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Relationship Between Death by Drowning and Air Temperature in the 23 Wards (Municipalities) of Tokyo

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Abstract

Background: Accidental death is one of the major causes of death in Japan. And the death rate due to drowning is higher than that of traffic accidents. So far, there have been some studies of drowning in Japan, the relationship between death by drowning and temperature in the 23 wards of Tokyo has not been investigated.

Study design: This is an ecological study. Aim: The aim of this study was to explore the link between the number of accidental deaths by drowning and air temperature in the 23 wards (municipalities) of Tokyo, Japan.

Methods: Monthly data of accidental death by drowning from Jan 2002 to Dec 2014 were obtained from the Tokyo Medical Examiner's Office official website. Air temperature parameters i.e. mean air temperature, mean of the highest air temperature, mean of the lowest air temperature, the highest air temperature and the lowest air temperature for the same period were obtained from the Japan Meteorological Agency official website. The relation between the number of deaths by drowning and air temperature was evaluated.

Results: The number of deaths by drowning was 11.1 ± 7.0 deaths per month and the mean air temperature was 16.6 ± 7.5□C. The total number of deaths by drowning in January was the highest among the months in both men and women. In addition, the number of deaths by drowning was significantly and negatively correlated with air temperature parameters.

Conclusion: The number of deaths by drowning was closely associated with air temperature, and effective measures for preventing accidental death by drowning are urgently required.

Keywords: drowning, accident, sudden death, air temperature

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INTRODUCTION

It is well known that accidental death is one of the major causes of death in Japan (1). Indeed, accidental death is the 6th most common cause according to the Ministry of Health, Labour and Welfare, Japan (1). Among accidental deaths, death by drowning (7,508), traffic accidents (5,717) and death by asphyxia (9,806) are the major causes (2).

There are some studies regarding death by drowning in Japan (3-9). We have previously reported the relationship between lower air temperature, ambulance transports and death in some cities in Japan (10-12). In addition, the number of deaths while bathing was significantly and negatively correlated with air temperature (13) and the number of deaths by asphyxia in January was the highest among the months in the 23 wards of Tokyo (data not shown). However, the relationship between the number of deaths by drowning and air temperature was not examined in the 23 wards of Tokyo.

Therefore, in this study, we investigated the number of deaths by drowning and its relationship to air temperature parameters in the 23 wards (municipalities) of Tokyo, Japan.

METHODS

Study area

The central area in Tokyo, consists of 23 wards (municipalities) with over 9,000,000 people living in an area of about 600 km^2. The population density is about 14,000 people/km^2 in 2014.

Death by drowning

Monthly data of the number of accidental deaths by drowning from Jan 2002 to Dec 2014 were obtained from the official website of the Tokyo Medical Examiner's Office (14). Accidental death was defined by specialists of forensic medicine in the 23 wards of Tokyo (15). Data of sex and the number of the deaths by drowning were also used for this analysis.

Air temperature parameters

To investigate the link between the number of deaths by drowning and air temperature, we used the following air temperature parameters of the 23 wards of Tokyo *i.e.* mean air temperature (°C), mean of the highest air temperature (°C), mean of the lowest air temperature (°C), the highest air temperature (°C) and the lowest air temperature (°C) for the same required period reported by the Japan Meteorological Agency (16). The observation spot is located at almost the center of the 23 wards of Tokyo.

Statistical analysis

Data are expressed as mean ± SD. Comparison of the number of deaths by drowning was analyzed by the Kruskal-Wallis test and Steel test, where $p < 0.05$ was statistically significant. Simple correlation analysis was also used to evaluate the linear regression between the number of deaths by drowning and air temperature.

RESULTS

The number of deaths by drowning and air temperature parameters is summarized in Table 1. The number of deaths by drowning was 11.1 ± 7.0 deaths per month and the mean air temperature was 16.6 ±7.5°C for a period of 13 years.

Table 1 Clinical data of death by drowning and air temperature parameters in the 23 wards of Tokyo

	Mean ± SD	Minimum	Maximum
Number of month	156		
Number of death by drowning (Total)	11.1 ± 7.0	0.0	33.0
Number of death by drowning (Men)	6.2 ± 4.0	0.0	18.0
Number of death by drowning (Women)	4.9 ± 3.8	0.0	16.0
Mean air temperature (℃)	16.6 ± 7.5	4.8	29.6
Mean of the highest air temperature (℃)	20.3 ± 7.5	8.3	33.5
Mean of the lowest air temperature (℃)	13.3 ± 7.8	1.5	27.0
The highest air temperature (℃)	26.5 ± 7.0	11.1	39.5
The lowest air temperature (℃)	8.9 ± 7.5	-1.5	23.6

Table 2 Comparison of the number of death by drowning as classified by month group

