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Comparison of Deaths by Fall as Classified by Month in the 23 Wards (municipalities) of Tokyo

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Abstract

Background: Accidental death by fall is one of the major causes of accidental death in Japan. And the number of deaths by fall is higher than that of deaths in traffic accidents. In addition, it is well known that falls are one of the major causes of people becoming bedridden or being unable to return to prior level of activities in daily life. So far, there have been some studies of falls in Japan. However, the relationship between death by falls and temperature in the 23 wards of Tokyo has not been investigated.

Study design: This is an epidemiologic study.

Aim: The purpose of the present study was to compare the number of deaths by fall as classified by month in the 23 wards (municipalities) of Tokyo.

Methods: Monthly data for the number of deaths by fall from January 2002 to December 2014 in the 23 wards of Tokyo were obtained from the Tokyo Medical Examiner's Office official website. Monthly air temperature data for the same period in the 23 wards of Tokyo were also obtained from the Japan Meteorological Agency official website. The effects of month and/or air temperature on the number of deaths by fall were evaluated by ecological study.

Results: The number of deaths by fall and mean air temperature were 20.6 ± 5.9 subjects per month and 16.6 ±7.5 °C. The number of deaths by fall in December was highest, and significantly higher than in April and September in all subjects. In addition, the number of deaths weakly and negatively correlated with air temperature parameters in all subjects and in men.

Conclusion: These results show that the number of deaths by fall was higher in the winter, especially in December, which suggests that proper education to prevent falls may be needed in the 23 wards (municipalities) of Tokyo, Japan.

Key Words: Deaths by fall, accidental death, the 23 wards of Tokyo, meteorological parameters

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INTRODUCTION

Accidental death by fall is one of the major causes of accidental death in Japan (1). For example, a total of 7,946 subjects were reported to have died due to accidental death by fall by the Ministry of Health, Labour and Welfare, Japan (2). It is noteworthy that the number of deaths by fall was higher than that of deaths in traffic accidents. In addition, it is well known that falls are one of the major causes of people becoming bedridden or being unable to return to a prior level of activities in daily life (3).

We have previously shown a relationship between lower air temperature and health problems. In some Japanese cities, there were significant relationships between ambulance transports and/or death and lower air temperature (4, 5, 6). Regarding accidental deaths, in the cases of deaths by asphyxiation there was a close association with lower air temperature (7). There were also some reports of the relationship between falls and climate parameters (8, 9, 10, 11); however, this has not been fully discussed in the 23 wards of Tokyo, in cases where the accidental death was accurately evaluated and defined.

Therefore, in this study, we evaluated the number of deaths by fall as classified by month and the relationship between the number of deaths by fall and air temperature parameters.

METHODS

Study area

The 23 wards (municipalities) of Tokyo is the central area in Tokyo, Japan, where over 9,000,000 people live, the area is about 600 km^2 and population density was about 14,000 people/km^2 in 2014.

Deaths by fall

Monthly data of the number of deaths by fall from January 2002 to December 2014 were obtained from the Tokyo Medical Examiner's Office official website (12), where all accidental deaths by fall were accurately defined by experts in forensic medicine (13). Data by sex was also used for this analysis.

Meteorological parameters

Monthly air temperature data for the same period was obtained from the Japan Meteorological Agency official website (14). The observation spot was centrally located in the 23 wards of Tokyo. We used data of mean air temperature (°C), mean of the highest air temperature (°C), mean of the lowest air temperature (°C), highest air temperature (°C) and lowest air temperature (°C).

Statistical analysis

Data were expressed as mean ± SD. Parameters among months were analyzed by Kruskal-Wallis test and Steel test, where $p < 0.05$ was significant. Simple correlation analysis was also used to evaluate the relation between the number of deaths and air temperature parameters. Spearman's rank correlation coefficient was used to evaluate the link between the number of deaths by fall and years in January and December.

RESULTS

The clinical profiles of the number of deaths by fall and air temperature parameters were

summarized in Table 1. The number of deaths by fall was 20.6 ± 5.9 subjects per month and mean air temperature was 16.6 ± 7.5°C. Mean of the highest temperature, mean of the lowest air temperature, highest air temperature and lowest air temperature were 20.3 ± 7.5 °C, 13.3 ± 7.8 °C, 26.5 ± 7.0 °C and 8.9 ± 7.5 °C, respectively.

men, the number of deaths by fall in December was also significantly higher than in September.

