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Association between climatic elements and acute appendicitis in Japan

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ABSTRACT

Background: In Japan, it has been reported that an increase in atmospheric pressure is associated with a higher incidence of acute appendicitis. The aim of this epidemiologic study was to investigate the association between climatic elements and the incidence of acute appendicitis.

Materials and methods: A case-crossover design was used in the present study. Two wk before diagnosis was used for the target period. The same 2-wk period, but 1, 2, and 3 y before diagnosis, was used for the control period. The study participants were patients with acute appendicitis (10-29 y) from 14 facilities in the Greater Tokyo Area. Mean of the observed values for atmospheric pressure, temperature, relative humidity, and hours of sunshine calculated for each target and control period were used as climatic elements to investigate trends 1 and 2 wk before diagnosis.

Results: The year of diagnosis, a statistically significant moderate upward trend in atmospheric pressure was observed during the 2-wk period before diagnosis of acute appendicitis (tau = 0.47; $P = 0.0213$), whereas a weak nonsignificant downward trend was observed 1 y before diagnosis (tau = −0.29; $P = 0.1596$), and weak nonsignificant upward trends were observed 2 (tau = 0.24; $P = 0.2505$) and 3 y (tau = 0.28; $P = 0.1634$) before diagnosis.

Conclusions: An association was found between atmospheric pressure and the incidence of acute appendicitis. However, no significant differences were found in relation to sex or age. These findings suggest that changes in atmospheric pressure are associated with the likelihood of patients visiting the hospital.

Introduction

Although acute appendicitis is a well-known disease with a long history, its cause remains unclear.[1] In recent years, research has been conducted around the world on the association between climatic elements and the incidence of acute appendicitis,[2] with studies from Western countries such as the United States,[3-6] Canada,[7] Italy,[8] and Finland[9] and from Asian countries such as South Korea[10] and Taiwan[11] reporting that acute appendicitis occurs more frequently during the summer. Since acute appendicitis has been reported to be more likely to occur during the summer, direct associations with factors such as relative humidity, gastrointestinal infections, changes in diet, and travel are suspected in these

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studies. In Japan, some studies have reported finding an association between the incidence of acute appendicitis and increases in atmospheric pressure.[12-14] However, no such association was found in another study[15]; therefore, a definitive conclusion has yet to be reached.

Japan is located in the mid-latitudes and has a temperate climate. In Tokyo, the mean temperature is lowest in January (5.2°C) and highest in August (26.4°C). The weather in this area is quite seasonal. The Greater Tokyo Area experiences migratory anticyclone activity in the spring (March to May) and autumn (September to November). The first half of the summer (June to mid-July) is the rainy season, whereas the second half (mid-July to August) is hot and humid with clear skies. The winter (December to February) is marked by cold and sunny days with relatively low precipitation and low humidity. In addition, several typhoons pass through the Greater Tokyo Area each year in the summer and autumn months.[16]

If the incidence of acute appendicitis is affected by climatic elements, this association should be apparent in areas with high seasonal variability and changing weather patterns. Therefore, the aim of this epidemiologic study was to investigate the association between climatic elements and the incidence of acute appendicitis.

Methods

A case-crossover design was used in the present study. Two wk before diagnosis was used for the target period. The same 2-wk period, but 1, 2, and 3 y before diagnosis, was used for the control period.

For data regarding the incidence of acute appendicitis, we used information from a control group of patients with acute appendicitis who participated in a different case-control study in Japan.[17] These patients (age range, 10-29 y) were being treated for acute appendicitis at 14 facilities in the Greater Tokyo Area. Ethical review of the protocol of the study was conducted at each facility. All patients were recruited at the time of diagnosis in each facility and asked to take part in interviews and complete a questionnaire survey. Informed consent was received from all patients. For patients who were minors, informed consent was also received from the patient's guardian.

Of the 546 diagnosed cases, 416 (76.2%) agreed to participate. Of these, 357 patients with a confirmed date of diagnosis of acute appendicitis who were living in the Greater Tokyo Area (Tokyo's 23 wards, suburban Tokyo, Kanagawa, Saitama, and Chiba) were included for analysis in the present study. In the analysis, we investigated the incidence of acute appendicitis according to sex, age group (10- to 19-y or 20- to 29-y old), and date of diagnosis.

In previous studies in East Asia, atmospheric pressure, temperature, relative humidity, hours of sunshine, and precipitation were considered in the analyses.[10,11] Therefore, in the present study, we also considered these weather elements. For climatic elements, we obtained data from the Japan Meteorological Agency website.[18] The observation point was Otemachi, a district in central Tokyo. We used daily mean values for atmospheric pressure, temperature, and relative humidity and measured values for hours of sunshine and precipitation.

Means of the observed values were calculated for each target and control period and then assessed for trends in the 1- and 2-wk period before diagnosis. First, we investigated changes in atmospheric pressure, temperature, relative humidity, and hours of sunshine in the year of diagnosis. Second, we observed changes in atmospheric pressure 1, 2, and 3 y before diagnosis. Next, we investigated changes in atmospheric pressure in the year of diagnosis by sex, age, and season (spring: March-May; summer: June-August; autumn: September-November; and winter: December-February). The Mann-Kendall test was used to identify trends in the 1- and 2-wk periods before diagnosis. The significance level was set at 5%. Statistical analysis was performed using R statistical software (R Foundation for Statistical Computing, Vienna, Austria).

Results

The background characteristics of the participants are shown in Table 1. There were more male ($n = 198$, 55.5%) than female participants ($n = 159$, 44.5%), and more patients aged 10-19 y ($n = 185$, 51.8%) than 20-29 y ($n = 172$, 48.2%). Tokyo's 23 wards are located in the center of the Greater Tokyo Area, whereas Saitama is located to the north, Kanagawa to the south, Chiba

Table 1 – Participant background characteristics.

Background characteristics	*n*	%
Sex		
Male	198	55.5
Female	159	44.5
Age (y)		
10-19	185	51.8
20-29	172	48.2
Residential area		
Tokyo's 23 wards (central)	289	81.0
Suburban Tokyo (west side)	33	9.2
Kanagawa (south side)	14	3.9
Saitama (north side)	17	4.8
Chiba (east side)	4	1.1
Year of diagnosis		
2011	39	10.9
2012	75	21.0
2013	145	40.6
2014	94	26.3
2015	4	1.1
Month of diagnosis		
March-May (spring)	71	19.9
June-August (summer)	96	26.9
September-November (autumn)	113	31.7
December-February (winter)	77	21.6
Total	357	100.0