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Original Article

Abrupt temperature change triggers arthralgia in patients with juvenile rheumatoid arthritis

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Background and Purpose: Juvenile rheumatoid arthritis (JRA) is the most common form of arthritis in children and affects both quality of life and school attendance. Weather and temperature conditions are believed to affect joint pains; however, very few studies have investigated this issue. This study examined the association between joint pain in JRA patients and weather conditions.
Methods: The daily pain ratings of 52 patients previously diagnosed with JRA were recorded on visual analog scales over 4 months beginning January 1, 2004. These ratings were then compared with weather data to evaluate possible correlation between these two factors.
Results: Twenty nine patients kept daily records during the first 2 months. There was no positive correlation between weather parameters (such as temperature, humidity, and barometric pressure) and pain ratings. Interestingly, the pain rating significantly increased the day after the advent of a cold wave (sign test, $p<0.01$; Wilcoxon signed ranks test, $p=0.001$). The number of patients who experienced joint swelling was not related to weather conditions. Twenty one participants continued maintaining the diaries during the next 2 months. The patients reported higher pain levels in the first 2 months during the cold wave period than in the next 2 months when the cold wave period had ended ($p<0.001$).
Conclusion: A dramatic weather change such as a sudden cold wave might influence the experience of joint pain.

Key words: Arthralgia, juvenile rheumatoid arthritis, microclimate, weather

Introduction

Rheumatic pain is widely believed to be related to weather conditions. Although rheumatologic diseases are recognized as autoimmune disorders, it is believed that weather influences rheumatic pain. Sensitivity to weather is even considered a minor criterion for the diagnosis of fibromyalgia [1]. The term “rheumatic disease” is known as “wind wet disease” in Chinese. However, the effect of weather on rheumatic pain is still controversial according to various studies [2], carried out in Europe and the United States. Furthermore, there is no study in the literature that focuses on juvenile rheumatoid arthritis (JRA), possibly because of the small number and young age of the patients. JRA, which may be multi-etiologic [3], is the most common form of arthritis in children and affects patients’ quality of life and school attendance [4,5]. Exploring the relationship between weather and pain may provide useful information for JRA patients, their parents, doctors, and teachers. Therefore, we conducted a study to explore the influence of weather on JRA patients in Taiwan.

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Methods

Patients

This study included 52 patients previously diagnosed with JRA from the Department of Pediatrics of National Taiwan University Hospital. JRA was diagnosed by the criteria of the American College of Rheumatology [6], and all 3 types were included. The patient-maintained self-recorded diaries were handed in or mailed to the

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clinic. Informed consents were obtained from the patients. The participants were told that the purpose of the study was to identify whether their rheumatic pain scores were consistent. They were not informed that correlations between their daily pain ratings and objective weather parameters would be examined. Parents were advised to help their young children complete their daily records and regard record keeping as play or homework to be done before going to bed. The rheumatologists were not asked to modulate their practice of prescription during the study. If the diary was not maintained during the study period, it was considered an incomplete record. Those participants who had incomplete records, had left Taiwan, or were hospitalized for other reasons were excluded from the study.

Pain assessment

The participants rated their overall daily pain levels before bedtime on a 100-mm non-scoring visual analog scale (VAS), extending from no pain (0) to extreme pain (100). A happy face and a sad face were representative of “no pain” and “extreme pain”, respectively. VAS is widely accepted as a reliable tool for pain measurement and is valid for children as young as 5 years [7,8]. Besides, two questions on “joint swellings or not” and “extra-drug needed for unusual pain or not” had to be answered daily.