However, significant differences in the number of deaths by fall between December and the other months were not noted in women. Next, we evaluated the relationship between the number of deaths by fall and air temperature parameters by

Table 1 Clinical data of deaths by fall in the 23 wards of Tokyo

	Mean ± SD	Minimum	Maximum
Number of months	156		
Number of deaths by fall (Total)	20.6 ± 5.9	7.0	42.0
Number of deaths by fall (Men)	14.5 ± 4.3	4.0	30.0
Number of deaths by fall (Women)	6.1 ± 3.1	0.0	17.0

Table 2 Comparison of the number of deaths by fall as classified by month

	Total	Men	Women
January	24.0 ± 7.4	17.3 ± 5.1	6.7 ± 3.8
February	20.7 ± 4.1	14.8 ± 3.3	5.9 ± 2.8
March	21.5 ± 4.1	14.9 ± 3.4	6.6 ± 2.3
April	17.0 ± 3.9	13.1 ± 2.9	3.9 ± 2.6
May	18.7 ± 5.1	12.7 ± 3.8	6.0 ± 2.6
June	19.2 ± 4.4	14.3 ± 2.7	4.9 ± 2.7
July	19.8 ± 4.7	12.8 ± 3.8	6.9 ± 2.7
August	18.6 ± 5.4	13.2 ± 4.3	5.4 ± 2.7
September	15.4 ± 3.7	10.2 ± 2.6	5.2 ± 2.2
October	23.8 ± 4.4	16.4 ± 3.4	7.5 ± 2.6
November	22.3 ± 5.7	16.5 ± 4.8	5.8 ± 3.0
December	25.8 ± 8.5 a	17.3 ± 5.6 b	8.5 ± 5.0

a: $p < 0.05$ vs. April and September

b: $p < 0.05$ vs. September

Comparison of deaths by fall between December and other months by Steel test.

We compared the number of deaths by fall as classified by month in Table 2 and Figure 1. The number of deaths by fall in December was the highest among months, and significantly higher than in April and September in total subjects. In

simple correlation analysis (Table 3). In all subjects and men, the number of deaths by fall was weakly and negatively correlated with air temperature parameters *i.e.* mean air temperature, mean of the highest air temperature, mean of the lowest air temperature, highest air temperature and

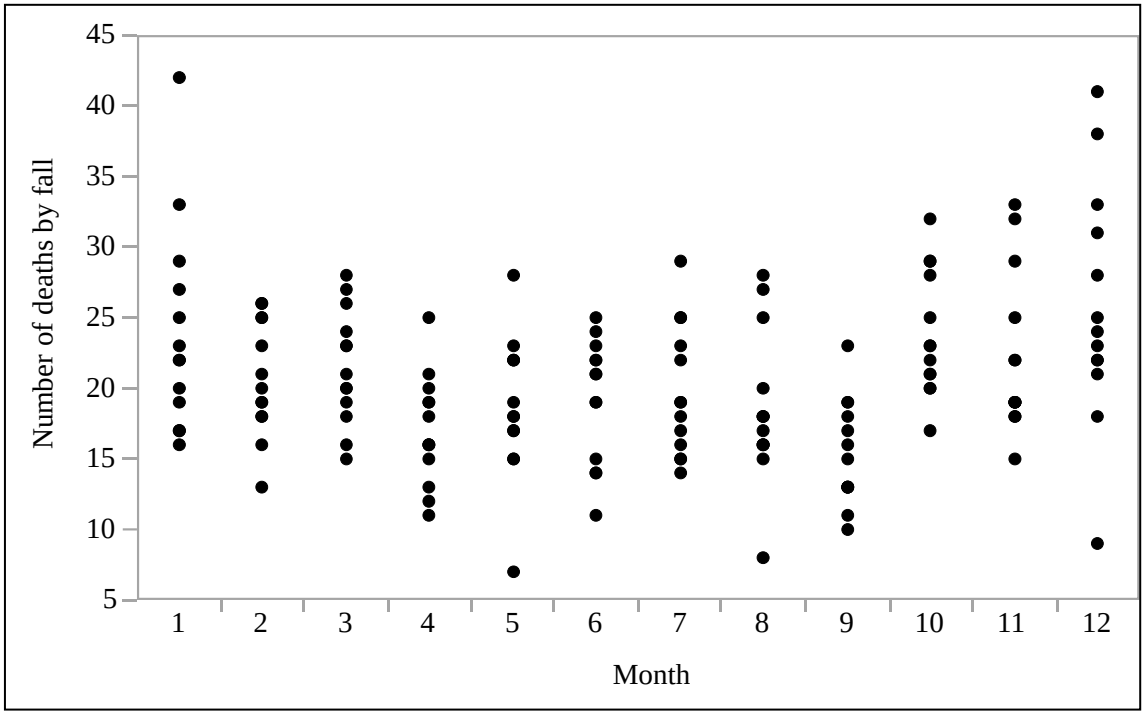

Figure 1 Comparison of the number of deaths by fall as classified by month in the 23 wards of Tokyo

lowest air temperature. In women, the number of death by fall was not significantly correlated with air temperature parameters.

