	(42.3)	22	(100.0)	0	(0.0)	
Road	52	(12.2)	12	(5.7)	1	(16.7)	22	(13.9)	14	(53.8)	0	(0.0)	3	(100)	
Building	23	(5.4)	10	(4.8)	1	(16.7)	12	(7.6)	0	(0.0)	0	(0.0)	0	(0.0)	
School	3	(1.0)	2	(1.0)	0	(0.0)	0	(0.0)	1	(3.8)	0	(0.0)	0	(0.0)	

Health care facility	3 (1.0)	3 (1.4)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Call to contact with a patient by EMS, min, mean (SD)	6.5 (5.0)	6.4 (3.1)	7.3 (4.0)	6.1 (3.1)	6.5 (3.0)	7.0 (2.2)	33.7 (42.0)	<0.001
Call to hospital arrival, min, mean (SD)*	48.6 (25.6)	55.7 (27.6)	43.0 (17.0)	43.0 (20.6)	43.2 (23.3)	41.8 (30.8)	99.0 (0.0)	<0.001
Type of hospitals, n (%)								<0.001
No transportation	82 (19.3)	30 (14.3)	3 (50.0)	38 (24.1)	0 (0.0)	9 (40.9)	2 (66.7)	
Non critical care medical center	289 (68.0)	154 (73.3)	1 (16.7)	117 (74.1)	9 (34.6)	7 (31.8)	1 (33.3)	
Critical care medical center	54 (12.7)	26 (12.4)	2 (33.3)	3 (1.9)	17 (65.4)	6 (27.3)	0 (0.0)	
Type of transported department, n (%)*								<0.001
Surgery	168 (39.5)	24 (11.4)	1 (16.7)	108 (68.4)	26 (100.0)	9 (40.9)	0 (0.0)	
Internal medicine	162 (38.1)	145 (69.0)	2 (33.3)	11 (7.0)	0 (0.0)	3 (13.6)	1 (33.3)	
Pediatrics	8 (1.9)	8 (3.8)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Psychiatry	5 (1.2)	3 (1.4)	0 (0.0)	1 (0.6)	0 (0.0)	1 (4.5)	0 (0.0)	

EMS, Emergency Medical Services; SD, standard deviation.

*Calculated only for self-harms transported to institutions.

†Comparison between the 6 groups were evaluated with Fisher exact test.

Table 2. Outcomes of emergency self-harm among adolescents in Osaka City.

	Total		Gender		P	Poisoning by		Poisoning by		Cutting skin		Jumping		Hanging		Drowning		P
			Boy	Girl		drugs		Gas				from heights						
	(n=425)		(n=88)	(n=337)	values	(n=210)		(n=6)		(n=158)		(n=26)		(n=22)		(n=3)		Values*
Refusal of transport by patients, n, (%)	30 (7.1)		7 (8.0)	23 (6.8)	0.647	24 (11.4)		0 (0.0)		4 (2.5)		0 (0.0)		2 (9.0)		0 (0.0)		0.017
Only prehospital treatments, n, (%)	43 (10.1)		4 (4.5)	39 (11.6)	0.072	6 (2.9)		1 (16.7)		34 (21.5)		0 (0.0)		0 (0.0)		2 (66.7)		<0.001
No hospital admission after transportation, n, (%)	212 (49.9)		30 (34.1)	182 (54.0)	0.001	92 (43.8)		1 (16.7)		112 (70.9)		6 (23.1)		1 (4.5)		0 (0.0)		<0.001
Hospital admission, n, (%)	119 (28.0)		34 (38.6)	85 (25.2)	0.016	88 (41.9)		2 (33.3)		8 (5.0)		15 (57.7)		6 (27.3)		0 (0.0)		<0.001
Death, n, (%)	21 (4.9)		13 (14.8)	8 (2.4)	<0.001	0 (0.0)		2 (33.3)		0 (0.0)		5 (19.2)		13 (59.1)		1 (33.3)		<0.001
Death confirmed at the scene	9 (2.1)		7 (8.0)	2 (0.6)		0 (0.0)		2 (33.3)		0 (0.0)		0 (0.0)		7 (31.8)		0 (0.0)		
Death confirmed at the hospital admission	12 (2.8)		6 (6.8)	6 (1.8)		0 (0.0)		0 (0.0)		0 (0.0)		5 (19.2)		6 (27.3)		1 (33.3)		

*Comparison between the 6 groups (type of self-harm) were evaluated with Fisher exact test.

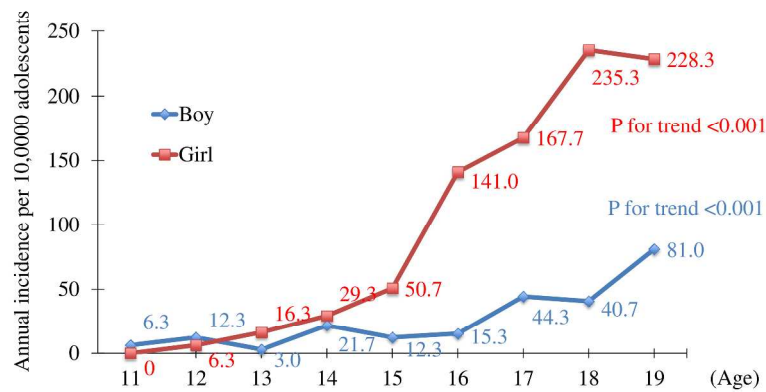
Figure 1

Figure 1
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Figure 2A

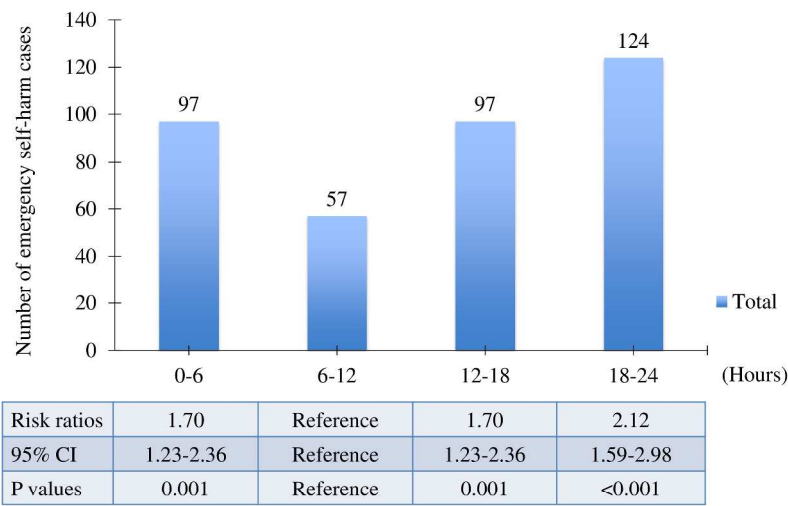


Figure 2A
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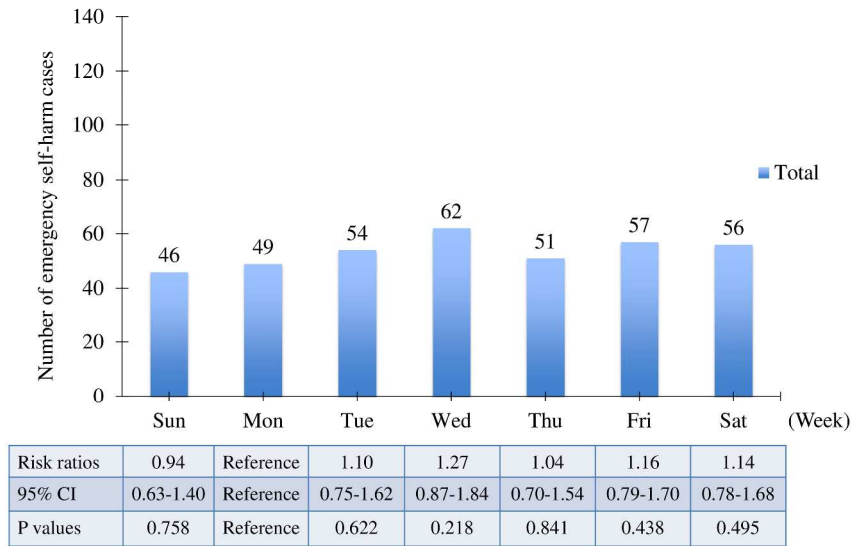


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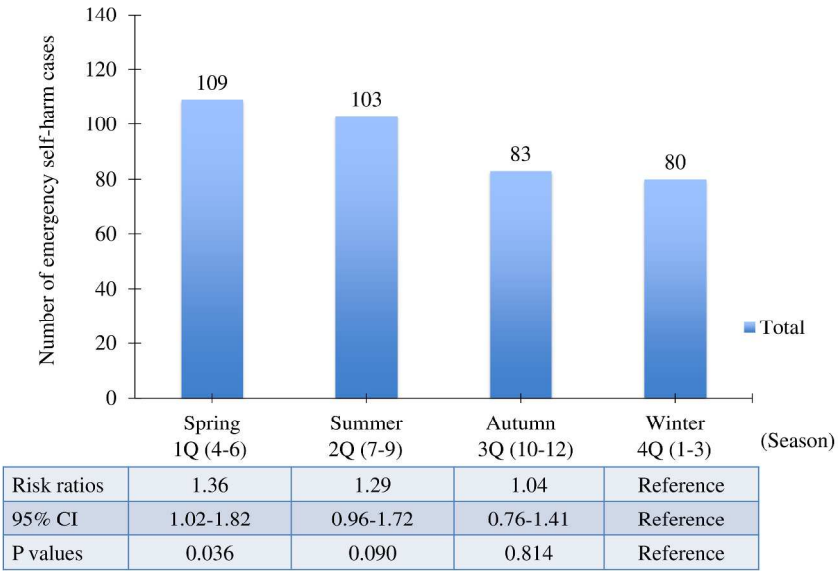


