Influence of meteorological elements on osteoarthritis pain: a review of the literature

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ABSTRACT

Despite the frequent assertion that the weather conditions change the intensity of pain in osteoarthritis (OA), this influence is controversial and difficult to measure. This analysis aims to review articles related to the influence of meteorological elements in the OA pain. The literature review was performed with the bibliographical survey databases of the Medical Literature Analysis and Retrieval System Online (MEDLINE) and the Latin American and Caribbean Health Sciences (LILACS), and active search in the list of references of the articles and reviews retrieved. The inclusion criteria for this analysis were prospective studies that evaluated the presence of pain related to some variable of weather in OA patients. The articles were published in Portuguese, English, and Spanish. Of the 247 abstracts analyzed, eight (3.2%) included articles from the electronic database consulted (n = 7), and active case finding (n = 1). Atmospheric pressure was the most frequently variable with some influence on OA pain in five of the included studies, while precipitation was less related to the symptoms of OA; wind was not analyzed. Despite the methodological diversity and biases of the analyzed studies, there is a trend to confirm the influence of weather in OA pain intensity, mainly in more recent publications. Besides checking the effect of meteorological elements in the OA pain, it is necessary to evaluate the interference in daily activities and impairing of the quality of life.

Keywords: osteoarthritis, arthralgia, atmospheric pressure, weather.

INTRODUCTION

Osteoarthritis (OA), a rheumatic disease characterized by insufficiency of articular cartilage, presents pain and rigidity in joints as the main clinical manifestations. Despite the difficulty in measuriung, some studies aim to assess the influence of meteorological changes in OA patients, based on their frequent affirmation that conditions related to the weather modify the pain intensity. A study of patients with rheumatic diseases showed that between one and two thirds of this patients believed that their symptoms were sensitive to meteorological elements.[1]

More recently, the relation of pain perception and weather changes was assessed using a self-applied questionnaire through the Visual Analogue Scale (VAS), in which the authors observed that 70% of the interviewees believed that their disease was influenced by the weather, and 40% said that it had great influence. Patients considered fall and winter the seasons associated to higher intensity of pain. Regarding meteorological variables, relative humidity (67%) and low temperature (59%) were the most mentioned. The authors concluded that the perception of atmospheric changes influencing on pain and consequently on disease occurred to a high number of patients.[2] However, this solid relation of articular pain and weather factors has been hard to confirm – in a review of 16 articles involving several rheumatic diseases was not observed a consensus about this effect.[3–7]

This study aims to assess the influence of meteorological elements in OA pain.

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MATERIAL AND METHOD

Narrative literature review was performed after bibliographic database survey on the Medical Literature Analysis and Retrieval System on line (MEDLINE), and the Latin American and Caribbean Literature in Health Sciences (LILACS), and active search in the reference lists of the articles and reviews selected until January 2010. As a strategy for study identification, relevant research terms for this review – described in Box 1 – were used.

The inclusion criteria were prospective studies that evaluated the pain response in OA patients related to some meteorological variable in articles published in Portuguese, English, and Spanish.

Box 1
Descriptors for study identification.

OR		OR
		climate[Title]
		weather[Title]
osteoarthrit*[Title]		**temperature[Title]**
pain[Title]	AND	**humidity[Title]**
rheumatic[Title]		**precipitation[Title]**
arthrit*[Title]		**wind speed[Title]**
		forecast[Title]
		meteorolog*[Title]

RESULTS

From the 247 recovered and analyzed abstracts, 16 (6.5%) referred to the subject; eight of them were excluded because they were not in accordance with the analysis criteria (Figure 1); in one of them it was not possible to identify the total of OA and rheumatoid arthritis (RA) patients.[8] Eight articles (3.2%) were included from consulted electronic database (n = 7) and active search (n = 1).

