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RESEARCH ARTICLE

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Under the Weather: A Survey Study Done on Weather and Pain in a Back Pain Clinic

Keqing Li[1], Pawel Rutkowski[2], William Yang[3], Elanit Berkower[4] and David Berkower DO[5]

[1]St. George's University School of Medicine, University Centre Grenada, West Indies, Grenada.
[2]Poznan University of Medical Sciences, Poznan, Poland.
[3]St. George's University School of Medicine, University Centre Grenada, West Indies, Grenada.
[4]University of Maryland, College of Computer, Mathematical, and Natural Sciences 2300 Symons Hall, 7998 Regents Dr, College Park, MD 20742.
[5]Berkower pain & Spine Rehabilitation, 1 SW 129th Ave STE 305, Pembroke Pines, FL 33027.

ABSTRACT

Many believe that bad weather exacerbates pain. Research results have shown inconsistent results until a large study, "Cloudy with a chance of pain," was done using the help of a mobile app. This study discovered a similar relationship between weather and pain in a different climate and lower back pain patients. Furthermore, we have seen a residual effect post-weather. We suspect that the patient's mental status affects weather rather than the compartment of body parts. We recommend the integration of cognitive-behavioral therapy (CBT) and serotonin-norepinephrine reuptake inhibitor (SNRI) into chronic pain management.

ARTICLE HISTORY

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Introduction

"When your joints all start to ache, rainy weather is at stake" [1]. Many of us have heard similar quotes about weather's effect on pain, especially arthritic pain. Research has long hypothesized that low barometric pressure can exacerbate pain among fibromyalgia patients and lab rats [2,3]. More studies have suggested relations among weather, mood, and pain [4]. However, other studies have shown inconsistent weather and pain [5, 6], specifically among lower back pain patients [7]. A recent survey study, "Cloudy with a chance of pain," done in the UK with large samples of patients followed throughout 12 months, has found a moderate effect relative humidity has on patients' pain levels through online survey [8]. This study hopes to extrapolate the findings to a climate different from the UK across a more diverse chronic pain patient population. We conducted our survey in sunny Florida, where the average temperature varies from 62 F to 90 F, and humidity reaches 100% from May to October [9]. We have included four weather types in our survey: rainy, cold, humid, and cloudy, which chronic pain patients have responded to the most throughout past research [2,3,8]. Moreover, our research focuses primarily on lower back patients, which differs from "Cloudy with a chance of pain." We are curious to see if the weather still impacts patients with different pain etiologies in a different climate.

Methods

Procedure

This survey study was carried out in the Berkower pain & Spine Rehabilitation located at Pembroke Pines, Florida, approved by Dr. Berkower. Three medical students were trained with standardized procedures to be survey collectors and interviewers. A trial run was performed prior to official data collection to standardize the data collection process. Student doctors were told to ask for patients' verbal and written consents first, then proceed to have patients fill out our pain and weather survey. Interviewers then proceed to fill out patients' biometric information based on their medical records at the clinic. All of the patients during the survey collection period were asked to fill out the survey with some of them consented, proceeded, and later collected as part of our data. Patients were instructed by interviewers to only answer "Yes" to the survey if there is a change of their pain level shown on the pain scale before, during, or after the specific weather. Some patients were confused about the questions and put in the same pain level before, during, and after the same weather. In such a case, the interviewers clarified the requirement once again and redirected the patient's intention, and such questionnaires were then completed with the patient's correct choice.

At the end of the first author and a data entry specialist completed all the data entry on spreadsheets during the data collection period. The first author later analyzed the data. This study used the same survey, consent form, and biometric page throughout the official survey collection.

Survey and data entry

Researchers first asked the patients to fill out the biometric page explaining what and how their data will be used during the study. Researchers only proceeded with the rest of the survey if the patient completed the consent form.