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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract	3
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	3-4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	6
Objectives	3	State specific objectives, including any prespecified hypotheses	6-7
Methods			
Study design	4	Present key elements of study design early in the paper	7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	7-8
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	7-8
		(b) For matched studies, give matching criteria and number of exposed and unexposed	NA
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	9
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	NA
Bias	9	Describe any efforts to address potential sources of bias	NA
Study size	10	Explain how the study size was arrived at	8
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8-9
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	9
		(b) Describe any methods used to examine subgroups and interactions	NA
		(c) Explain how missing data were addressed	8
		(d) If applicable, explain how loss to follow-up was addressed	NA
		(e) Describe any sensitivity analyses	NA
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed	10

		eligible, included in the study, completing follow-up, and analysed	
		(b) Give reasons for non-participation at each stage	10
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	10-11, (Table 1)
		(b) Indicate number of participants with missing data for each variable of interest	NA
		(c) Summarise follow-up time (eg, average and total amount)	NA
Outcome data	15*	Report numbers of outcome events or summary measures over time	11-12, (Table 2)
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10-12 (Figure 1, Table 2)
		(b) Report category boundaries when continuous variables were categorized	Figure 2
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	13
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13-15
Generalisability	21	Discuss the generalisability (external validity) of the study results	15
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	NA

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

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**Incidence and Outcomes of Emergency self-harm among Adolescents:
A Descriptive Epidemiological Study in Osaka City, Japan**

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Abstract

Objectives: To evaluate the incidence and outcomes of self-harm from ambulance records.

Design: A retrospective, observational study.

Setting: Osaka city

Participants: 365 adolescents aged 10-19 with emergency self-harm treated by emergency-medical-service personnel such as poisoning by drugs or gas, cutting skin, jumping from heights, hanging, and drowning from January 2010 through December 2012.

Primary outcome measurements: Incidence per 100,000 persons and outcome at the scene or hospital arrival by age and gender. Poisson regression models for incidence evaluation were used; reporting relative risks (RRs) and their 95% confidence intervals (CIs).

Results: During the study period, a total of 425 self-harm events were documented in 365 adolescents. The incidence of self-harm increased significantly between the ages of 11 and 19, from 6.3 to 81.0 among boys and the ages of 12 and 19 from 6.3 to 228.3 among girls, respectively (both $P < 0.001$). Although there was no incidence difference between girls and boys in the group aged 11-14 years (RR, 1.20; 95% CI, 0.59-2.47), the incidence was significantly higher among girls than boys in the group aged 15-19 years (RR, 4.18; 95% CI, 3.20-5.45). The overall proportion of death by self-harm was 4.9%. The proportion of hospital admission and death by self-harm was higher among

48 boys than among girls (38.6% versus 25.2%, $P=0.016$ and 14.8% versus 2.4%,
49 $P<0.001$).

50 **Conclusions:** Based on ambulance records in Osaka, the incidence of emergency
51 self-harm among adolescents increased with age, and was higher among girls than boys
52 in the group aged ≥ 15 years. However, the proportion of hospital admission and death
53 due to self-harm was greater among boys than girls.

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55 **Strengths and limitations of this study**

- 56 ■ To our knowledge, this is the first to assess EMS-related adolescent self-harm and
57 provides important epidemiological information which may help prevent incidents
58 of self-harm among adolescents in Asia
- 59 ■ No other such large-scale evaluations have been conducted using ambulance
60 records in Asia.
- 61 ■ This study included only emergency patients treated by emergency-medical-service
62 personnel, and we therefore have no information on walk-ins with self-harm or
63 patients who did not request emergency services
- 64 ■ We did not obtain information on the purpose/motivation of self-harm such as
65 suicidal intention.

66 Introduction

67 World Health Organization (WHO) reported that upwards of 800,000 people commit
68 suicide all over the world, with one death by suicide every 40 seconds.¹ While annual
69 suicide incidence decreased from 12.5 to 10.4 per 100,000 persons in the 1990s,
70 incidence has been rising again since the 2000.² Suicide is one of the major causes of
71 death in a number of populations, particularly adolescents, and the third-leading cause of
72 death among those aged 10-14 years and the leading cause of death among those aged
73 15-19 years in Japan,³ as well as the second-leading cause of death among those aged
74 15-24 years in the United States.⁴

75 Self-harm is the strongest risk factor for future suicide.⁵⁻⁶ A number of studies have
76 been conducted on the topic of pediatric self-harm. While incidence of self-harm has
77 been shown to be higher among adolescents than adults,^{2,7} rates of lifetime experience of
78 self-harm vary by community, producing conflict findings.⁸ For example, where some
79 studies found that adolescent females were more likely to have had a self-harm
80 experience than males among adolescents, others noted no significant gender disparities
81 among adolescents.⁹⁻¹¹ Of note, most reports on adolescent self-harm have collected data
82 using interviews of theoretical sampling or from single-center medical records, but
83 relatively few population-based studies have evaluated incidence of emergency
84 self-harm and their outcomes treated by emergency medical service (EMS) personnel.

85 Osaka City is the largest metropolitan community in western Japan, and ambulances
86 are dispatched over 200,000 times every year. Using the ambulance records in Osaka
87 City, we conducted a population-based epidemiological study to provide fundamental

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88 information for the prevention of adolescent self-harm.
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90 **Methods**

91 **Study design, population, and settings**

92 Our descriptive study retrospectively observed the ambulance records of Osaka
93 Municipal Fire Department from January 2010 through December 2012. All adolescents
94 (aged 10-19 years) treated by EMS personnel for self-harm in Osaka City were included.
95 If two or more incidents of self-harm were confirmed from one adolescent (e.g., both
96 cutting skin and poisoning were confirmed simultaneously from one adolescent), each
97 event was treated as an independent case. In this study, self-harm was classified by the
98 EMS/physicians as the following: poisoning by drugs, poisoning by gas, cutting skin,
99 jumping from heights, hanging, and drowning according to previous studies.¹²⁻¹³ For
100 patients transported to a hospital, the diagnosis of self-harm was clinically confirmed by
101 the physicians caring for the patient after hospital arrival in collaboration with EMS
102 personnel. For patients not transported to any hospital, the diagnosis was made by EMS
103 personnel based on on-site observations and the EMS interview with the patient. This
104 study was approved by the Ethics Committee of Kyoto University Graduate School of
105 Medicine and the Ethics Committee of Kyoto Prefectural University of Medicine. Since
106 the personal identifiers were already removed from the database by the EMS personnel,
107 the requirement of informed consent of patients was waived by the Personal Information
108 Protection Law and the national research ethics guidelines of Japan.

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110 **EMS system and emergency hospitals in Osaka City**

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6 111 Osaka City has an area of 222 km², and a population is approximately 2.7 million in
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8 112 2010 (population density, about 12,000 persons/km²).¹⁴ The municipal EMS system of
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10 113 Osaka City is similar to that used in other areas of Osaka Prefecture, as previously
11
12 114 described.¹⁵ The system is operated by the Osaka Municipal Fire Department and is
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14 115 activated by dialing the emergency number “119” on a telephone.¹⁶ In 2010, Osaka City
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16 116 had 25 fire stations (60 ambulances in total) and one dispatch center. Usually, each
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18 117 ambulance typically operates with a crew of three emergency care providers including
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20 118 at least one emergency life-saving technician, a highly-trained in providing prehospital
21
22 119 emergency care. Osaka City had 186 hospitals (32,922 beds) in 2012, 94 of
23
24 120 which—including six critical care centers—were equipped to treat patients with
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26 121 life-threatening emergencies.¹⁶ All patients who requested emergency services were
27
28 122 transported to one of these 186 hospitals. During the study period, emergency
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30 123 dispatchers in Osaka City EMS did not call a hospital for acceptance, leaving
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32 124 ambulances crews to select an appropriate hospital for emergency care.¹⁶
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126 **Data collection and quality control**

127 The following data were uniformly collected via regular forms including age, gender,
128 location of call, type of self-harm, temporal patterns, and the time-course of
129 transportation, destination hospital/department type, and patient outcomes. The forms
130 were completed by EMS personnel in cooperation with the physicians caring for the
131 patient, transferred to the EMS Information Center of Osaka Municipal Fire Department,

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6 132 and then checked by the investigators. If any data were missing, the investigators
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8 133 returned the form to the relevant EMS personnel for data completion.
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11 12 13 135 **Incidence and Outcomes**

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15 136 The study was to evaluate the incidence per 100,000 adolescents and their clinical
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17 137 outcomes of emergency self-harm at the scene or on hospital arrival. Outcomes were
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19 138 classified as follows: refusal of transport by patients, only prehospital treatments at the
20
21 139 scene, no hospital admission after transportation, hospital admission, or death (death
22
23 140 confirmed at the scene or death confirmed at the hospital arrival).
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28 29 30 142 **Statistical analysis**

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32 143 Incidence and outcomes of self-harm were compared by the background characteristics
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34 144 and temporal patterns using either chi-square test or Fisher's exact test, outcomes were
35
36 145 additionally compared by gender. Incidence of self-harm per 100,000 adolescents by
37
38 146 age and gender was calculated with the 2010 Osaka census data.¹⁴ Poisson regression
39
40 147 models were applied for incidence trends by age and gender with risk ratios (RRs) and
41
42 148 their 95% confidence intervals (CIs) were calculated. Time of day was divided into the
43
44 149 4 groups by 6-hour interval. As for season, the period from April to June was defined as
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47 150 spring: 1st quarter (1Q), July to September summer: 2nd quarter (2Q), October to
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49 151 December autumn: 3rd quarter (3Q), and January to March winter: 4th quarter (4Q),
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52 152 respectively. All statistical analyses were performed using SPSS statistical package
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153 version 22.0J (IBM Corp. Armonk, NY). All tests were two-tailed, and P-values of
154 <0.05 were considered statistically significant.
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156 Results

157 Population

158 During the study period, a total of 633,359 emergency patients including 18,516
159 adolescents were documented in Osaka City. Of 18,516, a total of 365 adolescents with
160 425 incidents of self-harm were identified. The youngest boy and girl were 11 and 12
161 years old, respectively. The incidence per 100,000 persons by age and gender was
162 shown in Figure 1. The incidence of self-harm increased significantly between the ages
163 of 11 and 19, from 6.3 to 81.0 among boys and the ages of 12 and 19 from 6.3 to 228.3
164 among girls, respectively (both $P < 0.001$). The incidence was highest in 19 years old.
165 Although no marked difference in incidence was noted between girls and boys in the
166 group aged 11-14 years (RR, 1.20; 95% CI, 0.59-2.47), the incidence was significantly
167 higher among girls than boys in the group aged 15-19 years (RR, 4.18; 95% CI,
168 3.20-5.45).