Finally, we evaluated the link between the number of deaths by fall and years in January and December. Spearman's rank correlation coefficient (January: rs = 0.7410, $p = 0.0038$, December: rs = 0.404, $p = 0.1705$) showed an association between the number of deaths by fall and years.

DISCUSSION

In this study, we examined the number of accidental deaths by fall as classified by month and found that the number was highest in December in the 23 wards (municipalities) of Tokyo.

Hemenway *et al.* reported that a cold climate appeared to be a significant risk factor for fall deaths among white women in a prospective cohort study (8). Yoshimoto *et al.* reported that the number of ambulance transports due to falls was frequently observed in winter in Kochi city, Japan (9). Kojima *et al.* also showed that approximately 60% of falls occurred during winter in Hokkaido

Table 3 Relationship between deaths by fall and air temperature parameters

	Total		Men		Women	
	r	*p*	r	*p*	r	*p*
Mean air temperature (℃)	-0.297	0.0002	-0.323	<0.0001	-0.115	0.1518
Mean of the highest air temperature (℃)	-0.303	0.0001	-0.329	<0.0001	-0.119	0.1397
Mean of the lowest air temperature (℃)	-0.292	0.0002	-0.319	<0.0001	-0.111	0.1688
Highest air temperature (℃)	-0.306	0.0001	-0.338	<0.0001	-0.113	0.1584
Lowest air temperature (℃)	-0.279	0.0004	-0.309	<0.0001	-0.101	0.2118

(10). The most common location, where falls occurred, was on roads or sidewalks (10). Yoshioka *et al.* showed that incidents and near misses were highest in winter among the middle-aged and elderly during walking and village-vicinity mountain climbing (11). In this study, the number of deaths by fall was highest in December among the months in the 23 wards of Tokyo. The results of this study largely agreed with previous reports showing that falls occurred more often in winter.

Why are more accidental deaths by fall more observed in winter? In community-dwelling elderly Japanese, Mizukami *et al.* reported that hemiplegia due to stroke (men), arthritis in the legs (men and women) and taking at least four daily prescription medications (men and women) were associated with falls (15). Regarding the association between falls and winter, Stevens *et al.* showed that the average rate of fatal falls was 9.1% higher in colder climates, regardless of the season (16). Bulajic-Kopjar reported that slipping on ice and snow seems to be a causal mechanism (17). Reduced dorsiflexor strength in winter may predispose older people to an increased risk of tripping-related falls (18). In this study, the number of deaths by fall was highest in December and was weakly and negatively correlated with air temperature parameters in all subjects and men. Taken all together, external and/or internal environmental factors may induce the increasing number of deaths by fall in the 23 wards of Tokyo. In addition, the number of deaths by fall has tended to increase with years, which may be partially due to aging. Therefore, proper prevention for accidental deaths by fall is needed in future.

There are some potential limitations in this study. First, this was an epidemiologic study and, therefore, the results cannot apply for individuals. Second, we could not obtain individual data such as age. Third, a difference by sex in the relationship between the number of deaths by fall and air temperature parameters was noted. Although Stevens *et al.* reported that non-fatal fall related injuries disproportionately affected women (19), fatal falls may be different from non-fatal falls. Nevertheless, it is reasonable to suggest strategies to counter the risk of the deaths by fall in winter would be helpful to reduce the number of accidental deaths by fall in the 23 wards of Tokyo. In fact, a structured multi-factorial intervention on falls significantly reduced the number of falls in nursing home patients (20). Further ongoing studies are urgently required to reduce accidental deaths by fall.

CONCLUSION

These results show that the number of deaths by fall was higher in the winter, especially in December, which suggests that proper education to prevent falls may be needed in the 23 wards (municipalities) of Tokyo, Japan.

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Conflict of interests: The authors declare that there are no conflicts of interest.

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