Weather parameters

Daily weather data were obtained from the Taipei Weather Station (121°30'24.15"E, 25°02'22.62"N) of the Central Weather Bureau (CWB). The hourly barometric pressure (in millibars), humidity (relative humidity in percentage), temperature (°C), amount of rain (mm/h), and wind speed (m/min) from all parts of Taiwan are available on the official CWB website (http://www.cwb.gov.tw). The daily data at noon served as the parameters because there is more variation in weather conditions during this time period as compared to at other times of the day. Greater attention was paid to the days on which the noontime temperatures dropped dramatically as a result of cold waves, which are major meteorological events during the winters in Taiwan**,** and the first day on which the noontime temperature dropped by more than 5°C was defined as D-day. A day with minimal amount of rain (0.1 mm/h) for more than 5 h was defined as a rainy day.

Statistical analysis

Daily ratings were collated for data management and transformation. Since most patients did not experience obvious pain on most days, the mean daily ratings (MDRs) of all subjects were used as a screening tool to determine the relationship between weather parameters and pain. The correlation between weather parameters and pain rating was obtained by an X-Y scatter plot and the r value was calculated using Excel. Statistical analyses were performed by Statistical Package for the Social Sciences (SSPS) for Windows (Version 11.5; SPSS, Chicago, IL, USA) and an alpha level of 0.05 was considered significant.

Results

In all, 29 patients maintained a daily diary during a 2-month period (January and February). We excluded 23 patients (including 2 who left Taiwan) due to incomplete records. The most common reason for incomplete records was that the children forgot to enter daily records in their diaries. The mean age of the 29 patients was 14 years (range, 6 years 9 months to 26 years 9 months) and the mean disease duration was 4 years and 7 months (range, 4 months to 15 years). The sample included 10 polyarticular, 9 oligoarticular, and 10 systemic-onset patients (15 males and 14 females). All subjects resided in northern Taiwan; 25 (86%) of these lived in Taipei. The mean (± standard deviation [SD]) pain intensity rating of all the diaries was 11.5 ± 14.5 (n = 29 × 60 person-days; range, 1-82) on the 100-mm VAS. The patients tended to report their pain as mild-to-moderate; this phenomenon was consistent with a previous report [9]. We used the MDR of all subjects (n = 60 days) as a screening tool. No significant correlation was observed between the MDR and the weather parameters by linear regression analysis (temperature, °C [r = 0.073, p=0.578]; humidity, % [r = 0.050, p=0.698]; and barometric pressure, millibars [r = –0.310, p=0.016]) [Fig. 1]. We were unable to demonstrate a strong correlation between pain ratings and weather parameters by any method; thus, we suggest that pain associated with JRA is not correlated with weather parameters.

Many patients complain of pain during cold wave periods. Fig. 2 shows the characteristic temperature variations in Taipei that are characterized by serial cold waves. The 6 D-days during which temperatures dropped sharply by more than 5°C were assigned as the first day of a cold wave. MDR values on D-days were not higher than on previous days (paired t test, p>0.05); however, the MDR was significantly higher on the day following D-days (D-after days) than on the D-days (paired t test, p<0.05) [Table 1]. MDR on D-after days,