170 Temporal patterns

171 Temporal patterns were described in Figure 2. The number of cases by time of day was
172 the lowest at the period of 6-12h, and the number was doubled during the period of
173 18-24h (RR, 2.12; 95% CI, 1.59-2.98). The number was the same between the period of
174 0-6h and 12-18h (Figure 2A). Regarding influence of day of the week, the number did
175 not markedly differ by day (Figure 2B). As for seasons, the number was 1.36-times
176 (95% CI, 1.02-1.82) greater in spring: 1Q (Apr-Jun) than in winter: 4Q (Jan-Mar)
177 (Figure 2C).

178

179 **Characteristics**

180 Population characteristics by type of self-harm are shown in Table 1. A total of 88
181 (20.7%) incidents of self-harm were reported among boys, versus 337 (79.3%) among
182 girls, with an overall mean age of 17.3 years. Proportions of types of self-harm were as
183 follows: 210 (49.4%) cases of poisoning by drugs, 158 (37.2%) cases of cutting skin, 26
184 (6.1%) cases of jumping from heights, 22 (5.2%) cases of hanging, 6 (1.4%) cases of
185 poisoning by gas, and 3 (0.7%) cases of drowning. There was no self-harm by firearms
186 in this area. Locations where self-harm occurred were home (80.9%), road (12.2%),
187 building (5.4%), school (1.0%), and health care facility (1.0%), respectively. The mean
188 time from call to EMS contact and to hospital arrival was 6.5 mins and 48.6 mins,
189 respectively. A total of 54 (12.7%) self-harm were transported to critical care medical
190 centers and 289 (68.0%) to non-critical care medical centers, whereas the number of
191 non-transported patients including cases with refusal of transport by themselves, only
192 prehospital treatments, or death confirmed at the scene was 82 (19.3%). Patients
193 transported to medical centers were treated at the following departments: 168 (39.5%)
194 in surgery, 162 (38.1%) in internal medicine, 8 (1.9%) in pediatrics, and 5 (1.2%) in
195 psychiatry.

196

197 **Outcomes**

198 Outcomes by type of self-harm are shown in Table 2. A total of 73 (17.2%) patients
199 (7.1% transportation rejection by patients and 10.1% only pre-hospital treatment) were

not transported to hospitals. About 50% of adolescents transported to hospitals were only treated at the emergency room but were not admitted to hospitals. Hospital admission was more frequent among boys than among girls (38.6% versus 25.2%, $P=0.016$). The proportion of death by self-harm was 4.9% and was higher for boys than for girls (14.8% versus 2.4%, $P<0.001$). As for type of self-harm, 41.9% of patients with poisoning by drugs were admitted to hospitals. Most of adolescents with cutting skin (70.9%) were not admitted to hospitals. A total of 15 (57.7%) adolescents who harmed themselves by jumping from heights were admitted to hospitals and five (19.2%) died. The proportion who died by hanging reached 59.1%. As for poisoning by gas, two patients were admitted to hospitals and two died (33.3%, respectively).

211 **Discussion**

212 Here, we conducted a population-based study on adolescents treated for self-harm by
213 EMS personnel by assessing ambulance records in Osaka City, Japan. The incidence of
214 emergency treatment for self-harm by adolescents increased with age and our findings
215 also demonstrated the gender paradox that whereas the incidence was higher among
216 girls than boys, particularly in the group aged ≥ 15 years, the proportions of deaths were
217 greater among boys. The overall proportion of deaths due to self-harm was
218 approximately 5%, with values differing by type of self-harm. Although a number of
219 studies have been conducted on the topic of adolescent self-harm, no other such
220 large-scale evaluations have been conducted using ambulance records in Japan. In
221 addition, to our knowledge, this is the first to assess EMS-related adolescent self-harm
222 and provides important epidemiological information which may help prevent incidents
223 of self-harm among adolescents in Asia.

224 Some reports showed that the incidence of self-harm varied between communities
225 and/or countries.⁸ In the present study, approximately 5% of total self-harm incidents
226 resulted in death, a value similar to that reported by the WHO in another study¹ Most
227 incidents of self-harm manifested as poisoning by drugs or cutting skin in our study, a
228 finding similar to that in a previous report from the United States.¹⁷ However, some
229 discrepancies were noted in our present findings and those in other similar studies; for
230 example, in the United States, the most frequent manner of death by self-harm is reported
231 to be by firearm,² and this is unlikely to be reported in Japan due to strict firearm
232 regulations. Self-harm—even that performed outside of a suicide attempt—is

233 well-known to be a major risk factor for future suicide attempts; as such, ardent efforts
234 should be made to reduce or prevent incidents of self-harm, irrespective of type.⁵⁻⁶

235 The youngest participants in the present study were aged 11 years, and incidence
236 increased with age among both genders, a result consistent with findings from preceding
237 studies in western countries.^{2,7} This shift in incidence with age may be due to a range of
238 factors, such as increasing prevalence of psychiatric disorders, and development of
239 cognitive function as well as lifestyle, life events and problems, and social
240 influences.^{9,18-21} For example, O'Connor and colleagues demonstrated that smoking,
241 drug use, bullying, physical abuse, sexual orientation worries, serious boy/girlfriend
242 problems, and self-harm by friends or family were associated with self-harm as life style,
243 life events and problems, and social influences.²¹ In addition, the prevalence of
244 psychiatric disorders—one of the important causes of self-harm—,dramatically
245 increased during adolescence.¹⁸⁻¹⁹ Therefore, wide measures with consideration for
246 situations surrounding adolescents and their developmental stage are needed to prevent
247 suicides.

248 Although no marked difference in incidence was noted between girls and boys aged
249 11-14 years, incidence was significantly higher among girls than boys aged ≥ 15 years,
250 possibly due to the high incidence of psychiatric disorders among girls compared with
251 boys.¹⁹ Puberty of girls is another plausible reason for high incidence of self-harm.²² For
252 example, puberty might cause lack of synchrony between age and cognitive development
253 and be at risk of self-harm. Although boys also go through puberty, female hormones
254 may lead to the increased prevalence of self-harm among girls.²³ However, while

255 incidence of self-harm was higher in girls than in boys, self-harm by boys more often
256 resulted in hospital admission or death. Although the cause of the increased severity of
257 incidents among boys is unclear, our findings here are consistent with those in the United
258 States.^{24,25} Given these present findings and reports of gender differences in effectiveness
259 of suicide prevention efforts,²⁶ gender-specific preventions and interventions should be
260 developed for adolescents who engage in self-harm even in Japan.

261 To our knowledge, no other studies have investigated rates of self-harm among
262 adolescents by temporal patterns. In the present study, we found that the rate of self-harm
263 was higher in spring months than in winter ones, a finding which concurred with results
264 in previous studies on adult self-harm.²⁷⁻²⁸ With regard to time of day, incidents of
265 self-harm were fewest from 6-12h, a result consistent with those of a prior study
266 conducted in adults.¹³ However, while a previous study in adults found that numbers of
267 self-harm incidents were highest on Mondays, we found no significant differences by the
268 day of week in this study. Given these present and previous findings, temporal patterns
269 of self-harm in adolescents seem to be basically similar to those in adults, and our
270 findings could yield fundamental information on improving prevention strategies such as
271 more careful monitoring of children with identified potential risk factors²¹ by parents or
272 school staff based on these temporal patterns in order to reduce the incidence of
273 adolescent self-harm.

274 Adolescent self-harm is the greatest risk factors for future suicide.¹⁶⁻¹⁷ A recent
275 meta-analysis showed that active interventions among adolescents following an instance
276 of self-harm helped prevent future self-harm and suicide.²⁹ Given the effectiveness of

active and gender-specific interventions in preceding studies,^{26,29} comprehensive measures of self-harm prevention for adolescents, especially girls should be taken even in Japan as with the suicide prevention³⁰ in cooperation with various organizations.

However, this study has several inherent limitations. First, the data used in this study were based on ambulance records by EMS personnel, and we did not obtain information on the purpose/motivation of self-harm such as suicidal intention, adolescents' comorbidities or history of suicide or self-harm attempt, or outcomes after hospital admissions. At present, we are prospectively collecting data on emergency patients with these data in Osaka Prefecture since 2015 and will address these concerns in future. Second, our study included only emergency patients treated by EMS personnel, and we therefore have no information on walk-ins with self-harm or patients who did not request emergency services, although a previous study demonstrated that the number of patients with self-harm who did not request emergency services is about eight times as large as those who did.³¹ The last important limitation was that we could not detect repeating self-harm in an adolescent, thereby lifetime experience of self-harm might lead to being overestimated from our study.