This study used Wong-Baker's pain scale as a reference for patients for the pain survey. There are five questions in total,

Contact: Keqing Li St. George's University School of Medicine, University Centre Grenada, West Indies, Grenada.

with the first question being, "Does the weather change your pain." The following four questions follow the same format as the first questions but on different weather, including rainy, cold, humid, and cloudy days. Interviewers instructed patients to fill out yes only if their pain level differs before, during, and after the specific weather.

Patients' age, gender, BP, HR, height, weight, BMI were extracted from the clinic's online data for the biometric page. The patient's most current pain levels, currently active pain medication, duration, and location of their pain were asked directly and reported by interviewers. All diagnoses were entered based on the clinic's medical records. Data entry specialists later grouped the diagnoses and pain medication.

The location of pain was grouped into seven categories: back including upper back, mid-back, and lower back; upper extremities including shoulders, arms, forearms, and hands; lower extremities including hip, thighs, legs, and feet; neck; joints including all joints; abdomen, and head.

Specifically, we identified diagnoses into six categories based on the different natures of diseases: noninflammatory pain, neuropathy, fibromyalgia, muscle spasm, inflammatory pain, and others. We stratified back pain, neck pain, spondylosis, spondylolisthesis, disc herniation, osteoarthritis into mechanical pain, diabetic neuropathy, neuropathy into neuropathy; fibromyalgia into its category; muscle spasm into its category; Bursitis, rheumatoid arthritis into inflammatory pain, and finally complex regional pain syndrome and all other diagnoses into the other category.

Pain medications were grouped into nine categories: Opioid, acetaminophen, non-steroidal anti-inflammatory drugs (NSAID), Lidocaine patch, tricarboxylic acid cycle (TCA), Gabapentin, steroid, muscle relaxant, and selective serotonin reuptake inhibitor/serotonin-norepinephrine reuptake inhibitors (SSRI/SNRI). Opioids include tramadol, oxycodone, hydrocodone-acetaminophen, and morphine. Acetaminophen is its category, NSAID includes Ibuprofen and Aleve. Lidocaine patch is its category. TCA includes amitriptyline and nortriptyline. Gabapentin includes gabapentin, and pregabalin. Muscle relaxant includes baclofen, cyclobenzaprine, and tizanidine. SSRI/SNRI includes duloxetine, fluoxetine, and citalopram.

Statistical analysis

Mean, medium, percentage, lowest range, and the highest range was calculated using the spreadsheet function for the biometric page. For the pain survey, two population Z score was employed to calculate the p-value for if the weather changes patients' pain level with a null hypothesis = 0.5, assuming patients answered Yes to this question randomly. To determine if there is a significant change of pain level before, during, and after for rainy days, cold days, humid days, and cloudy days, we used the Wilcoxon Signed-Ranked Test calculator based on the non-nominal distribution determined by the Kolmogorov-Smirnov test [10], dependent data sets, and the ordinal nature of pain scale. An alpha level of .05 was used for all analyses.

Results

Patient's demographics are shown in Table 1. The location of the pain, diagnosis, and treatment are summarized in Table 2. A total of 160 surveys were collected, with two being withdrawn from the study due to incomplete survey and change of consent. Patients enrolled in the study are predominantly middle-aged to senior (mean = 59.64 years old, SD = 16.97) with high pain intensity (mean = 7, SD = 0) and chronic pain conditions (mean = 10.19 years, SD = 0). The majority had pain located at the back (67.09%), with the diagnosis that belongs to our category of mechanical pain (84.18%) managed on opioids (65.82%).

Table 1: Patient demographics.

	All patients (N=158) Mean (SD)	Min-Max
Gender, number	Female, 91 Male, 67	
Age	59.64 (16.97)	25-91
Baseline pain	7 (0)	2-10
Duration of pain (years)	10.19 (0)	0.04-62
BMI	30.14 (3.17)	17.8-53.96

Two data sets withdrawn from the study due to incompleteness.

