



## Association between acute gouty arthritis and meteorological factors: An ecological study using a systematic review and meta-analysis



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### ABSTRACT

**Objectives:** The aims of this study were as follows: (1) to analyze the literature systematically regarding the seasonal and monthly variation of the occurrence of episodes of acute gouty arthritis, and (2) to investigate the relationship between the occurrence of episodes of acute gouty arthritis and meteorological parameters.

**Methods:** The present authors systematically reviewed databases for articles published before November 2015. Studies with quantitative data on episodes of acute gouty arthritis by months and/or seasons were included. Meteorological data such as the highest temperature, lowest temperature, diurnal temperature range, change in mean temperature between neighboring days, relative humidity and wind speed for the geographic place(s), and study period where and when each study took place were obtained from meteorological websites.

**Results:** Ten studies published between 1920 and 2015 were included. A meta-analysis by season showed that acute gouty arthritis occurred significantly more frequently in spring than in other seasons. Analysis by month showed an increase in episodes of acute gouty arthritis from March to July, being the highest in July. The trend reversed, and episodes of acute gouty arthritis started decreasing from July to September, being the lowest in September. The change in mean temperature between neighboring days was the only meteorological parameter that was significantly correlated with the number of monthly episodes of acute gouty arthritis.

**Conclusions:** Acute gouty arthritis seems to develop more frequently during the period in which the temperature increases significantly between neighboring days: spring by season and between March and July by month in the northern hemisphere.

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Acute gouty arthritis, characterized by intermittent episodic flares with varying intervals, is one of the most common forms of inflammatory arthritis [1]. Although a strong, positive correlation between serum uric acid concentration and the risk of developing acute gouty arthritis has been reported [2], it is known that only 10% of the people with hyperuricemia will eventually develop acute gouty arthritis [3]. Factors other than hyperuricemia

may predispose patients to an acute gout attack. In addition to comorbidities and medications that can influence uric acid levels and/or facilitate monosodium urate crystal formation, socio-economic and dietary factors are important in determining the risk of developing clinically evident gout [4]. While meteorological factors may be predisposing factors for acute gouty arthritis [5], the findings for seasonal variations of occurrence of acute gouty arthritis have been conflicting yet [6–14]. However, there has been no systematic review and meta-analysis on the seasonal variations of the occurrence of acute gouty arthritis.

The aims of this study were as follows: (1) to analyze the literature systematically regarding the seasonal and monthly variation of the occurrence of episodes of acute gouty arthritis, and (2) to investigate the relationship between the occurrence of episodes of acute gouty arthritis and meteorological factors.

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## Materials and methods

This study is based on the Cochrane Methods, and reporting follows the Meta-analysis Of Observational Studies in Epidemiology statements [15].

### Data sources and searches

In November 2015, the present authors performed a comprehensive literature search of electronic databases, including MEDLINE, EMBASE, the Cochrane library, and KoreaMed for all articles published before November 2015. No restrictions were imposed in terms of the publication language, time, or status. Electronic database searches used both free text words and medical subject headings. The search strategy was adapted for all databases searched, taking into account the differences in indexing terms and search syntax for each database (Supplementary Table S1). The present authors identified further relevant studies for possible inclusion by hand-searching the reference lists of the studies identified by our initial search strategies.

### Study selection

The inclusion of studies was independently decided by 3 reviewers (K.Y.P., S.Y.Y., and J.B.J.) based on predefined inclusion criteria. Studies were included in our systematic review if they had quantitative data on episodes of acute gouty arthritis according to seasons and/or months. Discrepancies were resolved by discussion between the reviewers. Study selection included 2 levels of screening. Three reviewers independently screened the titles and abstracts of the identified studies. The present authors retrieved the articles of any citation identified by the reviewers for full-text review. Three reviewers then assessed the reports to ensure that they met the inclusion criteria detailed below.