CONCLUSION

The incidence of emergency adolescents with self-harm increased with age, and was higher among girls than boys in the group aged ≥ 15 years. However, the proportion of hospital admissions and death due to self-harm was greater among boys than among girls. It would be necessary to establish active, gender-specific, and comprehensive

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299 prevention strategies for adolescent self-harm, based on our findings showing the
300 age-and gender-differences of self-harm among adolescents.
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304 Department and concerned physicians in Osaka City for their indispensable cooperation
305 and support.

306

307 **Contributions**

308 Conceived and designed the study: TM, T Kitamura, SH, MN, TI Analyzed the data:
309 TM, T Kitamura, KK, T Kawamura Wrote the paper: TM, T Kitamura, BO

310

311 **Funding**

312 None.

313

314 **Competing interests**

315 None.

316

317 **Ethics approval**

318 This study was approved by the Ethics Committee of Kyoto University Graduate School
319 of Medicine and the Ethics Committee of Kyoto Prefectural University of Medicine.
320 Since the personal identifiers were already removed from the database by the EMS
321 personnel, the requirement of informed consent of patients was waived by the Personal
322 Information Protection Law and the national research ethics guidelines of Japan.

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324 **Provenance and peer review**

325 Not commissioned; externally peer reviewed.

326

327 **Data sharing statement**

328 TM and TK had full access to all of the data in the study and takes responsibility for the
329 integrity of the data and the accuracy of the data analysis.

330

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426 **Figure legends**

427 **Figure 1:** Incidence per 100,000 persons of emergency adolescents with self-harm by
428 age and gender

429 **Figure 2:** Number of emergency self-harm cases among adolescents by temporal
430 patterns such as (A) hour, (B) week, and (C) season

Table 1. Characteristics of emergency self-harm among adolescents in Osaka City.

	Total	Poisoning by drugs	Poisoning by Gas	Cutting skin	Jumping from heights	Hanging	Drowning	P Values †
	(n=425)	(n=210)	(n=6)	(n=158)	(n=26)	(n=22)	(n=3)	
Boy, n, (%)	88 (20.7)	40 (19.0)	5 (83.3)	20 (12.7)	9 (34.6)	13 (59.0)	1 (33.3)	<0.001
Girl, n, (%)	337 (79.3)	170 (81.0)	1 (16.7)	138 (87.3)	17 (65.4)	9 (41.0)	2 (66.7)	
Age, year, n, (%)								<0.001
11	2 (0.5)	1 (0.5)	0 (0.0)	0 (0.0)	1 (3.8)	0 (0.0)	0 (0.0)	
12	6 (1.5)	1 (0.5)	0 (0.0)	2 (1.3)	1 (3.8)	2 (9.1)	0 (0.0)	
13	6 (1.5)	5 (2.4)	0 (0.0)	0 (0.0)	0 (0.0)	1 (4.5)	0 (0.0)	
14	16 (4.2)	7 (3.3)	0 (0.0)	2 (1.3)	7 (26.9)	1 (4.5)	0 (0.0)	
15	20 (5.2)	12 (5.7)	1 (16.7)	7 (4.4)	1 (3.8)	2 (9.1)	0 (0.0)	
16	49 (12.9)	32 (15.2)	0 (0.0)	21 (13.3)	1 (3.8)	0 (0.0)	1 (33.3)	
17	65 (17.1)	37 (17.6)	1 (16.7)	24 (15.2)	7 (26.9)	2 (9.1)	2 (66.7)	
18	94 (24.7)	57 (27.1)	0 (0.0)	43 (27.2)	4 (15.4)	6 (27.3)	0 (0.0)	
19	117 (30.7)	58 (27.6)	4 (66.7)	59 (37.3)	4 (15.4)	8 (36.4)	0 (0.0)	
Place, n, (%)								<0.001
Home	344 (80.9)	183 (87.1)	4 (66.7)	124 (78.5)	11 (42.3)	22 (100.0)	0 (0.0)	
Road	52 (12.2)	12 (5.7)	1 (16.7)	22 (13.9)	14 (53.8)	0 (0.0)	3 (100)	
Building	23 (5.4)	10 (4.8)	1 (16.7)	12 (7.6)	0 (0.0)	0 (0.0)	0 (0.0)	
School	3 (1.0)	2 (1.0)	0 (0.0)	0 (0.0)	1 (3.8)	0 (0.0)	0 (0.0)	
Health care facility	3 (1.0)	3 (1.4)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Call to contact with a patient by EMS, min, mean (SD)	6.5 (5.0)	6.4 (3.1)	7.3 (4.0)	6.1 (3.1)	6.5 (3.0)	7.0 (2.2)	33.7 (42.0)	<0.001

Call to hospital arrival, min, mean (SD)*	48.6	(25.6)	55.7	(27.6)	43.0	(17.0)	43.0	(20.6)	43.2	(23.3)	41.8	(30.8)	99.0	(0.0)	<0.001
Type of hospitals, n (%)	<0.001														
No transportation	82	(19.3)	30	(14.3)	3	(50.0)	38	(24.1)	0	(0.0)	9	(40.9)	2	(66.7)	
Non critical care medical center	289	(68.0)	154	(73.3)	1	(16.7)	117	(74.1)	9	(34.6)	7	(31.8)	1	(33.3)	
Critical care medical center	54	(12.7)	26	(12.4)	2	(33.3)	3	(1.9)	17	(65.4)	6	(27.3)	0	(0.0)	
Type of transported department, n (%)*	<0.001														
Surgery	168	(39.5)	24	(11.4)	1	(16.7)	108	(68.4)	26	(100.0)	9	(40.9)	0	(0.0)	
Internal medicine	162	(38.1)	145	(69.0)	2	(33.3)	11	(7.0)	0	(0.0)	3	(13.6)	1	(33.3)	
Pediatrics	8	(1.9)	8	(3.8)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	
Psychiatry	5	(1.2)	3	(1.4)	0	(0.0)	1	(0.6)	0	(0.0)	1	(4.5)	0	(0.0)	

EMS, Emergency Medical Services; SD, standard deviation.

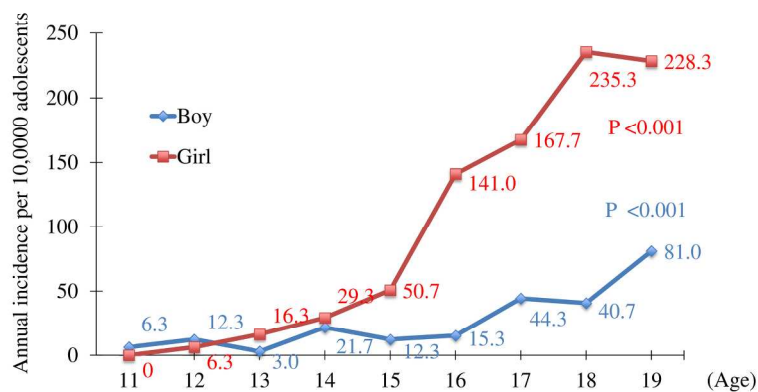
*Calculated only for self-harms transported to institutions.

†Comparisons between the 6 groups were evaluated with Fisher exact test.

Table 2. Outcomes of emergency self-harm among adolescents in Osaka City.

	Total		Gender				Poisoning by		Poisoning by		Cutting skin		Jumping from		Hanging		Drowning		P Values*	
			Boy		Girl		drugs		Gas				heights							
	(n=425)		(n=88)		(n=337)	P values	(n=210)		(n=6)		(n=158)		(n=26)		(n=22)		(n=3)			
Refusal of transport by patients, n, (%)	30	(7.1)	7	(8.0)	23	(6.8)	0.647	24	(11.4)	0	(0.0)	4	(2.5)	0	(0.0)	2	(9.0)	0	(0.0)	0.017
Only prehospital treatments, n, (%)	43	(10.1)	4	(4.5)	39	(11.6)	0.072	6	(2.9)	1	(16.7)	34	(21.5)	0	(0.0)	0	(0.0)	2	(66.7)	<0.001
No hospital admission after transportation, n, (%)	212	(49.9)	30	(34.1)	182	(54.0)	0.001	92	(43.8)	1	(16.7)	112	(70.9)	6	(23.1)	1	(4.5)	0	(0.0)	<0.001
Hospital admission, n, (%)	119	(28.0)	34	(38.6)	85	(25.2)	0.016	88	(41.9)	2	(33.3)	8	(5.0)	15	(57.7)	6	(27.3)	0	(0.0)	<0.001
Death, n, (%)	21	(4.9)	13	(14.8)	8	(2.4)	<0.001	0	(0.0)	2	(33.3)	0	(0.0)	5	(19.2)	13	(59.1)	1	(33.3)	<0.001
Death confirmed at the scene	9	(2.1)	7	(8.0)	2	(0.6)		0	(0.0)	2	(33.3)	0	(0.0)	0	(0.0)	7	(31.8)	0	(0.0)	
Death confirmed at the hospital admission	12	(2.8)	6	(6.8)	6	(1.8)		0	(0.0)	0	(0.0)	0	(0.0)	5	(19.2)	6	(27.3)	1	(33.3)	

*Comparisons between the 6 groups (type of self-harm) were evaluated with Fisher exact test.