Table 2: Patient's diagnosis and treatment.

	All patients (N=158) Total Number	Percentage
Location of pain:		
Back	106	67.09
Upper extremities	22	13.92
Lower extremities	48	31.01
Neck	23	14.56
Joints	61	38.61
Abdomen	10	6.33
Head	7	4.4
Diagnosis:		
Mechanical pain	132	84.18
Inflammatory pain	10	6.3
Neuropathy	12	7.59
Fibromyalgia	7	4.43
Muscle spasm	35	22.15
Others	104	66.46
Pain medication:		
Opioid	104	65.82
Acetaminophen	29	18.35
NSAID	43	27.22
Lidocaine patch	6	3.80
TCA	1	0.63
Gabapentin	37	24.05
Steroid	2	1.27
Muscle relaxant	17	10.76
SSRI/SNRI	3	1.90

Two data sets withdrawn from the study due to incompleteness.

The pain survey results are shown in Table 3. 75.32% of the participants answered "Yes" to "Does the weather change your pain?", which is statistically significantly different from the possibility of our null hypothesis that people respond to this question randomly ($p<0.00001$). Most people (69.62%) answered that rainy days change their pain, followed by colder days (66.46%), humid days (35.44%), and cloudy days (26.58%). There are significant differences between the before vs. during, during vs. after, and before vs. after pain level ($p<0.00001$). Moreover, before vs. during and during vs. after have shown large effect sizes across all weather groups (>0.71), whereas

before vs. after shows medium effect sizes (>0.36).

Table 3: Analysis of change and comparisons of pain under different weather conditions.

All patient (N=158)	Number of "Yes"	Percentage	Mean	Z-score	Effect Size
Does the weather change your pain?	119	75.32		4.57	
Do rainy days change your pain?	109	69.62			
Before, Before vs. During			6.04	-8.19	0.84
During, During vs. After			8.03	-8.19	0.84
After, Before vs. After			6.68	-4.11	0.49
Do colder days change your pain?	105	66.46			
Before, Before vs. During			6.36	-5.95	0.82
During, During vs. After			8.42	7.31	0.78
After, Before vs. After			6.86	-3.21	0.42
Do humid days change your pain?	56	35.44			
Before, Before vs. During			6.49	-5.95	0.82
During, During vs. After			8.16	4.74	0.71
After, Before vs. After			7.10	-2.93	0.57
Do cloudy days change your pain?	42	26.58			
Before, Before vs. During			6.35	-5.13	0.81
During, During vs. After			7.97	4.33	0.82
After, Before vs. After			6.89	-1.72	0.36

Note: Z-score for the first question is analyzed using two population proportion test with H0=0.5. All the other Z scores are obtained using Wilcoxon Signed-Rank Test. Alpha is set at 0.05, and all p-values in the tables were < 0.0001.

Figure 1. compares participants' medium pain levels before, during, and after the four different weather types. The before pain level is shown to be the lowest, the during pain level is the highest, and the after-pain level is slightly higher than the before pain level across all four weather types. Differences between before vs. during, during vs. after, and before vs. after are all significant across all four weather types (p<0.0001).

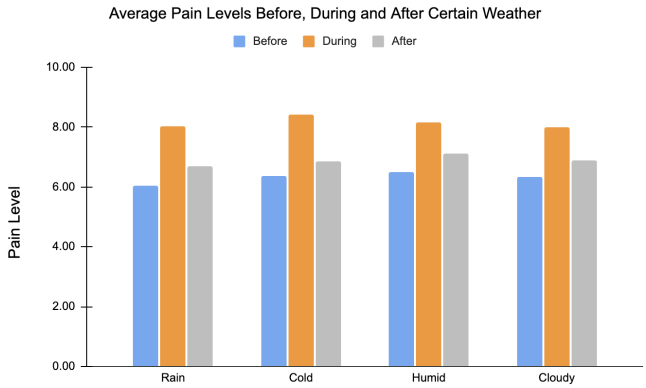

Figure 1.