The publications have occurred sparsely since the 1960's; four, publications were identified in the last eight years (Table 1). The studies were performed at North America (USA [3/4], and Canada [1/4]), Europe (United Kingdom, and Spain), Asia

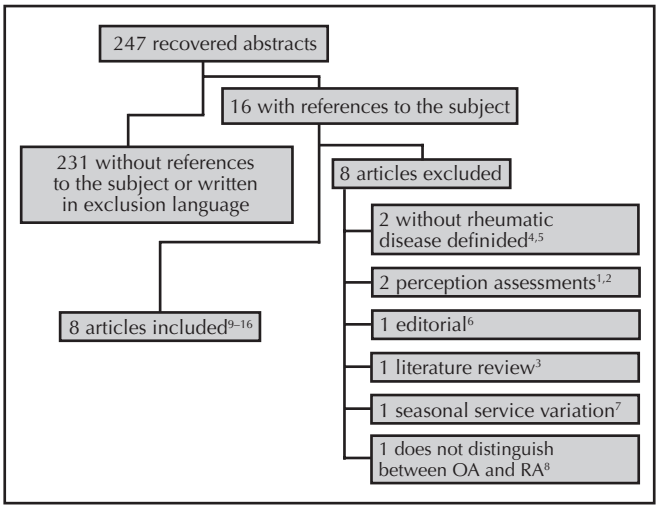

Figure 1
Organizational chart of the bibliographic survey.

Table 1
Articles related to OA and meteorological elements

Year	Author(s)	Country	Follow-up time	Patients (n)	Meteorological variables				
					T	RH	AP	P	WS
1963	Hollander & Yeostros[9]	USA	14 days	4	–	+*	+*	NA	NA
1985	Sibley[10]	Canada	1 month	35	–	–	–	–	–
1990	Guedj & Weinberger[11]	Israel	1 month	24	+	–	+	+	NA
1991	Clarke & Nicholl[12]	United Kingdom	2 months	53	–	–	–	NA	NA
2002	Strusber et al.[13]	Argentina	12 months	52	+	+	–	NA	NA
2003	Wilder et al.[14]	USA	23 months	154	–	NA	+	–	NA
2004	Vergés et al.[15]	Spain	1 month	80	–	–	+	NA	NA
2007	McAlindon et al.[16]	USA	3 months	200	+	–	+	–	NA

T: temperature; RH: relative humidity; AP: atmospheric pressure; P: atmospheric precipitation; WS: wind speed; +: present correlation; –: absent correlation; NA: not assessed.
* RH increasing and AP decreasing simultaneously.

(Israel), and South America (Argentina). Follow-up time varied from 14 days to 23 months; only two studies involved the four seasons of the year. The number of studied patients also ranged widely, from four to 200. All studies used questionnaires (mostly self-assessment) that were completed by patients in predetermined days and hours.

Among seven elements related to meteorological conditions, atmospheric pressure was mentioned as the most frequent influence in OA pain, and precipitation presented the least frequent relation to OA symptoms in five of the eight included studies; wind was insufficiently analyzed.

Hollander and Yeostros[9] led a double-blind study where four OA patients and eight RA patients remained for two weeks in a climatized room with controlled air pressure, temperature, and humidity. The study observed, in addition to influence of these variables individually, the effect of simultaneous variation of the relative humidity and pressure in arthritis signs and symptoms. The diagnosis of these patients was established by the presence of characteristic OA physical signs, with no reference to the analyzed joints or radiographic changes. For articular involvement activity quantification, Lansbury index was used, which includes five parameters related to rigidity lenght, amount of analgesic needed for pain relief, hand grip strength, walking time and number of affected joints. When submitted to humidity increase and barometric pressure decrease, all patients worsened objectively in 73% of the expositions.

To assess whether some climate variable influenced the arthritis symptoms, and to determine the accuracy of patients' self-assessment, Sibley[10] conducted a 30-day double-blind study, using, innovatively, the Visual Analogue Scale (VAS), for considering it reliable and reproducible. For practical purposes, participants were told the research had the aim to determine how arthritis had affected the patients' life. OA diagnosis was performed by the presence of typical peripheral OA symptoms, with radiological evidences of articular space narrowing and presence of osteophytes in the absence of laboratory changes. Neither affected joint, nor radiographic severity were evidenced. Among 35 included patients, one presented diagnosis of rheumatic polymyalgia using prednisone with a 9 mg/day dosage. In addition to meteorological variable average, the analysis included a combination of meteorological elements, as atmospheric pressure change associated with relative humidity; temperature associated with relative humidity; and air temperature associated with atmospheric pressure, involving an amount of averages of 13 variables. The results did not show evidences of correlation between these variables and OA symptoms.