### Data extraction

Two reviewers (K.Y.P. and S.Y.Y.) independently performed data extraction using a predefined form. Any disagreement unresolved by discussion was reviewed by a third author. The following variables were extracted from the studies: (1) demographic characteristics, including first author's name, year of publication, country where the study was performed, total number of participants, mean age, and proportion of men and women; (2) the number of episodes of acute gouty arthritis according to seasons and/or months; and (3) if the information regarding the confirmatory methods of episodes of acute gouty arthritis was available, it was extracted. When study provided figures as the only source of data, data were extracted from figures, using the JR Screen Ruler (<http://www.spadixbd.com/freetools/jruler.htm>). The JR Screen Ruler is a virtual ruler for computer screens. It is a tool that allows for the measurement of things on computer screens. It can be used when measuring graphics or web page browser sizes. It can display measurement in terms of pixels, inches, picas, or centimeters.

### Collection of meteorological data

Meteorological data of the place(s) and the study period where and when each study took place were obtained from meteorological websites. The meteorological websites used in this study are shown in Table 1. Four studies [6,9,12,14] included the meteorological data during their respective study period. Another 4 studies [7,8,10,11] did not have the meteorological data during their exact study period, and thus the authors used data from the 5 years closest to the study period for each study. The remaining

**Table 1**  
Characteristics of 10 studies analyzed in this review

Article	Subjects		Diagnostic criteria of acute gouty arthritis	Study		Meteorological data		Inclusion in each analysis*		
	Number (men:women)	Mean age (years)		Period	Place(s); country	Source/period	1	2	3	
Arber et al. [5]	82 (70:12)	66.0	Classic clinical presentation and serum uric acid > 8 mg/dL	NR	Tel Aviv; Israel	1997–2001	<a href="http://www.wunderground.com/">http://www.wunderground.com/</a>	0	0	0
Choi et al. [6]	256 (246:10)	52.2	MSU or ACR criteria	2013	South Korea	1997–2001	<a href="http://www.kma.go.kr/2013">http://www.kma.go.kr/2013</a>	0	0	0
Elliot et al. [7]	NR	NR	ICD-9 code 274	1994–2007	United Kingdom	1997–2001	<a href="http://www.wunderground.com/">http://www.wunderground.com/</a>	–	0	0
Gallerani et al. [8]	210 (196:14)	57.0	MSU & [WBC > 2000/mm <sup>3</sup> or ≥ 10/HPF in SF]	1990–1997	Ferrara; Italy	1997–2011	<a href="http://www.wunderground.com/">http://www.wunderground.com/</a>	0	0	0
Karmacharya et al. [9]	28,172	NR	ICD-9-CM code 274.01	2009–2011	USA	–	–	0	0	–
Punzi et al. [10]	85	NR	MSU	1992–1997	Venice; Italy	1997–2011	<a href="http://www.wunderground.com/">http://www.wunderground.com/</a>	0	–	0
Rovensky et al. [11]	79 (76:3)	NR	MSU	1961–1994	Bratislava; Slovakia	1997–2011	<a href="http://www.wunderground.com/">http://www.wunderground.com/</a>	0	0	0
Schlesinger et al. [12]	359	NR	MSU	1990–1995	Philadelphia; USA	1990–1995	<a href="http://www.wunderground.com/">http://www.wunderground.com/</a>	0	0	0
Williamson et al. [13]	116	48.0	NR	NR	Chicago; USA	1948–1952	<a href="http://www.wunderground.com/">http://www.wunderground.com/</a>	0	0	0
Zampogna et al. [14]	72 (63:9)	61.9	ACR criteria	2000–2007	Rome; Italy	2000–2007	<a href="http://www.wunderground.com/">http://www.wunderground.com/</a>	0	0	0

ACR, American College of Rheumatology; HPF, high-power field; ICD-9, International Classification of Diseases, 9th Revision; CM, clinical modification; MSU, monosodium urate crystal in synovial fluid by polarization microscope; NR, not reported; SF, synovial fluid.

1. Meta-analysis for seasonal variation of the number of episodes of acute gouty arthritis according to month; and 3. Multiple regression analyses of climate parameters on the number of episodes of acute gouty arthritis.

\*\*0" and "–" indicate "included" and "not included" in each analysis.

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