Influence of Weather Conditions on Rheumatic Pain

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ABSTRACT. ***Objective.*** To evaluate the influence of the weather in Cordoba City, Argentina, on pain in patients with rheumatic pain; to correlate different climate variables with the patients' impression of weather sensitivity; and to assess correlations between pain and climate conditions on 5 days preceding and following painful episode.

Methods. Self-reported questionnaires to assess the presence and features of spontaneous daily pain during one year (1998) were completed by 151 outpatients with osteoarthritis (OA) (n = 52), rheumatoid arthritis (RA) (n = 82), and fibromyalgia (FM) (n = 17) and 32 healthy subjects. Data were correlated with daily temperature, atmospheric pressure, and relative humidity obtained during the same period. Only p values < 0.001 were considered significant.

Results. Low temperature, high atmospheric pressure, and high humidity were significantly correlated with pain in RA ($r = -0.30$, $r = 0.34$, $r = 0.23$, respectively; $p < 0.001$); in OA, pain correlated with low temperature and high humidity ($r = -0.23$, $r = 0.24$; $p < 0.001$); in FM, with low temperature and high atmospheric pressure ($r = -0.255$, $r = 0.22$; $p < 0.001$) and no correlation was found in controls. Patients self-described as being weather sensitive correlated only with high humidity ($r = 0.45$; $p < 0.001$). There was no better correlation with climate variables, except for humidity, 5 days before or after the day of the painful episode.

Conclusion. These results support the belief that weather influences rheumatic pain, albeit in different ways depending on the subjacent pathology and subjective weather sensitivity. This influence may not depend on weather conditions of the previous or following days, indicating that climate would not be a pain predictor and vice versa. (J Rheumatol 2002;29:335–8)

Key Indexing Terms:
WEATHER PAIN RHEUMATOID ARTHRITIS
OSTEOARTHRITIS FIBROMYALGIA

Results of studies on the influence of weather conditions on rheumatic pain that correlate meteorological variables not only with clinical symptoms[1-3] but also with laboratory variables[4,5] are scarce and contradictory. Research has been done mainly in rheumatoid arthritis (RA)[1-4,6], osteoarthritis (OA)[1,7], fibromyalgia syndrome (FM)[7,8], and gout[9,10].

Some of the studies have been done in cold or maritime climate areas such as The Netherlands, Belgium, or Canada, where there is a great difference between internal and external climate due to artificial indoor conditions[8,11].

Cordoba, a city in the middle of Argentina in a Mediterranean climate zone, does not present extreme temperatures and the difference between indoor and outdoor settings is, in general, small. On the other hand, although the whole planet is suffering climate changes, which also affect this area, it is still possible to differentiate 4 seasons. Thus, it was reasonable to do the research in this city. We evaluated the influence of 3 major components of weather (temperature, humidity, and atmospheric pressure) on onset of spontaneous musculoskeletal pain in rheumatic patients and healthy controls of Cordoba to correlate subjective feelings of weather sensitivity with the same weather variables, and to assess correlation between pain and climate conditions 5 days preceding and following episodes of pain.

MATERIALS AND METHODS

Patients. In this prospective and comparative research, 32 healthy controls of both sexes and 151 outpatients from the metropolitan area of Cordoba consented to participate. Controls were people who accompanied patients to the visit and who were free of clinically evident rheumatic disease. In general, they came from the same labor and social background as patients. Eighty-two patients had rheumatoid arthritis (RA), 52 had osteoarthritis (OA), and 17 had fibromyalgia syndrome (FM) according to the American College of Rheumatology criteria[12-14]. All drug doses had to be constant and disease activity had to be stable for at least 2 months prior to the beginning of the study. A self-reported questionnaire about presence or absence of pain, nongraded 10 cm visual analog scale (VAS), Likert scale for pain, moment of the day of worst pain, affected joint/s, and causes to which patients attributed pain were filled out in a daily booklet during one year (January 1 to December 31, 1998). Weather sensitivity was not mentioned, to avoid inducing any answer. The diary was given and returned by mail or personally and was completed in the evening. Patients attended the center every 3 months. Days in which patients were out of the city were excluded from statistical analysis, as were patients who presented an exacerbation of their disease due to psychological problems, excess of physical activity, trauma, concomitant disease, or changes in treatment. Weather sensitivity was considered when, in the opinion of the patient, weather affected his/her pain in any way.

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Weather variables. Climatological data (temperature, atmospheric pressure, and relative humidity) during 1998 were obtained from reports of the Cordoba Meteorological Observatory office of the Argentine Air Force, which covers the area of Cordoba. Reports were taken daily at 3:00 and 9:00 AM and PM. For study purposes the mean of these 4 measurements was obtained. Minimum temperature (˚C) was measured by an alcohol "minimum thermometer," while maximum temperatures (˚C) were obtained with a mercury thermometer. Relative humidity (%) was measured by a psicrometer and was calculated according to the psicrometric table, adjusted by the seasons in Cordoba. Atmospheric pressure (millibars) was obtained with Fortini's barometer and was adjusted with a correction table according to sea level and local temperature and humidity.