OA patients with no specification of the affected joint, also diagnosed by characteristic symptom presence and radiological evidence on decreasing of articular space with osteophytes, were followed-up during 30 days by Guedj and Weiberger,[11] in a region of Israel where temperature and relative humidity ranged, respectively, from 8 ºC to 27 ºC and from 39% to 96%. During four weeks, the subjects answered a questionnaire for pain and articular swelling assessment, as well as daily ability level in a scale from 0 to 2. Pain was influenced by air temperature, precipitation, and atmospheric pressure.

Clarke and Nicholl[12] presented their results in a brief letter to the editor, involving accented OA patients with indication of arthroplasty, analyzed during 30 days in winter and summer. They compared atmospheric pressure and humidity with pain and articular rigidity recorded in a rating scale used every day, and found no correlation to these variables.

In a study with a healthy control group, Strusberg et al.[13] assessed pain reports during 12 months using VAS and Likert verbal scale in OA, RA, and fibromyalgia (FM) patients diagnosed by the American College of Rheumatology (ACR) criteria. Among these pain reports recorded, 37.94% were OA patients correlated to low temperature and high humidity.

In order to verify the association of atmospheric pressure, precipitation, and air temperature to the VAS pain score in OA patients at cervical spine, hands, shoulder, knee and feet, Wilder et al.[14] performed a study in which participants ignored the objective, with follow-up average from 19 to 23 months. OA evidence was noticed by the presence of a 2-degree radiologic change according to Kellgren and Lawrence criteria. The authors noticed that an increase pain was significantly associated with decrease in atmospheric pressure in women with hand OA.

Vergés et al.,[15] in a study with OA, RA, and control group patients to assess articular pain, used VAS and included functional capacity assessment using the Health Assessment Questionnaire (HAQ). Patients performed consecutive 30-day register, and their data showed that, among three meteorological variables analyzed, low atmospheric pressure was the sign which exacerbated articular pain. Involved joints, diagnostic criteria, radiologic involvement degree, and severity of the articular pain picture were not defined.

More recently, to determine if meteorological parameters influenced in OA knee arthralgia rated by the ACR criteria, McAlindon et al.[16] performed a longitudinal analysis involving 200 participants. To eliminate obliquity related to geographic distribution, patients from several regions of the United States were selected, and they were informed about

the study hypothesis only after the data collection conclusion. The authors used the WOMAC index (Western Ontario and McMaster Universities) for OA.[17] Results evidenced that atmospheric pressure increase and air temperature decrease influenced in the intensity of pain in that joint.

DISCUSSION

In this review, the influence of one or more meteorological variables was significantly frequent in OA symptoms, despite the different methodologies and the number of patients involved. The same variable showed conflicting results in OA symptoms, e.g, high atmospheric pressure had a positive effect on joint pain,[11,16] and low pressure promoted worsening of pain.[14,15] While in some studies low temperature was associated to pain of greater intensity,[13,16] on other side, increased temperature worsened articular symptoms.[11]

The initial point in the research involving meteorological variables and OA symptoms was Hollander and Yeostros' study,[9] which assessed scores of each participant individually. The small number of patients was an obliquity which, associated with a short observation period, limited the external validation of the results. The financial aspect was an obstacle for building a spacious environment to accommodate more participants for a longer period of time and to assemble a better climatization equipment to regulate the propitious conditions to the study. Its maintenance costs and daily participants' needs, like food and hygiene, were also harmed.

This study confirmed the previous one, performed by Edström,[5] in a constantly hot and dry environment, where patients showed improvement of arthritis signs and symptoms. In addition to the small number of participants, involving only 10 RA patients, no attempt was done to control the air pressure or to study effects of changing atmospherical conditions. These two studies in controlled environments showed similar results, favorable to the influence of meteorological elements in pain both for OA and RA.