	Total	Men	Women
January	22.0 ± 5.3 a	12.1 ± 4.0 b	9.9 ± 2.8 b
February	16.6 ± 4.4	8.7 ± 3.9	7.9 ± 3.6
March	15.3 ± 5.0	8.8 ± 3.1	6.5 ± 3.5
April	11.8 ± 3.9	6.2 ± 2.9	5.5 ± 2.6
May	8.2 ± 2.4	4.8 ± 1.7	3.4 ± 2.0
June	6.0 ± 2.6	2.9 ± 1.5	3.1 ± 1.7
July	4.5 ± 2.4	3.1 ± 1.9	1.5 ± 1.1
August	4.2 ± 2.5	2.7 ± 2.3	1.5 ± 1.5
September	4.4 ± 2.3	2.5 ± 1.4	1.8 ± 1.5
Octorber	7.2 ± 2.5	4.2 ± 1.6	3.0 ± 1.8
November	12.3 ± 3.4	7.8 ± 1.8	4.5 ± 2.4
December	20.5 ± 4.3	10.7 ± 2.6	9.8 ± 3.2

a: $p < 0.05$ vs other months except February and December

b: $p < 0.05$ vs other months except February, March and December

Comparison of death by drowning between January and other months was perfoemed by Steel test.

We compared the number of deaths by drowning in each month (**Table 2 and Figure 1**). In total, the number of deaths by drowning in January was the highest, and significantly higher than in other months except February and December. For both men and women, the number of deaths by drowning was also the highest in January, and significantly higher than in other months except February, March and December.

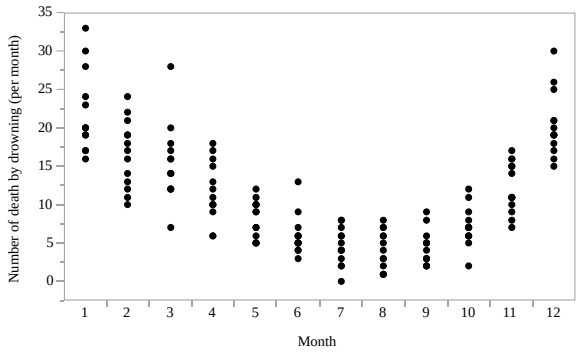

Figure 1. Comparison of the total number of death by drowning as classified by month group in the 23 wards (municipalities) of Tokyo

Next, the relationships between the number of deaths by drowning and air temperature parameters were evaluated (**Table 3**). The number of deaths by drowning was significantly correlated with all air temperature parameters, such as mean air temperature, mean of the highest air temperature, mean of the lowest air temperature, the highest air temperature and the lowest air temperature. Finally, the number of deaths by drowning in January was not correlated with the year by simple correlation analysis (r = 0.116, p = 0.7052).

DISCUSSION

In this study, we evaluated the number of accidental deaths by drowning in the 23 wards (municipalities) of Tokyo, and found a significant relationship between the number of deaths by drowning and air temperature parameters.

In Japanese children, Shinsugi *et al.* investigated the seasonality of child and adolescent injury or deaths, and there was a peak in summer for drowning (incidence ratio: 2.00) (3). Preschool-aged children, especially toddlers, were at greatest risk of drowning or near-drowning, and boys had a three-time greater risk than girls (4). However, although the proportion of households with bathrooms has increased, the drowning mortality rate of children has decreased (5). In adults, Kido *et al.* evaluated the epidemiologic and pathophysiologic characteristics of sudden death while bathing, and the leading cause of death was cardiovascular disease (60.4%), followed by cerebrovascular disease (18.7%) and drowning (11.2%) (6). Possible mechanisms, such as development of extra systole, ventricular tachycardia, hypotensive syncope, sympathetic tone and cold climate were

Table 3 Relationship between death by drwoning and air temperature parameters

	Total		Men		Women	
	r	*p*	r	*p*	r	*p*
Mean air temperature (℃)	-0.840	<0.0001	-0.7590	<0.0001	-0.7481	<0.0001
Mean of the highest air temperature (℃)	-0.839	<0.0001	-0.7585	<0.0001	-0.7467	<0.0001
Mean of the lowest air temperature (℃)	-0.836	<0.0001	-0.7567	<0.0001	-0.7442	<0.0001
The highest air temperature (℃)	-0.853	<0.0001	-0.7823	<0.0001	-0.7468	<0.0001
The lowest air temperature (℃)	-0.815	<0.0001	-0.7331	<0.0001	-0.7304	<0.0001

suspected in death while bathing and/or by drowning (7-9).

In this study, we found that the number of deaths by drowning was significantly and negatively correlated with air temperature parameters. As shown in our previous reports, the number of deaths while bathing was negatively correlated with air temperature in the 23 wards of Tokyo (13). Although difficulties in diagnosis remain consequent to the accidental and natural aspects of the "dead in hot bathtub" phenomenon (17), most of the deaths were due to drowning suspected to be related to bathing and most of them were elderly person (80%~) (7). According to an explosive increase aging of population in Japan, the number of deaths by drowning may increase in the near future. Proper strategies, such as awareness seasonal conditions and social support systems for preventing death by drowning, are needed.

Potential limitations of this study are as follows. First, this was an ecological study; therefore, the results obtained from this study cannot be applied to individuals. Second, we could not obtain detailed individual data, such as age. Third, we also could not obtain findings that could explain why the number of deaths by drowning was the highest in January.

CONCLUSION

The higher number of accidental deaths by drowning may be closely associated with lower air temperature. Therefore, our results may be useful for promotion and prevention of accidental deaths by drowning.

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Conflict of interests: Not available.

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