Figure 1

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Figure 2A

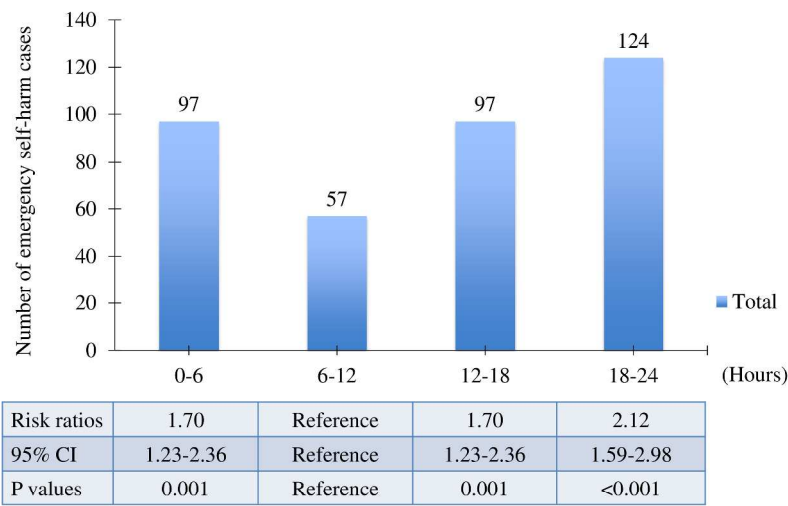


Figure 2A
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Figure 2B

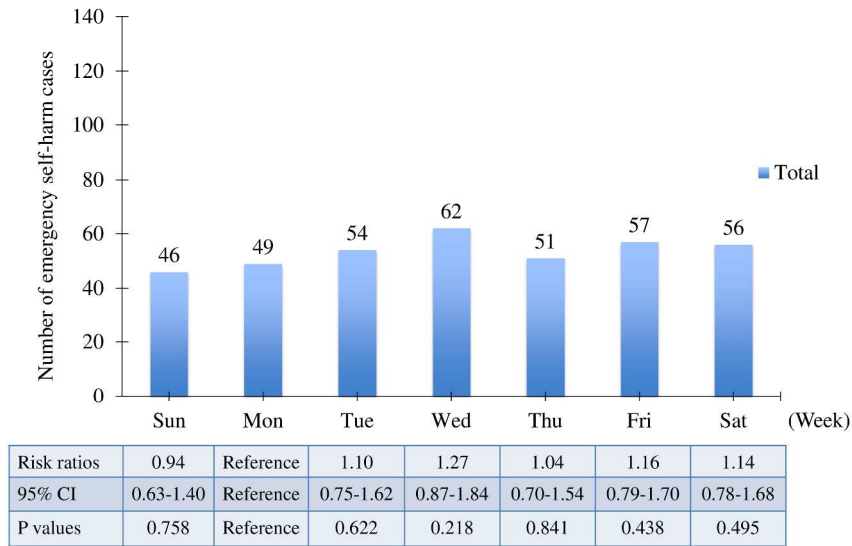


Figure 2B
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Figure 2C

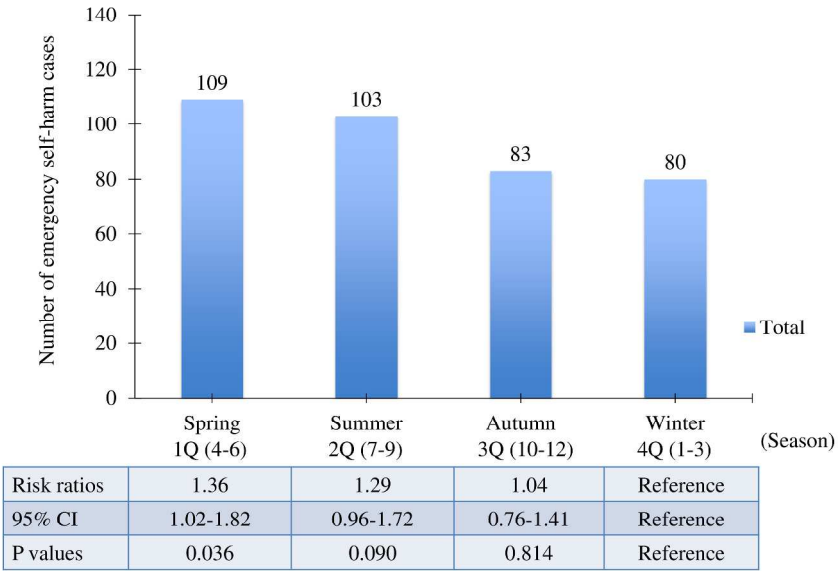


Figure 2C
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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract	3
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	3-4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	6
Objectives	3	State specific objectives, including any prespecified hypotheses	6-7
Methods			
Study design	4	Present key elements of study design early in the paper	7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	7-8
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	7-8
		(b) For matched studies, give matching criteria and number of exposed and unexposed	NA
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	9
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	NA
Bias	9	Describe any efforts to address potential sources of bias	NA
Study size	10	Explain how the study size was arrived at	8
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8-9
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	9
		(b) Describe any methods used to examine subgroups and interactions	NA
		(c) Explain how missing data were addressed	8
		(d) If applicable, explain how loss to follow-up was addressed	NA
		(e) Describe any sensitivity analyses	NA
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed	10

		eligible, included in the study, completing follow-up, and analysed	
		(b) Give reasons for non-participation at each stage	10
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	10-11, (Table 1)
		(b) Indicate number of participants with missing data for each variable of interest	NA
		(c) Summarise follow-up time (eg, average and total amount)	NA
Outcome data	15*	Report numbers of outcome events or summary measures over time	11-12, (Table 2)
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10-12 (Figure 1, Table 2)
		(b) Report category boundaries when continuous variables were categorized	Figure 2
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	13
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13-15
Generalisability	21	Discuss the generalisability (external validity) of the study results	15
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	NA

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Incidence and Outcomes of Emergency self-harm among Adolescents: A Descriptive Epidemiological Study in Osaka City, Japan

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**Incidence and Outcomes of Emergency self-harm among Adolescents:
A Descriptive Epidemiological Study in Osaka City, Japan**

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26

For peer review only

Abstract

Objectives: To evaluate the incidence and outcomes of self-harm from ambulance records.

Design: A retrospective, observational study.

Setting: Osaka city, Japan

Participants: 365 adolescents aged 10-19 with emergency self-harm treated by emergency-medical-service personnel such as poisoning by drugs or gas, cutting skin, jumping from heights, hanging, and drowning from January 2010 through December 2012.

Primary outcome measurements: Incidence per 100,000 persons and outcome at the scene or hospital arrival by age and gender. Poisson regression models for incidence evaluation were used; reporting relative risks (RRs) and their 95% confidence intervals (CIs).

Results: During the study period, a total of 425 self-harm events were documented in 365 adolescents. The incidence of self-harm increased significantly between the ages of 11 and 19, from 6.3 to 81.0 among boys and the ages of 12 and 19 from 6.3 to 228.3 among girls, respectively (both $P < 0.001$). Although there was no incidence difference between girls and boys in the group aged 11-14 years (RR, 1.20; 95% CI, 0.59-2.47), the incidence was significantly higher among girls than boys in the group aged 15-19 years (RR, 4.18; 95% CI, 3.20-5.45). The overall proportion of death by self-harm was 4.9%. The proportion of hospital admission and death by self-harm was higher among

48 boys than among girls (38.6% versus 25.2%, $P=0.016$ and 14.8% versus 2.4%,
49 $P<0.001$).

50 **Conclusions:** The incidence of emergency treatment for self-harm by adolescents
51 increased with age and our findings also demonstrated the gender paradox. It would be
52 necessary to establish active, gender-specific, and comprehensive prevention strategies
53 for adolescent self-harm, based on our findings showing the age-and gender-differences
54 of self-harm among adolescents.

55

56 **Strengths and limitations of this study**

- 57 ■ To our knowledge, this is the first study to assess EMS-related adolescent self-harm
58 and provides important epidemiological information which may help prevent
59 incidents of self-harm among adolescents in Asia
- 60 ■ No other such large-scale evaluations have been conducted using ambulance
61 records in Asia.
- 62 ■ This study included only emergency patients treated by emergency-medical-service
63 personnel, and we therefore have no information on walk-ins with self-harm or
64 patients who did not request emergency services
- 65 ■ We did not obtain information on the purpose/motivation of self-harm such as
66 suicidal intention.

67 Introduction

68 World Health Organization (WHO) reported that upwards of 800,000 people commit
69 suicide all over the world, with one death by suicide every 40 seconds.¹ While annual
70 suicide incidence decreased from 12.5 to 10.4 per 100,000 persons in the 1990s,
71 incidence has been rising again since the 2000.² Suicide is one of the major causes of
72 death in a number of populations, particularly adolescents, and the third-leading cause of
73 death among those aged 10-14 years and the leading cause of death among those aged
74 15-19 years in Japan,³ as well as the second-leading cause of death among those aged
75 15-24 years in the United States.⁴

76 Self-harm is the strongest risk factor for future suicide.⁵⁻⁶ A number of studies have
77 been conducted on the topic of pediatric self-harm. While incidence of self-harm has
78 been shown to be higher among adolescents than adults,^{2,7} rates of lifetime experience of
79 self-harm vary by community, producing conflict findings.⁸ For example, where some
80 studies found that adolescent females were more likely to have had a self-harm
81 experience than males among adolescents, others noted no significant gender disparities
82 among adolescents.⁹⁻¹¹ Of note, most reports on adolescent self-harm have collected data
83 using interviews of theoretical sampling or from single-center medical records, but
84 relatively few population-based studies have evaluated incidence of emergency
85 self-harm and their outcomes treated by emergency medical service (EMS) personnel.

86 Osaka City is the largest metropolitan community in western Japan, and ambulances
87 are dispatched over 200,000 times every year. Using the ambulance records in Osaka
88 City, we conducted a population-based epidemiological study to provide fundamental

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89 information for the prevention of adolescent self-harm.

