Correlation between death while bathing and meteorological parameters in the 23 wards of Tokyo

Naoko Tanaka¹, Nobuyuki Miyatake², Hiroshi Kinoshita¹*, Tatsushige Fukunaga³

Abstract: Study’s Objectives. Japanese people bathe every day and every home has a bathtub. The number of deaths while bathing increases during colder months. The present ecological study aimed to determine whether or not low air temperature is associated with death while bathing in Japan.

Materials and Methods. The monthly numbers of deaths while bathing in the 23 wards of Tokyo were obtained from the Tokyo Medical Examiner’s Office and data on air temperature and humidity were obtained from the Japan Meteorological Agency.

Results. The monthly numbers of deaths while bathing significantly and negatively correlated with air temperature and humidity (mean air temperature, r = -0.943; p < 0.0001). A single regression line showed that a decrease in mean air temperature of 1°C corresponded to a monthly increase of 0.095 deaths per 100,000 persons.

Conclusions. Lower air temperature is closely associated with higher rates of death while bathing in the 23 wards of Tokyo, Japan.

Key Words: death during bathing, air temperature, 23 wards of Tokyo, ecological study.

Lower and higher air temperatures are closely associated with health problems. Several authors have used V-, U- or J-shaped correlations to describe the effects of air temperature on mortality [1-4]. We also found that lower air temperatures are closely associated with more ambulance transports in Sakata, Yamagata prefecture, Japan [5].

Almost every Japanese home has a bathtub and Japanese customarily bathe every day. Over 1,000 deaths occur annually while bathing within the 23 wards (metropolitan districts) of Tokyo, and the number often increases during colder months [6, 7]. However, the relationship between death while bathing in Japan and meteorological parameters such as air temperature has yet to be fully explored.

We therefore investigated, in an ecological study, the correlations between death while bathing and climatic parameters, including air temperature and humidity, in the 23 wards of Tokyo.

MATERIALS AND METHODS

1. Study area
The 23 wards of Tokyo comprise the core and the most populous part of Tokyo, Japan. By December 2012, the nighttime population surpassed nine million, and the population density is 14,485/km².

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2. Deaths related to bathing
Monthly data on the deaths that occurred while bathing in the 23 wards of Tokyo over the 60 months between January 2008 and December 2012 were collected from the Tokyo Medical Examiner's Office [6]. During this period, approximately 14,000 unnatural deaths were reported annually for this region, and over 1000 deaths occurred while bathing [6]. To adjust for population shifts, monthly population data for the same period were also obtained from the Statistics Division Bureau of General Affairs, Tokyo [8].

3. Meteorological parameters
Data on the monthly meteorological parameters for a central part of Tokyo were obtained for the same period from the Japan Meteorological Agency [9]. The monthly meteorological parameters for the mean, mean highest, and mean lowest air temperatures (°C), the highest and lowest air temperatures (°C), and the mean and lowest humidity ratios (%) were analyzed.

4. Statistical analysis
Data are expressed as means ± standard deviation (S.D.), and were assessed using a simple correlation analysis with p < 0.05 considered to represent statistical significance.

RESULTS
Table 1 summarizes the profiles of deaths that occurred while bathing and climatic parameters in the 23 wards of Tokyo. The monthly frequency (± S.D.) of deaths while bathing was 105.9 ± 66.1. The frequency of death was the highest during January of each year. Death while bathing significantly and negatively correlated with all meteorological parameters, including mean overall, mean highest, mean lowest, highest, and lowest air temperatures (°C), as well as mean and lowest humidity (%) (r = -0.717 to -0.945, p < 0.0001; Table 2).

For example, the correlation coefficient between mean air temperature and death while bathing (/100,000 persons/month) was -0.943 (p < 0.0001; Fig. 1). Simple regression analysis showed that a decrease of 1°C in mean air temperature corresponded to an increase of 0.095 deaths/100,000 persons/month.

DISCUSSION
We used an ecological analysis to evaluate the relationship between death while bathing and climatic parameters, particularly air temperatures, in the 23 wards of Tokyo, and found that death during bathing was closely associated with air temperature.

The incidence of death each month significantly and negatively correlated with monthly mean air temperature (r = -0.922, p < 0.0001) among 199 bath-related deaths [10]. The difference in air temperature within a day also positively correlated to the incidence of death while bathing [10]. Ambulance calls while bathing significantly and negatively correlated with mean air temperature (r = -0.72, p < 0.01) in the Sapporo area, Japan [11]. A cold climate, hot water immersion, and hydrostatic pressure might affect physiological compensation along with existing coronary stenosis or weakened respiratory function [12].

This study found a significant relationship between the number of deaths that occurred while bathing and changes in air temperature in the 23 wards of Tokyo. We systematically and accurately compared 13,000-14,000 unnatural deaths that were reported annually, between 2008 and 2012 in the Tokyo metropolitan areas with those of other areas in Japan [6, 7]. Therefore, our

<table>
<thead>
<tr>
<th>Table 1. Profiles of death occurring while bathing and climate parameters in the 23 wards of Tokyo</th>
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<tr>
<td><strong>Number of months</strong></td>
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<tr>
<td>Number of deaths per month while bathing</td>
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<td>Total (/100,000 persons)</td>
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<td>Mean air temperature (°C)</td>
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<td>Highest air temperature (°C)</td>
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<td>Lowest air temperature (°C)</td>
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<td>Mean humidity (%)</td>
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<td>Lowest humidity (%)</td>
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Values are presented as mean ± SD (standard deviation).
The accidental death of elderly persons is a general concern, and that while bathing is a significant problem in Japan [6, 7]. Although the etiology of death while bathing is inconclusive, other factors involved in death while bathing should be investigated to determine appropriate preventive measures.

### COnCluSiOn

We evaluated the relationships between death while bathing and climatic parameters, particularly air temperature. A decrease of 1°C in mean air temperature corresponded to a monthly increase of 0.095 deaths/100,000 persons. Lower air temperature was closely associated with higher death rates while bathing in the 23 wards of Tokyo, Japan.

**Conflict of interest.** The authors have none to declare.

### References