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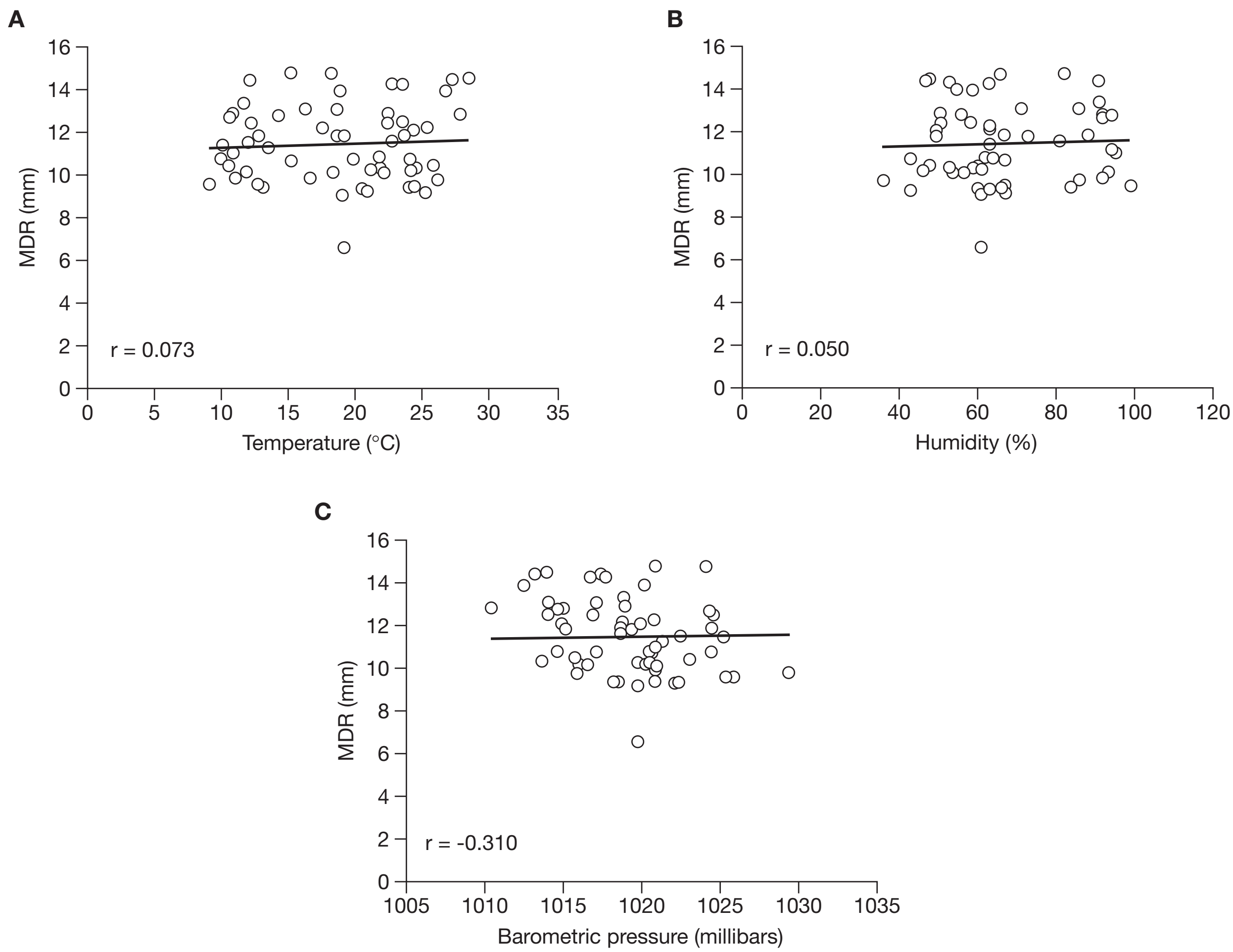

Fig. 1. Scatter plots of the mean daily ratings (MDR) of all subjects versus temperature (A), humidity (B), and barometric pressure (C).

but not on D-before or D-days, was greater than the average (one sample *t* test, average = 11.5, $p<0.05$). We used non-parametric methods to avoid bias. Each patient's daily ratings on 6 D-after days were significantly higher than on D-days (n = 29 × 6 person-days; sign test, $p=0.003$; Wilcoxon signed ranks test, $p=0.001$). Table 2 shows the number of patients who experienced more, equal, or lesser pain on the 6 D-days and the preceding and subsequent days (n = 174, 29 × 6) as compared to the previous days. The number of "more painful" items on D-after days was 51, which is higher than the number of "less painful" items, i.e., 24 (sign test, $p<0.01$). However, no such relationship was found on the D-before or D-days. It is possible that patients experience more pain immediately following a sharp decline in temperature. This finding is compatible with popular beliefs. Besides, temperature and humidity were found to be highly correlative ($r = -0.758$, $p<0.001$) during the first 2 months. During the study, D2, D3, D4, and D5 were rainy days. Although no rain was recorded around D1 day, the relative humidity was rather high (92% at noontime).