All other identified studies were performed with patients in their natural environments. One of them compared the perception of the meteorological factors influencing OA pain among downtown Chicago's residents, whose atmospheric environment was extremely changed by human impact on environment, and residents of a rural region, which had environmental conditions with less human interferences. The results suggested that the distinctive climatic feature of urban area would be propitious for articular pain.[1]

An important aspect of assessing records in which patients quantified their perception of pain (scales mostly numerical) is that the score of sensations is subjective and individual. Given this subjectivity, it is possible to occur a great dispersion of the values obtained, as well as of the standard deviation of each participant. In order not to underestimate particular features, this aspect was observed in three studies involving OA patients,[9,10,16] two of which showed influences of some of the meteorological variables.

The individual score assessment compared to the meteorological elements was performed also by Gorin et al.[18] and Smedslund et al.[19] Their studies involved RA patients and considered the pain response for weather conditions a highly individualized phenomenon. Gorin et al.[18] referred that, although the weather sensibility had been observed, this effect was not clinically significant, while Smedslund et al.[19] observed in their sample that, for some patients, pain was significantly associated with meteorological elements. However, it is possible that in previous studies the conflicting results in this area are related to the fact that statistical analysis was performed only with the mean values of the analyzed group. Therefore, it is important to notice individual differences.

In a study performed in Australia, with data collected during 30 days in each season period, the results showed that among the meteorological variables, low temperature and high humidity were the most associated to increased pain and rigidity in arthritis patients.[8] But it was considered that a research performed in 12 months would probably show more sensitive results, and that confounding variables such as physical exercises, other associated diseases, drug use, hormonal changes, massage, stress, and life style should be eliminated in a following study.

Israel is a region where fall and winter are cold and clammy and spring and summer are hot and dry. There, in a study performed during 30 days, with temperature variation between 8 ºC to 27 ºC, OA patients were sensitive to air temperature and atmospheric pressure, with worsening of articular pain. Among the reviewed studies, only this one presented relation between pain intensity and precipitation.[11]

In South America, in Cordoba (Argentina), the results of Strusberg et al.[13] supported the belief in the influence of meteorological factors in rheumatic pain, but with different intensity and with the meteorological variables influencing more or less, according to the diagnosis. Low temperature and high atmospheric pressure and relative humidity were significantly correlated to RA pain. The authors found positive correlation between low temperature and high humidity in OA patients, while low temperature and high atmospheric pressure occurred in FM patients. There was no reason to ensure the predictor factor of pain for weather

change. Patients absent from the city during the study and those who presented worsening in their disease due to psychological problems, excess of physical activity, traumatism, concomitant disease or changes in treatment were excluded. The authors also used a healthy control group which presented no correlation.

When assessing the influence of meteorological factors in pain, registering its intensity by OA affected region, Wilder et al.[14] observed that, among the assessed associations, hand OA presented greater intensity of pain during high atmospheric pressure, with statistical significance, while in other days with constant or falling atmospheric pressure, no influence in articular pain intensity was observed. The remaining analyzed segments with OA showed no changes, suggesting little relation, in its totality, between OA pain and meteorological variables. Different from most studies, authors were sensitive to the OA localization and the weather influence per segment.

Patients residing in the metropolitan area of Barcelona (Spain), characterized by the Mediterranean climate, showed increase in articular pain as a response to the atmospheric pressure decrease, indicating, contrary to the published reports, that atmospheric pressure exacerbates articular pain.[15] Authors of this study considered satisfactory the involved patients' number, making their results more reliable – however, because it was performed over a very short period, gave no opportunity for participants to experience seasonal changes.

Two studies[10,12] have found no significant changes in OA symptoms related to meteorological elements, unlike the majority of OA and RA patients claim. Sibley,[10] analyzing RA and OA patients, showed no correlation between patients' symptoms, individually or in group, in any of 13 combinations of meteorological variables. Clarke and Nicholl[12] also found no correlation between pain and rigidity symptoms and atmospheric pressure and relative humidity in patients with arthroplasty indication. However, they pointed out the limitations of their study, such as short follow-up time, use of few meteorological variables, and the clinical severity of their patients.