Statistical analysis. Parametric data were expressed as mean ± standard deviation (SD). Distribution data were indicated in percentages. One-way ANOVA with Newman-Keuls post hoc comparison and chi square test were used to assess, respectively, age and sex differences between controls and patients. Nonparametric data were expressed as median (95% CI) and were analyzed by the Mann-Whitney U test. Pain presence was the most important variable from all the information obtained. Therefore, the total number of patients with pain was correlated with each climate variable. Simple correlation was done to investigate the relationship between them. All statistical procedures were performed using Statistica 5.5 and Excel 97 for Windows. In all cases, values were considered significant when $p < 0.001$. All calculated p values were 2 tailed.

RESULTS

The data for patients are shown in Table 1. The percentage of patients who completed the diary was 92.2%. A total of 8001 pain records were collected, 4233 in patients with RA, 1973 in OA, 1343 in FM, and 452 in the control group. Patients presented more spontaneous pain episodes than controls; annual median of painful episodes of patients was 21 (95% CI 20-21), while in controls it was 1 (95% CI 1-2, $p < 0.001$). The proportion of FM patients with pain (annual median 4; 95% CI 3-4, 23.50%) was greater than that of RA patients (annual median 11; 95% CI 11-12, 13.41%) or OA patients (annual median 5; 95% CI 5-6, 9.62%).

There was a significant correlation between low temperature and the total number of patients with pain ($r = –0.38$). High atmospheric pressure and increased humidity also correlated with an important number of patients with pain ($r = 0.37$ and $r = 0.24$, respectively). Such associations were statistically significant only in the rheumatic group ($p < 0.001$), not in controls.

When analyzed by disease, pain in patients with RA correlated with low temperature, high humidity, and high atmospheric pressure ($r = –0.30$, $r = 0.23$, $r = 0.34$, respectively; $p < 0.001$). In OA, pain correlated with low temperature and high humidity ($r = –0.23$ and $r = 0.24$, respectively; $p < 0.001$). In patients with FM, pain correlated with decreased temperature and high atmospheric pressure ($r = –0.255$, $r = 0.22$, respectively; $p < 0.001$).

The frequency of patients who reported they were weather sensitive presented an annual median = 1 (95% CI 1-1). Analysis by disease showed that the annual medians were too low: in FM it was 0 (95% CI 0-0); while for OA and RA it was 0 (95% CI 0-1) in both cases. Weather sensitivity was correlated with high relative humidity ($r = 0.45$, $p < 0.001$) (Figure 1).

Correlation between number of patients with pain and climate changes occurring in previous and following days was used as a prediction model of reciprocal influences between climate and pain, according to Patberg[15]. Considering all patients together, we used a 5 day period (phase shift: –5, +5); when analyzing by disease, we arbitrarily compared with a phase shift of –3, +3. Using this model, the painful episode did not correlate better with the climate at any phase shift than the zero day, except for humidity in some days (Table 2).

Table 1. Demographic characteristics of population under study.

Diagnosis	n	Age ± SD, yrs	Female:Male
Osteoarthritis (OA)	52	65.85 ± 9.70*	48:4
Rheumatoid arthritis (RA)	82	56.15 ± 12.60	68:14
Fibromyalgia (FM)	17	61.94 ± 10.99	17:0
Controls	32	55.37 ± 12.10	23:9**

*p < 0.05 between OA–RA and OA–controls, one-way ANOVA, Newman-Keuls test.

**p < 0.05 between controls and patients as a whole; chi-square test with Yates' correction

DISCUSSION

The ancient belief that weather affects joint pain has persisted and is a common expression of patients in daily practice. Some have postulated that psychological susceptibility can influence and create a false notion of association where one does not exist[16]. However, several researchers have indeed found a relationship[2,5-7]. Results in the published literature are hardly comparable because samples were small[2,3,5], meteorological variables were different in each study, and there were disparities in diagnoses[3,4,6] and in measuring pain[4,7]. For example, while Patberg[5,11] included RA patients with stable disease, Dequeker and Wuesternraed[2] chose hospitalized RA patients with exacerbation of their symptoms. Only one study included a healthy control group[3]. Except for Patberg[5,11], the other authors did followup after short periods (months or days).

The global analysis done in our study supports the possibility that meteorological factors can have some effect on spontaneous pain in rheumatic patients, since we found that pain, as a dependent variable, was affected negatively by temperature and positively by humidity and atmospheric pressure. We failed to observe a significant correlation in controls. The effect of each climatologic factor was considered separately.