Twenty one participants continued maintaining their diaries in March and April during which time no cold wave occurred. The mean (± SD) pain intensity rating recorded was 11.26 ± 14.28 (n = 21 × 60 person-days) on the 100-mm VAS during the winter (January through February), and was 8.58 ± 10.35 (n = 21 × 61 person-days) during spring (March through April). Based on these findings and the assumption that the disease progression was consistent in chronic patients, JRA patients might have higher mean pain levels and greater pain in winter than in spring ($p<0.001$).

Ten patients recorded joint swelling during the study period. There was no significant correlation between the number of patients with swollen joints and weather parameters. There was no evidence of cold wave-induced joint swelling. Only a few adult patients took additional medications to relieve the joint pain.

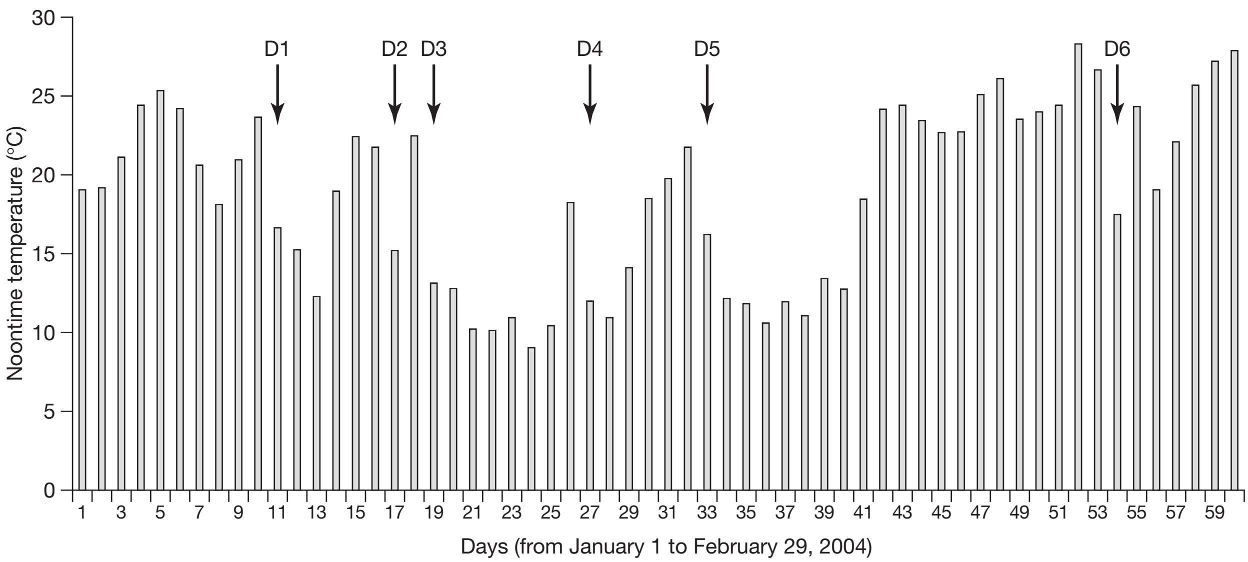

Fig. 2. Noontime temperature recorded at the Taipei Weather Station during the months of January and February 2004. D1-D6 = first day of cold wave.