Note: All p-values in the figure, including before vs. during, during vs. after, before vs. after were significant with alpha at 0.05.

Discussion

This study has demonstrated the considerable impact weather has on patients with chronic pain in the state of Florida. Moreover, our research shows that the effect of weather on pain can be replicated in different climates and across patients with other chronic pain etiology, such as lower back pain. The percentage of affected patients is similar to that of "Cloudy with a chance of pain" [8]. This statistical consistency implies that about ¾ chronic pain patients will get affected by weather regardless of the climate. Based on our survey results, all patients who reported "Yes" to weather's impact on pain level had an increase in their pain level during the specific weather. Most patients responded to rainy days followed by colder days, humid days, and cloudy days. However, on average, patients experienced a more significant increase in pain during colder days. In addition, there is a consistent decrease of pain level post-weather, but in comparison to their baseline pain level, still a minor increase. Patients' pain levels remained increased post weather before they eventually returned to their baseline level. This lag eludes that the relationship between weather and pain level might not be purely physical but more so psychological.

One of the most popular theories of how weather impacts pain is the barometric pressure theory [11], which states that body parts such as the bursa would swell under low barometric pressure, which irritates the diseased part of the body. This theory might explain the exacerbation of pain among rheumatoid arthritis patients. However, it is hard to generalize to patients with back pain considering the different underlying pathologies, primarily due to nerve irritations secondary to disc displacement. In addition, a drop in barometric pressure is commonly associated with earaches during flight, but there have been no reports on rheumatoid arthritis flare associated with flight [12]. The lack of temporal relationship between flying and arthritis flare-ups challenges the barometric pressure hypothesis.

Another theory looked at how dampened mood can impact people's perception of pain [13]. Some researchers have found that people's mood and cognition broadens in the spring after deprivation from long winter [4]. The "cloudy with a chance of pain" research also has a solid and independent association between mood and pain (OR 4.083) [3]. It is essential to recognize that pain, a highly subjective experience, has two components: the perception of sensory stimuli and the suffering, an emotional form of distress [14]. One of the most notable examples of how the experience of pain is highly subjective is that pain is interpreted as pleasure among patients with autism [14]. Perhaps the suffering during weather changes is manipulating the patients' experience in pain rather than the expansion of the body compartment.

Clinically, it is vital to address the suffering component of pain since pain, and depressive symptoms are often comorbid with each other. The concurrent rates of major depression and pain range from 38% in to 56% in different clinic settings [15]. Two large studies have found out that depressive symptoms can predict new-onset back pain [16,17]. Apart from clinical relevance, pain and depression have very similar underlying

biological mechanisms both involving deficiency of serotonin and norepinephrine [18,19]. Trials of SNRI, ketamine, cannabinoid, and cognitive behavioral therapy should be considered in chronic pain management, especially in cases where the pain is resistant to current pain medications [20].

The limitations of this study include a small sample, snapshot timeframe, and recall errors. However, since this patient population was universally surveyed during the 2-week time frame, we have eliminated confirmation biases based on the patient's belief in weather's impact on pain. In addition, despite the small sample size and the snapshot timeframe of the study, the results of this survey mirrored that of "Cloudy with a chance of pain." We are happy to see that chronic pain patients responded similarly to weather changes despite the differences in geographic locations and climates. Further study is needed to examine the correlation between bad weather, mood and pain level.

Conclusion

Weather changes impact and exacerbate chronic patients' perceptions of pain. This study found a clear relation between four weather conditions (cold, windy, humid, and cloudy) and exacerbation of people's pain levels. We hypothesize that the reasons behind the exacerbation are more so about the changes in subjective perception, the suffering part of the pain, than the changes in barometric pressures. Physicians should consider incorporate SNRI and CBT into the management of chronic pain syndrome.

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