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91 **Methods**

92 **Study design, population, and settings**

93 Our descriptive study retrospectively observed the ambulance records of Osaka
94 Municipal Fire Department from January 2010 through December 2012. All adolescents
95 (aged 10-19 years) treated by EMS personnel for self-harm in Osaka City were included.
96 If two or more incidents of self-harm were confirmed from one adolescent (e.g., both
97 cutting skin and poisoning were confirmed simultaneously from one adolescent), each
98 event was treated as an independent case. In this study, self-harm was classified by the
99 EMS/physicians as the following: poisoning by drugs, poisoning by gas, cutting skin,
100 jumping from heights, hanging, and drowning according to previous studies.¹²⁻¹³ For
101 patients transported to a hospital, the diagnosis of self-harm was clinically confirmed by
102 the physicians caring for the patient after hospital arrival in collaboration with EMS
103 personnel. For patients not transported to any hospital, the diagnosis was made by EMS
104 personnel based on on-site observations and the EMS interview with the patient. This
105 study was approved by the Ethics Committee of Kyoto University Graduate School of
106 Medicine and the Ethics Committee of Kyoto Prefectural University of Medicine. Since
107 the personal identifiers were already removed from the database by the EMS personnel,
108 the requirement of informed consent of patients was waived by the Personal Information
109 Protection Law and the national research ethics guidelines of Japan.

110

111 **EMS system and emergency hospitals in Osaka City**

Osaka City has an area of 222 km², and a population is approximately 2.7 million in 2010 (population density, about 12,000 persons/km²).¹⁴ The municipal EMS system of Osaka City is similar to that used in other areas of Osaka Prefecture, as previously described.¹⁵ The system is operated by the Osaka Municipal Fire Department and is activated by dialing the emergency number “119” on a telephone.¹⁶ In 2010, Osaka City had 25 fire stations (60 ambulances in total) and one dispatch center. Usually, each ambulance typically operates with a crew of three emergency care providers including at least one emergency life-saving technician, a highly-trained in providing prehospital emergency care. Osaka City had 186 hospitals (32,922 beds) in 2012, 94 of which—including six critical care centers—were equipped to treat patients with life-threatening emergencies.¹⁶ All patients who requested emergency services were transported to one of these 186 hospitals. During the study period, emergency dispatchers in Osaka City EMS did not call a hospital for acceptance, leaving ambulances crews to select an appropriate hospital for emergency care.¹⁶

126

127 **Data collection and quality control**

128 The following data were uniformly collected via regular forms including age, gender, 129 location of call, type of self-harm, temporal patterns, and the time-course of 130 transportation, destination hospital/department type, and patient outcomes. The forms 131 were completed by EMS personnel in cooperation with the physicians caring for the 132 patient, transferred to the EMS Information Center of Osaka Municipal Fire Department, 133 and then checked by the investigators. If any data were missing, the investigators

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6 134 returned the form to the relevant EMS personnel for data completion.
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10 11 136 **Incidence and Outcomes**

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13 137 The study was to evaluate the incidence per 100,000 adolescents and their clinical
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15 138 outcomes of emergency self-harm at the scene or on hospital arrival. Outcomes were
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17 139 classified as follows: refusal of transport by patients, only prehospital treatments at the
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19 140 scene, no hospital admission after transportation, hospital admission, or death (death
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21 141 confirmed at the scene or death confirmed at the hospital arrival).
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28 143 **Statistical analysis**

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30 144 Incidence and outcomes of self-harm were compared by the background characteristics
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32 145 and temporal patterns using either chi-square test or Fisher's exact test, outcomes were
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34 146 additionally compared by gender. Incidence of self-harm per 100,000 adolescents by
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36 147 age and gender was calculated with the 2010 Osaka census data.¹⁴ Poisson regression
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38 148 models were applied for incidence trends by age and gender with risk ratios (RRs) and
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40 149 their 95% confidence intervals (CIs) were calculated. Time of day was divided into the
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42 150 4 groups by 6-hour interval. As for season, the period from April to June was defined as
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44 151 spring: 1st quarter (1Q), July to September summer: 2nd quarter (2Q), October to
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46 152 December autumn: 3rd quarter (3Q), and January to March winter: 4th quarter (4Q),
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48 153 respectively. All statistical analyses were performed using SPSS statistical package
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50 154 version 22.0J (IBM Corp. Armonk, NY). All tests were two-tailed, and P-values of
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52 155 <0.05 were considered statistically significant.
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156 **Results**

157 **Population**

158 During the study period, a total of 633,359 emergency patients including 18,516
159 adolescents were documented in Osaka City. Of 18,516, a total of 365 adolescents with
160 425 incidents of self-harm were identified. The youngest boy and girl were 11 and 12
161 years old, respectively. The incidence per 100,000 persons by age and gender was
162 shown in Figure 1. The incidence of self-harm increased significantly between the ages
163 of 11 and 19, from 6.3 to 81.0 among boys and the ages of 12 and 19 from 6.3 to 228.3
164 among girls, respectively (both $P < 0.001$). The incidence was highest in 19 years old.
165 Although no marked difference in incidence was noted between girls and boys in the
166 group aged 11-14 years (RR, 1.20; 95% CI, 0.59-2.47), the incidence was significantly
167 higher among girls than boys in the group aged 15-19 years (RR, 4.18; 95% CI,
168 3.20-5.45).

170 **Temporal patterns**

171 Temporal patterns were described in Figure 2. The number of cases by time of day was
172 the lowest at the period of 6-12h, and the number was doubled during the period of
173 18-24h (RR, 2.12; 95% CI, 1.59-2.98). The number was the same between the period of
174 0-6h and 12-18h (Figure 2A). Regarding influence of day of the week, the number did
175 not markedly differ by day (Figure 2B). As for seasons, the number was 1.36-times
176 (95% CI, 1.02-1.82) greater in spring: 1Q (Apr-Jun) than in winter: 4Q (Jan-Mar)
177 (Figure 2C).

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179 Characteristics

180 Population characteristics by type of self-harm are shown in Table 1. A total of 88
181 (20.7%) incidents of self-harm were reported among boys, versus 337 (79.3%) among
182 girls, with an overall mean age of 17.3 years. Proportions of types of self-harm were as
183 follows: 210 (49.4%) cases of poisoning by drugs, 158 (37.2%) cases of cutting skin, 26
184 (6.1%) cases of jumping from heights, 22 (5.2%) cases of hanging, 6 (1.4%) cases of
185 poisoning by gas, and 3 (0.7%) cases of drowning. There was no self-harm by firearms
186 in this area. Locations where self-harm occurred were home (80.9%), road (12.2%),
187 building (5.4%), school (1.0%), and health care facility (1.0%), respectively. The mean
188 time from call to EMS contact and to hospital arrival was 6.5 mins and 48.6 mins,
189 respectively. A total of 54 (12.7%) self-harm were transported to critical care medical
190 centers and 289 (68.0%) to non-critical care medical centers, whereas the number of
191 non-transported patients including cases with refusal of transport by themselves, only
192 prehospital treatments, or death confirmed at the scene was 82 (19.3%). Patients
193 transported to medical centers were treated at the following departments: 168 (39.5%)
194 in surgery, 162 (38.1%) in internal medicine, 8 (1.9%) in pediatrics, and 5 (1.2%) in
195 psychiatry.

196

197 Outcomes

198 Outcomes by type of self-harm are shown in Table 2. A total of 73 (17.2%) patients
199 (7.1% transportation rejection by patients and 10.1% only pre-hospital treatment) were

not transported to hospitals. About 50% of adolescents transported to hospitals were only treated at the emergency room but were not admitted to hospitals. Hospital admission was more frequent among boys than among girls (38.6% versus 25.2%, $P=0.016$). The proportion of death by self-harm was 4.9% and was higher for boys than for girls (14.8% versus 2.4%, $P<0.001$). As for type of self-harm, 41.9% of patients with poisoning by drugs were admitted to hospitals. Most of adolescents with cutting skin (70.9%) were not admitted to hospitals. A total of 15 (57.7%) adolescents who harmed themselves by jumping from heights were admitted to hospitals and five (19.2%) died. The proportion who died by hanging reached 59.1%. As for poisoning by gas, two patients were admitted to hospitals and two died (33.3%, respectively).

211 Discussion

212 Here, we conducted a population-based study on adolescents treated for self-harm by
213 EMS personnel by assessing ambulance records in Osaka City, Japan. The incidence of
214 emergency treatment for self-harm by adolescents increased with age and our findings
215 also demonstrated the gender paradox that whereas the incidence was higher among
216 girls than boys, particularly in the group aged ≥ 15 years, the proportions of deaths were
217 greater among boys. The overall proportion of deaths due to self-harm was
218 approximately 5%, with values differing by type of self-harm. Although a number of
219 studies have been conducted on the topic of adolescent self-harm, no other such
220 large-scale evaluations have been conducted using ambulance records in Japan. In
221 addition, to our knowledge, this is the first study to assess EMS-related adolescent
222 self-harm and provides important epidemiological information which may help prevent
223 incidents of self-harm among adolescents in Asia.

224 Some reports showed that the incidence of self-harm varied between communities
225 and/or countries.⁸ In the present study, approximately 5% of total self-harm incidents
226 resulted in death, a value similar to that reported by the WHO in another study¹ Most
227 incidents of self-harm manifested as poisoning by drugs or cutting skin in our study, a
228 finding similar to that in a previous report from the United States.¹⁷ However, some
229 discrepancies were noted in our present findings and those in other similar studies; for
230 example, in the United States, the most frequent manner of death by self-harm is reported
231 to be by firearm,² and this is unlikely to be reported in Japan due to strict firearm
232 regulations. Self-harm—even that performed outside of a suicide attempt—is

233 well-known to be a major risk factor for future suicide attempts; as such, ardent efforts
234 should be made to reduce or prevent incidents of self-harm, irrespective of type.⁵⁻⁶
235 The youngest participants in the present study were aged 11 years, and incidence
236 increased with age among both genders, a result consistent with findings from preceding
237 studies in western countries.^{2,7} This shift in incidence with age may be due to a range of
238 factors, such as increasing prevalence of psychiatric disorders, and development of
239 cognitive function as well as lifestyle, life events and problems, and social
240 influences.^{9,18-21} For example, O'Connor and colleagues demonstrated that smoking,
241 drug use, bullying, physical abuse, sexual orientation worries, serious boy/girlfriend
242 problems, and self-harm by friends or family were associated with self-harm as life style,
243 life events and problems, and social influences.²¹ In addition, the prevalence of
244 psychiatric disorders—one of the important causes of self-harm—,dramatically
245 increased during adolescence.¹⁸⁻¹⁹ Therefore, wide measures with consideration for
246 situations surrounding adolescents and their developmental stage are needed to prevent
247 suicides.