Discussion

The influence of weather on rheumatic pain is controversial and several published studies on different rheumatic diseases have not demonstrated a definite relationship between weather parameters and rheumatic pain. Hawley et al [10] performed a pain and global severity assessment study that included 1424 patients with rheumatic disease for periods up to 24 years. They reported that the pain appeared to increase slightly in summer rather than in winter, and global severity was not related to the season. The final conclusion of this study was contradictory to the patients' beliefs. Challier et al [11] found that higher lumbar spine flexibility (Schober index) was associated with a higher climatic temperature and lower wind speed in patients with ankylosing spondylitis. For gouty arthritis, Arber et al [12] found that weather changes may precipitate a gouty attack 4 to 5 days later. Patberg et al [13] found that pain associated with RA is positively and significantly related with temperature and vapor pressure, and negatively and significantly related with relative humidity. Strusberg et al [14] reported that patients (living in an Argentine city in a Mediterranean climate zone) with different rheumatic diseases may be sensitive to changes in weather conditions. Dequeker and Wuestenraed [15] found that hospitalized patients with RA suffered less pain because of stable indoor ambient conditions. Some studies concluded that arthritis is not related to weather [16-18]. However, the differences in methods applied to the studies on weather effects hampered comparison between the controversial findings. Moreover, most studies were performed by measuring subjective disease variables, such as VAS, and by questionnaires, not by objective disease variables, such as C-reactive protein and erythrocyte sedimentation rate. A review by Patberg and Rasker [19] on RA proposed a hypothesis that "microclimate" (net meteorological effect on skin influenced by not only weather but also factors that hamper sweat vaporization such as clothing and housing) has a major effect on rheumatic pain. They used "microclimate" to explain different results, and concluded that rheumatic pain associated with RA is positively correlated with the humidity of the micro-climate on the patients' skin. Although there are a few reports regarding pain associated with JRA [4,9,20], none of these studies address weather as a factor.

Table 1. Mean daily ratings of all subjects on the 6 D-days (first days of cold waves), D-before days, and the D-after days

	D-before days Mean = 11.6	D-days Mean = 10.9	D-after days Mean = 13.2
D1	11.8	9.9	14.8
D2	10.8	10.7	12.8
D3	12.8	9.4	11.9
D4	10.1	10.0	12.9
D5	10.3	13.0	14.4
D6	13.9	12.2	12.1

At the start of our study, we attempted to determine whether weather parameters and daily ratings were

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Table 2. Number of patients who experienced more, equal, or less pain on the 6 D-days (first days of cold waves), D-before days, and D-after days (n = 174, 29 x 6) as compared to the previous days

	More pain	Equal pain	Less pain	Sign test/significance
D-before days	43	96	35	No
D-days	35	103	36	No
D-after days	51	99	24	Yes, p<0.01

correlated. However, the r values indicated no significant correlation between MDR and humidity, temperature, or barometric pressure. Hence, we studied the effect of cold waves — the weather events that appear to be the most likely cause of pain complaints.

Taiwan has a subtropical climate, with high temperatures and high humidity. However, cold waves from Siberia and Mongolia cause the atmospheric temperature in Taiwan to drop abruptly to as low as 5°C in winters (during our study, the highest noontime temperature recorded was 29°C and the lowest was 9°C; Fig. 2). Indoor heating systems are not used in Taiwan because of the subtropical climate; hence, the indoor temperature is closely related to the outdoor temperature. We found that daily ratings were significantly different between D-days and D-after days, indicating that people might experience more pain on D-after days immediately after a sharp temperature drop. No obvious change in pain levels was observed on days after D-after days, even on the coldest day. Hence, we concluded that the pain level is influenced by weather change rather than the weather itself. Not surprisingly, pain associated with JRA tends to be more severe in the months with greater weather variation (during the first 2 months than in the last 2 months of the study). However, it remains unclear as to whether the influence of weather on rheumatic pain is subjective or a reflection of disease activity. There are only a few reports discussing the mechanism of weather effect upon local tissue [21,22]. Patberg's microclimate hypothesis could be used to explain our study findings. During a cold wave, the temperature dropped and the humidity level was elevated. People would wear more clothes and stay indoors, leading to high vapor pressure and low skin temperature. The popular belief that "cold and wet is bad, warm and dry is good for rheumatic patients" also appears to hold true for JRA patients.

Our study has a few limitations. Although VAS is widely used, some investigators questioned the validity of the results reported by children [7]. The limited number of cold waves during a winter restricts the statistical value. The patient number is too small to determine the influence of weather on different patient groups. Lastly, weather features vary between geographical locations and patients in different places may be sensitive to different types of weather conditions. This may explain why previous studies have been unable to draw firm conclusions.

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