These outcomes are influenced by the larger sample size of patients with RA, in whom we found the same patterns. Drane, *et al* reported similar findings and indicated a minimal association, humidity being the variable that most contributed to pain[17]. Patberg, *et al* also considered that RA complaints worsen after increases in humidity[11]. Dequeker

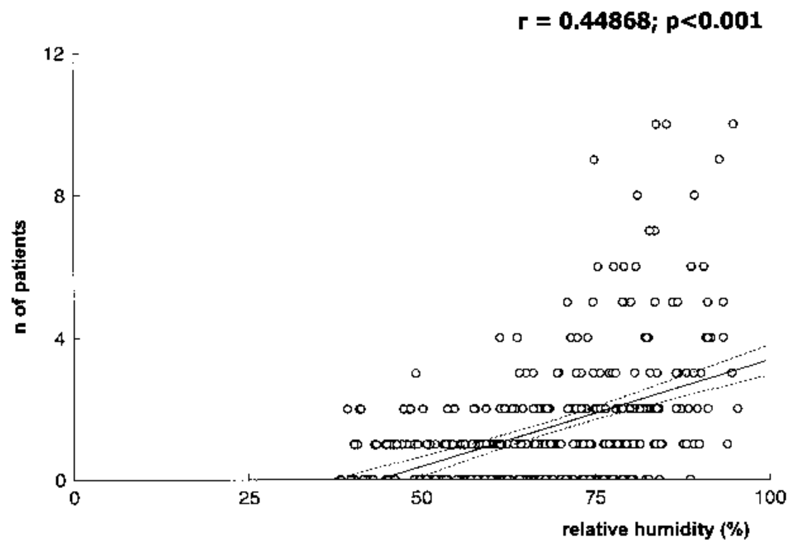

Figure 1. Correlation between means of daily relative humidity and weather sensitive patients during 1998.

Table 2. Phase shift correlation (r) values between patients with pain and climate variables preceding (negative) and following (positive) days of painful episode day zero.

Day	Temperature	Atmospheric Pressure	Relative Humidity
–5	–0.342	0.282	0.278*
–4	–0.342	0.287	0.261*
–3	–0.347	0.307	0.281*
–2	–0.345	0.322	0.253*
–1	–0.375	0.369	0.247*
0	–0.382	0.372	0.243
1	–0.373	0.319	0.262*
2	–0.348	0.257	0.264*
3	–0.327	0.240	0.235
4	–0.332	0.271	0.219
5	–0.312	0.278	0.202

*r values higher than day zero.

and Wuesternraed described less pain in hospitalized patients with RA when there was stable barometric pressure, low humidity, and high temperature[2]. Rasker and Peters offered a novel point of view when they described increased joint stiffness with elevated humidity[3]. Little research has been done in patients with FM, with confounding outcomes. Guedj and Weinberger[7] described that the increase of pain was associated with high barometric pressure, whereas de Blecourt, *et al* found no relationship at all[8]. We agree that pain in the FM group was independent from the influences of humidity. Regarding OA, Sibley[1] found that the weather did not affect patients significantly, while Guedj and Weinberger[7] described more pain with high temperatures and atmospheric pressure[7]. Conversely, our patients were affected when low temperature and high humidity were present.

Whereas the prevalence of weather sensitivity has been documented in about 60% of subjects[1,2,7,8,16], it was very low in this study. The explanation may be that this possibility was not mentioned to the patient when explaining how to consider the answers while filling out the booklets. Similarly to Guedj and Weinberger's results, we found FM patients were the most weather sensitive[7].

There is little evidence about the predictive power of pain with changing meteorological conditions. One study concluded that rain could be predicted in a high percentage of patients with OA, FM, and RA[7]. On the other hand, Patberg considered that pain in RA appeared after changes in temperature and vapor pressure, and found that the "annual variations in temperature and vapor pressure were followed with increasing delay by variations in erythrocyte sedimentation rate and pain score, respectively"[5,11]. In contrast, our results do not confirm a correlation between climate factors of the preceding and following days with pain appearance or with weather sensitivity, hence discarding the predictive value of these variables.

The physiopathology of these outcomes remains unclear. As early as 1948, Edstrom, *et al* investigated these matters in a climate laboratory trying to answer hypotheses related to microcirculation[18]. Currently, we are looking for answers in clinical and basic grounds. Experimental increased hydrostatic pressure in a chondrocyte-like cell line (HCS-2/8) induced high levels of interleukin 6 and tumor necrosis factor-α expression, with changes in the shape of the cells[19]. Although the influence of climatologic factors does not change the natural history of the diseases, it may affect pain feeling by modifying cytokine pathways involved in the painful sensation.

Some meteorological variables significantly affect the occurrence of pain in patients with OA, RA, and FM. The influence may not depend on weather conditions of the preceding or following days from which the pain occurs. This would indicate that climate would not be a pain predictor, and vice versa, pain would not be a predictor of any climate variation. It is unknown if climate factors might act directly or might interfere with pain or inflammation pathways.

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