In general, we can consider, as well as Quick,[3] that some factors complicate data collection and record on articular pain in humans, as this can only be measured through subjective assessment, even when using continuous scales. In addition, individuals have huge and inaccurate limits on the threshold and sensibility to pain. For any individual, pain sensibility may vary over a short period of time, and pain perception depends on difficult-control variables, as humor and mental activities.

One way to face pain variability would be to study a large number of cases, so that differences among "out of average" individuals could be reversed in a population as a whole. However, most studies, listed in Table 1, includes relatively few participants. None of the reviewed studies had mentioned, in the description of methods, how the sample size calculation was performed, which should consider the community's population and the OA's prevalence estimation. In a study, the building of a spacious environment to accommodate more participants for a longer period of time, according to author, was stopped by the insufficient financial cover to assemble a better climatization equipment to regulate the propitious conditions for studies, as well as its maintenance costs and the participants' daily needs, like food and hygiene. In the other studies it was clear that the sample is pure convenience, required by assistance in specialized services. Before the limitation of using a significant-size sample, the solution could be consider, in the statistic model, OA pain scores assessment individually, as three of the eight studies had done.[9,10,16] Dequeker & Wuestenraed[20] also assessed individually every single one of their 19 RA hospitalized patients. Among them, 69% were sensible to some meteorological variables (temperature, relative humidity and haziness).

The meteorological variables measurement is much more objective and less complicated than pain measurement. It basically consists of atmospheric pressure, temperature and relative humidity. For example, statistics refer to weather in the external environment, which can act on an individual's skin a different influence compared to the internal environment, biasing results. Almost all data related to time and joints pain came from homebodies which kept themselves warmed by clothing. When this homebodies occasionally went out to the external environment, only their hand joints were exposed to the weather, although only one study had mentioned the hand joints. None of the studies considered temperature variation in internal and external environments, nor exposition time in these environments. Trying to controll temperature, humidity, atmospheric pressure, and air flow variables, other authors idealized a climatizated environment where two participants were confined for two weeks, registering their "articular countdown", checking sensibility, edema, and movements pain with each joint in relation to sensibility, edema and pain during movements.

When searching for correlations between joints pain episodes and weather patterns, new investigations ought to include a wider range of parameters. Regarding pain, almost all studies published until nowadays have been referring to RA, OA and FM patients. In fact, these diseases are commonly related to weather-sensitive patients, and pain scale is quite variable. However, regarding the weather, six out of eight studies were

performed in periods up to three months; it is insufficient to include the full range of seasonal variations of the weather.

Half of the studies did not include a control-population, and only two studies presented a specific control-population of individuals without clinical evidences of rheumatic disease.[13,15] The others were internally controlled by several rheumatic diseases as RA, FM, systemic lupus erythematosus, Behçet and other inflammatory arthropathies. Thus, could authors assume that non-chronic rheumatic disease individuals would not experience any weather-related articular pain?

In the reviewed literature, the biggest mistake in study drawing, in addition to sample size, was the impossibility of keeping participants uninformed about the meteorological variations on the period they were elaborating their answers to the questionnaires about their articular pain intensity conditions. It was presumed that individuals, at some point, had known about climate conditions and weather forecast through the media. This information could be reflected unconsciously in the propensity to report OA pain. Only Hollander and Yeostros's study[9] canceled the meteorological forecasts influences, because individuals remained isolated in a climatized environment where authors controlled the meteorological variables regardless of the external environment conditions. Although this almost 50-year-old study is among the most rigidly controlled and produced a positive influence result, the subsequent studies continued showing conflicting results (Table 1).

Despite the analyzed studies', methodological diversity and obliquities, there is a frequency of significant results related to confirming the influence of weather conditions in the OA patients pain intensity, especially in the most recent publications. However, studies that concluded by a worsening relationship between joint pain and changes in meteorological variables did not survey their relationship with pain intensity, i.e., if this features would interfere in the patient's quality of life.

Therefore, in addition to checking weather effects in OA pain, more studies are needed to measure if this effect intensity interferes on the daily activities performance and to check if there is any possibility of damage in this individuals' quality of life.

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