Climatic Effects on Chest Pain, Headache, and Pain in Joint: Results from an Hospital at an Altitude of 1900 Meters

Göğüs Ağrısı, Baş Ağrısı ve Eklem Ağrısına İklimin Etkisi: 1900 Metre Yükseklikte Bir Hastaneden Alınan Sonuçlar

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Geliş Tarihi/*Received:* 15.03.2011
Kabul Tarihi/*Accepted:* 31.10.2011

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ABSTRACT Objective: We aimed to investigate the relationship between climate changes and the most commonly diagnosed three diseases according to ICD-10 coding registry of Ataturk University Hospital, located in Erzurum city center. **Material and Methods:** Between January 1 and December 31, 2009, 913 108 patients applied to Ataturk University Hospital outpatient clinics (including applications to the emergency unit). Data of 601 184 cases (65.8%) with an age range of 18-110 years were included in the study. The most common three diagnoses according to the ICD-10 codes were selected. These were "Other chest pain (R07.3)", "Headache (R51)", and "Pain in joint (M25.5)". Analyses were done to investigate the relationship between daily number of diagnoses and the studied meteorological values. **Results:** Mean age was 46.6 ± 17.6 years. Yearly averages of temperature, dew point, humidity, and atmospheric pressure were 5.50 ± 9.56°C (-28-22), -0.48 ± 7.30°C (-31-12), 69.27±15.0% (31-98) and 1017.28 ± 4.81 hPa (1000-1033), respectively. Pearson correlation analysis showed a significant positive correlation between M25.5 and temperature (r= 0.364, p< 0.001), dew point (r= 0.330, p<0.001), and atmospheric pressure (r= 0.140, p= 0.007) and a significant negative correlation between M25.5 and humidity (r= -0.234, p<0.001). There was no significant correlation between R07.3 as well as R51 and the meteorological variables (p> 0.05). In a linear regression analysis, temperature and atmospheric pressure were found as significant independent variables affecting number of daily admissions with M25.5. **Conclusion:** Meteorological variables affect daily admissions to hospital outpatient clinics with a diagnosis of "Pain in joint - M25.5". Contrary to classical knowledge, daily number of admissions due to "Pain in joint" has a negative correlation with humidity and has a positive correlation with atmospheric pressure.

Key Words: Climate; humidity; arthralgia; headache; chest pain; international classification of diseases; temperature

ÖZET Amaç: İklim değişiklikleri ile Erzurum şehir merkezindeki Atatürk Üniversite Hastanesinin ICD-10 kayıtlarına göre en sık başvuru yapılan üç hastalık arasındaki ilişkiyi araştırmayı amaçladık. **Gereç ve Yöntemler:** 1 Ocak-31 Aralık 2009 arasında 913 108 hasta Atatürk Üniversite Hastanesinin polikliniklerine başvurdu (acil servise başvurular dahil). Yaş aralığı 18-110 olan 601 184 (%65,8) olgunun verileri çalışmaya alındı. ICD-10 koduna göre en sık görülen üç hastalık seçildi. Bunlar 'göğüs ağrısı, diğer (R 07.3)', 'baş ağrısı (R51)' ve 'eklem ağrısı (M25.5)' idi. Günlük tanı sayıları ile çalışılan meteorolojik değerler arasındaki ilişkiyi kontrol etmek için inceleme yapıldı. **Bulgular:** Ortalama yaş 46,6 ± 17,6 yıldı. Sıcaklık, çiy oluşma derecesi, nem ve atmosfer basıncının yıllık ortalamaları sırasıyla 5.50 ± 9.56°C (-28-22), -0,48 ± 7,30°C (-31-12), 69,27 ± 15,0% (31-98), ve 1017,28 ± 4,81 hPa (1000-1033) idi. Pearson korelasyon analizinde M25.5 ve sıcaklık (r= 0,364, p<0,001), çiy oluşma derecesi (r= 0,330, p<0,001), ve atmosfer basıncı (r= 0,140, p= 0,007) arasında belirgin pozitif korelasyon, M25.5 ve nem arasında belirgin negatif korelasyon görüldü (r= -0,234, p<0,001). Meteorolojik değişkenler ile R07.3 ve R51 arasında anlamlı korelasyon yoktu (p>0,05). Doğrusal regresyon analizinde, sıcaklık ve atmosfer basıncının M25.5 nedeniyle günlük başvuru sayısını etkileyen önemli bağımsız değişkenler olduğu görüldü. **Sonuç:** İklimsel değişiklikler 'Eklem ağrısı- M25.5' tanısıyla hastane polikliniklerine günlük başvuruları etkilemektedir. Klasik bilginin aksine, 'eklem ağrısı' nedeniyle günlük başvuru sayısı ile nem arasında negatif korelasyon ve atmosfer basıncı arasında pozitif korelasyon vardır.

Anahtar Kelimeler: İklim; rutubet; artralji; başağrısı; göğüs ağrısı; hastalıkların uluslararası sınıflaması; ısı

doi: 10.5336/medsci.2011-23837

Turkiye Klinikleri J Med Sci 2012;32(2):389-93

There is an important relationship between environmental factors and health.[1-4] Ecological and climatological features are among environmental factors for which data are recorded throughout the year. Investigation of the relationship of these factors with human health and interpretation of the outcomes with regard to health services will be useful.