248 Although no marked difference in incidence was noted between girls and boys aged
249 11-14 years, incidence was significantly higher among girls than boys aged ≥ 15 years,
250 possibly due to the high incidence of psychiatric disorders among girls compared with
251 boys.¹⁹ Puberty of girls is another plausible reason for high incidence of self-harm.²² For
252 example, puberty might cause lack of synchrony between age and cognitive development
253 and be at risk of self-harm. Although boys also go through puberty, female hormones
254 may lead to the increased prevalence of self-harm among girls.²³ However, while

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6 255 incidence of self-harm was higher in girls than in boys, self-harm by boys more often
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8 256 resulted in hospital admission or death. Although the cause of the increased severity of
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10 257 incidents among boys is unclear, our findings here are consistent with those in the United
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12 258 States.^{24,25} Given these present findings and reports of gender differences in effectiveness
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14 259 of suicide prevention efforts,²⁶ gender-specific preventions and interventions should be
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16 260 developed for adolescents who engage in self-harm even in Japan.
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20 261 To our knowledge, no other studies have investigated rates of self-harm among
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22 262 adolescents by temporal patterns. In the present study, we found that the rate of self-harm
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24 263 was higher in spring months than in winter ones, a finding which concurred with results
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26 264 in previous studies on adult self-harm.²⁷⁻²⁸ With regard to time of day, incidents of
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28 265 self-harm were fewest from 6-12h, a result consistent with those of a prior study
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30 266 conducted in adults.¹³ However, while a previous study in adults found that numbers of
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32 267 self-harm incidents were highest on Mondays, we found no significant differences by the
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34 268 day of week in this study. Given these present and previous findings, temporal patterns
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36 269 of self-harm in adolescents seem to be basically similar to those in adults, and our
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38 270 findings could yield fundamental information on improving prevention strategies such as
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40 271 more careful monitoring of children with identified potential risk factors²¹ by parents or
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42 272 school staff based on these temporal patterns in order to reduce the incidence of
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44 273 adolescent self-harm.
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51 274 Adolescent self-harm is the greatest risk factors for future suicide.¹⁶⁻¹⁷ A recent
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53 275 meta-analysis showed that active interventions among adolescents following an instance
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55 276 of self-harm helped prevent future self-harm and suicide.²⁹ Given the effectiveness of
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277 active and gender-specific interventions in preceding studies,^{26,29} comprehensive
278 measures of self-harm prevention for adolescents, especially girls should be taken even
279 in Japan as with the suicide prevention³⁰ in cooperation with various organizations.

280 However, this study has several inherent limitations. First, the data used in this study
281 were based on ambulance records by EMS personnel, and we did not obtain information
282 on the purpose/motivation of self-harm such as suicidal intention, adolescents'
283 comorbidities or history of suicide or self-harm attempt, or outcomes after hospital
284 admissions. At present, we are prospectively collecting data on emergency patients with
285 these data in Osaka Prefecture since 2015 and will address these concerns in future.
286 Second, our study included only emergency patients treated by EMS personnel, and we
287 therefore have no information on walk-ins with self-harm or patients who did not request
288 emergency services, although a previous study demonstrated that the number of patients
289 with self-harm who did not request emergency services is about eight times as large as
290 those who did.³¹ The last important limitation was that we could not detect repeating
291 self-harm in an adolescent, thereby lifetime experience of self-harm might lead to being
292 overestimated from our study.

293

294 **CONCLUSION**

295 The incidence of emergency adolescents with self-harm increased with age, and was
296 higher among girls than boys in the group aged ≥ 15 years. However, the proportion of
297 hospital admissions and death due to self-harm was greater among boys than among
298 girls. It would be necessary to establish active, gender-specific, and comprehensive

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6 299 prevention strategies for adolescent self-harm, based on our findings showing the
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8 300 age-and gender-differences of self-harm among adolescents.
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For peer review only

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304 Department and concerned physicians in Osaka City for their indispensable cooperation
305 and support.

307 **Contributions**

308 Conceived and designed the study: TM, T Kitamura, SH, MN, TI Analyzed the data:
309 TM, T Kitamura, KK, T Kawamura Wrote the paper: TM, T Kitamura, BO

311 **Funding**

312 None.

314 **Competing interests**

315 None.

317 **Ethics approval**

318 This study was approved by the Ethics Committee of Kyoto University Graduate School
319 of Medicine and the Ethics Committee of Kyoto Prefectural University of Medicine.
320 Since the personal identifiers were already removed from the database by the EMS
321 personnel, the requirement of informed consent of patients was waived by the Personal
322 Information Protection Law and the national research ethics guidelines of Japan.

323

324 **Provenance and peer review**

325 Not commissioned; externally peer reviewed.

326

327 **Data sharing statement**

328 TM and TK had full access to all of the data in the study and takes responsibility for the
329 integrity of the data and the accuracy of the data analysis.

330

331 **Open Access**

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426 **Figure legends**

427 **Figure 1:** Incidence per 100,000 persons of emergency adolescents with self-harm by
428 age and gender

429 **Figure 2:** Number of emergency self-harm cases among adolescents by temporal
430 patterns such as (A) hour, (B) week, and (C) season

Table 1. Characteristics of emergency self-harm among adolescents in Osaka City.

	Total	Poisoning by drugs	Poisoning by Gas	Cutting skin	Jumping from heights	Hanging	Drowning	P Values †
	(n=425)	(n=210)	(n=6)	(n=158)	(n=26)	(n=22)	(n=3)	
Boy, n, (%)	88 (20.7)	40 (19.0)	5 (83.3)	20 (12.7)	9 (34.6)	13 (59.0)	1 (33.3)	<0.001
Girl, n, (%)	337 (79.3)	170 (81.0)	1 (16.7)	138 (87.3)	17 (65.4)	9 (41.0)	2 (66.7)	
Age, year, n, (%)								<0.001
11	2 (0.5)	1 (0.5)	0 (0.0)	0 (0.0)	1 (3.8)	0 (0.0)	0 (0.0)	
12	6 (1.5)	1 (0.5)	0 (0.0)	2 (1.3)	1 (3.8)	2 (9.1)	0 (0.0)	
13	6 (1.5)	5 (2.4)	0 (0.0)	0 (0.0)	0 (0.0)	1 (4.5)	0 (0.0)	
14	16 (4.2)	7 (3.3)	0 (0.0)	2 (1.3)	7 (26.9)	1 (4.5)	0 (0.0)	
15	20 (5.2)	12 (5.7)	1 (16.7)	7 (4.4)	1 (3.8)	2 (9.1)	0 (0.0)	
16	49 (12.9)	32 (15.2)	0 (0.0)	21 (13.3)	1 (3.8)	0 (0.0)	1 (33.3)	
17	65 (17.1)	37 (17.6)	1 (16.7)	24 (15.2)	7 (26.9)	2 (9.1)	2 (66.7)	
18	94 (24.7)	57 (27.1)	0 (0.0)	43 (27.2)	4 (15.4)	6 (27.3)	0 (0.0)	

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3	19	117	(30.7)	58	(27.6)	4	(66.7)	59	(37.3)	4	(15.4)	8 (36.4) 0 (0.0)
4												
5	Place, n, (%)											<0.001
6												
7	Home	344	(80.9)	183	(87.1)	4	(66.7)	124	(78.5)	11	(42.3)	22 (100.0) 0 (0.0)
8												
9	Road	52	(12.2)	12	(5.7)	1	(16.7)	22	(13.9)	14	(53.8)	0 (0.0) 3 (100)
10												
11	Building	23	(5.4)	10	(4.8)	1	(16.7)	12	(7.6)	0	(0.0)	0 (0.0) 0 (0.0)
12												
13	School	3	(1.0)	2	(1.0)	0	(0.0)	0	(0.0)	1	(3.8)	0 (0.0) 0 (0.0)
14												
15	Health care facility	3	(1.0)	3	(1.4)	0	(0.0)	0	(0.0)	0	(0.0)	0 (0.0) 0 (0.0)
16												
17	Call to contact with a patient by EMS, min, mean (SD)	6.5	(5.0)	6.4	(3.1)	7.3	(4.0)	6.1	(3.1)	6.5	(3.0)	7.0 (2.2) 33.7 (42.0) <0.001
18												
19	Call to hospital arrival, min, mean (SD)*	48.6	(25.6)	55.7	(27.6)	43.0	(17.0)	43.0	(20.6)	43.2	(23.3)	41.8 (30.8) 99.0 (0.0) <0.001
20												
21	Type of hospitals, n (%)											<0.001
22												
23	No transportation	82	(19.3)	30	(14.3)	3	(50.0)	38	(24.1)	0	(0.0)	9 (40.9) 2 (66.7)
24												
25	Non critical care medical center	289	(68.0)	154	(73.3)	1	(16.7)	117	(74.1)	9	(34.6)	7 (31.8) 1 (33.3)
26												
27	Critical care medical center	54	(12.7)	26	(12.4)	2	(33.3)	3	(1.9)	17	(65.4)	6 (27.3) 0 (0.0)
28												
29	Type of transported department, n (%)*											<0.001
30												
31	Surgery	168	(39.5)	24	(11.4)	1	(16.7)	108	(68.4)	26	(100.0)	9 (40.9) 0 (0.0)
32												
33	Internal medicine	162	(38.1)	145	(69.0)	2	(33.3)	11	(7.0)	0	(0.0)	3 (13.6) 1 (33.3)
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Pediatrics	8 (1.9)	8 (3.8)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Psychiatry	5 (1.2)	3 (1.4)	0 (0.0)	1 (0.6)	0 (0.0)	1 (4.5)	0 (0.0)

EMS, Emergency Medical Services; SD, standard deviation.

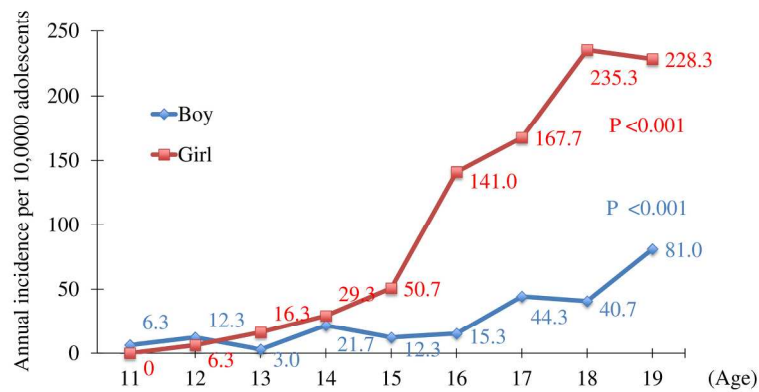
*Calculated only for self-harms transported to institutions.

†Comparisons between the 6 groups were evaluated with Fisher exact test.

Table 2. Outcomes of emergency self-harm among adolescents in Osaka City.

	Total		Gender				Poisoning by		Poisoning by		Jumping from		Hanging		Drowning		P Values*
			Boy		Girl		P values	drugs	Gas	Cutting skin	heights						
(n=425)	(n=88)	(n=337)	(n=210)	(n=6)	(n=158)	(n=26)	(n=22)	(n=3)									
Refusal of transport by patients, n, (%)	30 (7.1)	7 (8.0)	23 (6.8)	0.647	24 (11.4)	0 (0.0)	4 (2.5)	0 (0.0)	2 (9.0)	0 (0.0)						0.017	
Only prehospital treatments, n, (%)	43 (10.1)	4 (4.5)	39 (11.6)	0.072	6 (2.9)	1 (16.7)	34 (21.5)	0 (0.0)	0 (0.0)	2 (66.7)						<0.001	
No hospital admission after transportation, n, (%)	212 (49.9)	30 (34.1)	182 (54.0)	0.001	92 (43.8)	1 (16.7)	112 (70.9)	6 (23.1)	1 (4.5)	0 (0.0)						<0.001	
Hospital admission, n, (%)	119 (28.0)	34 (38.6)	85 (25.2)	0.016	88 (41.9)	2 (33.3)	8 (5.0)	15 (57.7)	6 (27.3)	0 (0.0)						<0.001	
Death, n, (%)	21 (4.9)	13 (14.8)	8 (2.4)	<0.001	0 (0.0)	2 (33.3)	0 (0.0)	5 (19.2)	13 (59.1)	1 (33.3)						<0.001	
Death confirmed at the scene	9 (2.1)	7 (8.0)	2 (0.6)		0 (0.0)	2 (33.3)	0 (0.0)	0 (0.0)	7 (31.8)	0 (0.0)							
Death confirmed at the hospital admission	12 (2.8)	6 (6.8)	6 (1.8)		0 (0.0)	0 (0.0)	0 (0.0)	5 (19.2)	6 (27.3)	1 (33.3)							

*Comparisons between the 6 groups (type of self-harm) were evaluated with Fisher exact test.

Figure 1

209x148mm (300 x 300 DPI)

Figure 2A

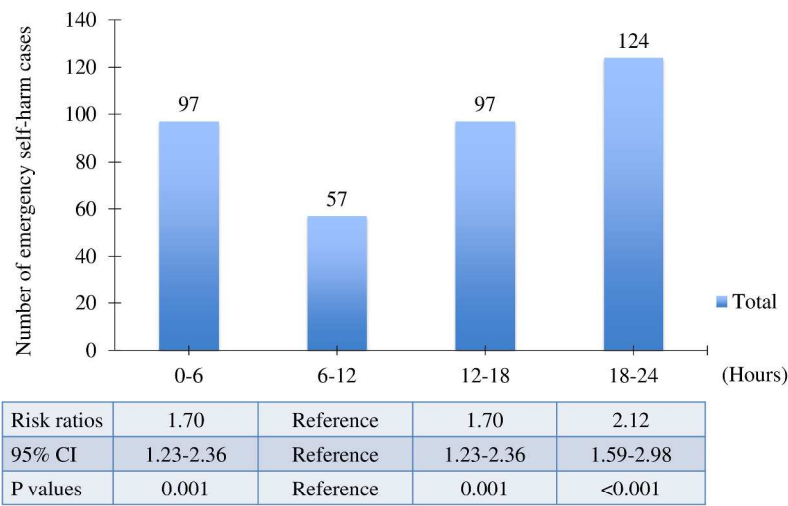


Figure 2A
297x209mm (300 x 300 DPI)

Figure 2B

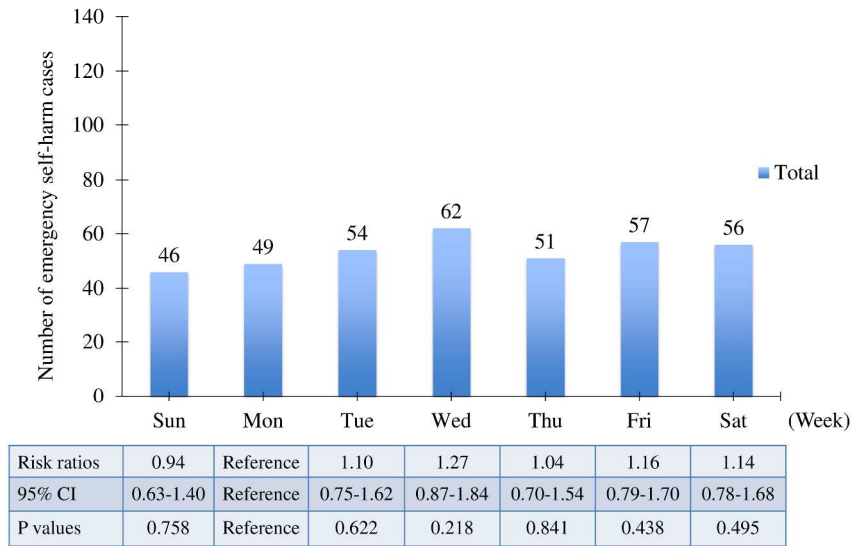


Figure 2B
297x209mm (300 x 300 DPI)

Figure 2C

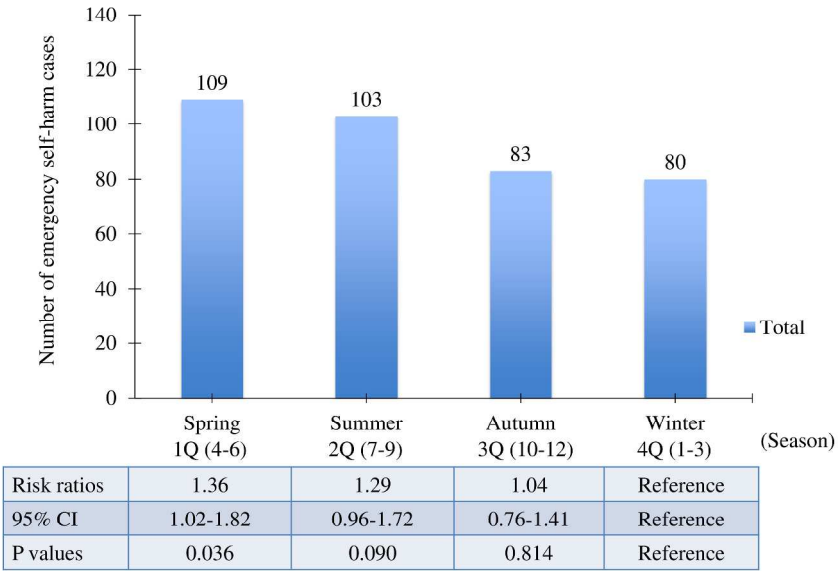


Figure 2C
297x209mm (300 x 300 DPI)

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract	3
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	3-4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	6
Objectives	3	State specific objectives, including any prespecified hypotheses	6-7
Methods			
Study design	4	Present key elements of study design early in the paper	7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	7-8
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	7-8
		(b) For matched studies, give matching criteria and number of exposed and unexposed	NA
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	9
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	NA
Bias	9	Describe any efforts to address potential sources of bias	NA
Study size	10	Explain how the study size was arrived at	8
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8-9
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	9
		(b) Describe any methods used to examine subgroups and interactions	NA
		(c) Explain how missing data were addressed	8
		(d) If applicable, explain how loss to follow-up was addressed	NA
		(e) Describe any sensitivity analyses	NA
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed	10

		eligible, included in the study, completing follow-up, and analysed	
		(b) Give reasons for non-participation at each stage	10
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	10-11, (Table 1)
		(b) Indicate number of participants with missing data for each variable of interest	NA
		(c) Summarise follow-up time (eg, average and total amount)	NA
Outcome data	15*	Report numbers of outcome events or summary measures over time	11-12, (Table 2)
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10-12 (Figure 1, Table 2)
		(b) Report category boundaries when continuous variables were categorized	Figure 2
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	13
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13-15
Generalisability	21	Discuss the generalisability (external validity) of the study results	15
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	NA

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.