Time of the year and seasonal changes have been linked with morbidity and mortality.[5] Respiratory and cardiovascular diseases are the conditions which are particularly associated with the changes in the weather.[6] The effect of seasonal changes and weather is more pronounced on the infectious diseases, such as influenza.[7] As a result, patients may be advised to live in areas better for their health.

Epidemiological studies addressing effects of climate on diseases were done in different fields such as cardiovascular and respiratory problems, infectious diseases, rheumatologic diseases, and headache.[6,8-12] There are only limited studies from Turkey addressing this issue.[13-16]

Erzurum is a city with 700 thousand inhabitants, located in Eastern Turkey, with an altitude of approximately 1900 m showing a typical continental climate. It is one of the unique cities in the world having such a population at the given altitude.

This study aimed to investigate the relationship between climatic variables and the most common three diseases coded according to the International Classification of Diseases-10 (ICD-10) coding registry in Atatürk University Hospital located in Erzurum city center.

MATERIAL AND METHODS

Between January 1 and December 31, 2009, 913 108 patients applied to Atatürk University Hospital outpatient clinics (including applications to the emergency unit), in Erzurum city center, Turkey. Data were obtained from the main hospital registry. Patients below 18 years of age were excluded. The oldest person in the registry was 110 years old. The data of 601 184 cases (65.8%) with an age of 18-110 years were included to the study. Reporting data from a single center at a high altitude may be regarded as a disadvantage. However, Erzurum is one of the unique cities in the world at the given altitude, where this kind of analysis was not done before.

The most common three diagnoses according to the ICD-10 codes were selected. These were "Other chest pain (R07.3)", "Headache (R51)", and "Pain in joint (M25.5)". Main outcome measures were daily admission frequencies of each disease.

Daily mean climatological values of temperature, dew point, humidity and atmospheric pressure were obtained from the Turkish State Meteorological Service. Analyses were done to determine the relationship between daily number of diagnoses and the studied meteorological values.

Statistical analyses were done using the SPSS software. Independent samples t test, Pearson correlation analysis, and linear regression analyses were performed. Statistical significance level was set at $p< 0.05$.

RESULTS

Data of 601 184 patients who were between the ages 18 and 110 years were analyzed. Mean age (±SD) was 46.6 (±17.6) years. Of the included persons, 252 007 (41.9%) were males and 349 158 (58.1%) were females.

Yearly averages (±SD) of temperature, dew point, humidity and atmospheric pressure were 5.50 ± 9.56 (-28-22) °C, -0.48 ± 7.30 (-31-12) °C, 69.27 ± 15.0 (31-98) % and 1017.28 ± 4.81 (1000-1033) hPa, respectively.

Of the included samples, 79 726 patients (13.2%) had one of the most common ICD-10 diagnoses. Frequencies of the diagnoses were as follows: 36 603 (6.1%) were diagnosed as R07.3, 22 771 (3.8%) were diagnosed as R51 and 20 352 (3.4%) were diagnosed as M25.5.

The mean age of the patients with R07.3 was 55.4 ± 15.6 years, and it was more common among males [19790 (54.1%) vs. 16813 (45.9%)]. The mean age of the patients with R51 was 45.4 ± 17.2 years and it was more common among females [13961

(61.3%) vs. 8807 (38.7%)]. The mean age of the patients with M25.5 was 45.6 ± 16.7 years and it was more common among females [11445 (56.2%) vs. 8905 (43,8%)]. The difference between the males and the females with regard to all three diagnoses was statistically significant (p< 0.001, Table 1).

Mean admission frequencies were compared between weekdays (Monday thru Friday; n=261) and weekends (Saturday and Sunday; n=104). Patients with R07.3 and R51 admitted more frequently during the weekends (8.9±4.3% vs. 5.7±1,9%; t= 9.589, p<0.001 and 5.5±3.8% vs. 3.6±1.5%; t= 6.710, p<0.001, respectively). Patients with M25.5, on the other hand,e admitted more frequently during the weekdays (1.7±2.1% vs. 3.1±1.9%; t= -5.767, p<0.001; Table 1).

Pearson correlation analysis showed a significant positive correlation between M25.5 and temperature (r=0.364, p<0.001, Figure 1a), dew point (r=0.330, p<0.001, Figure 1b) and atmospheric pressure (r=0.140, p=0.007, Figure 1c), and a significant negative correlation between M25.5 and humidity (r=-0.234, p<0.001, Figure 1d and Figure 2). There was no significant correlation between R07.3 as well as R51 and the meteorological variables (p>0.05).

A linear regression model was developed to check for the factors effecting daily admission fre-

TABLE 1: Most frequent outpatient diagnoses with regard to age, sex and admission frequencies.

	Other chest pain	Headache	Pain in joint
Age (mean±SD)	55.4±15.6	45.4±17.2	45.6±16.7
Gender [n (%)]			
Male	19790 (54.1)	8807 (38.7)	8905 (43.8)
	p<0.001	p<0.001	p<0.001
Female	16813 (45.9)	13961 (61.3)	11445 (56.2)
Daily admission ratio (% ± Standard Deviation)			
Weekdays	1.9±5.7	1.5±3.6	2.1±1.7
	p<0.001	p<0.001	p<0.001
Weekends	4.3±8.9	3.8±5.5	1.9±3.1

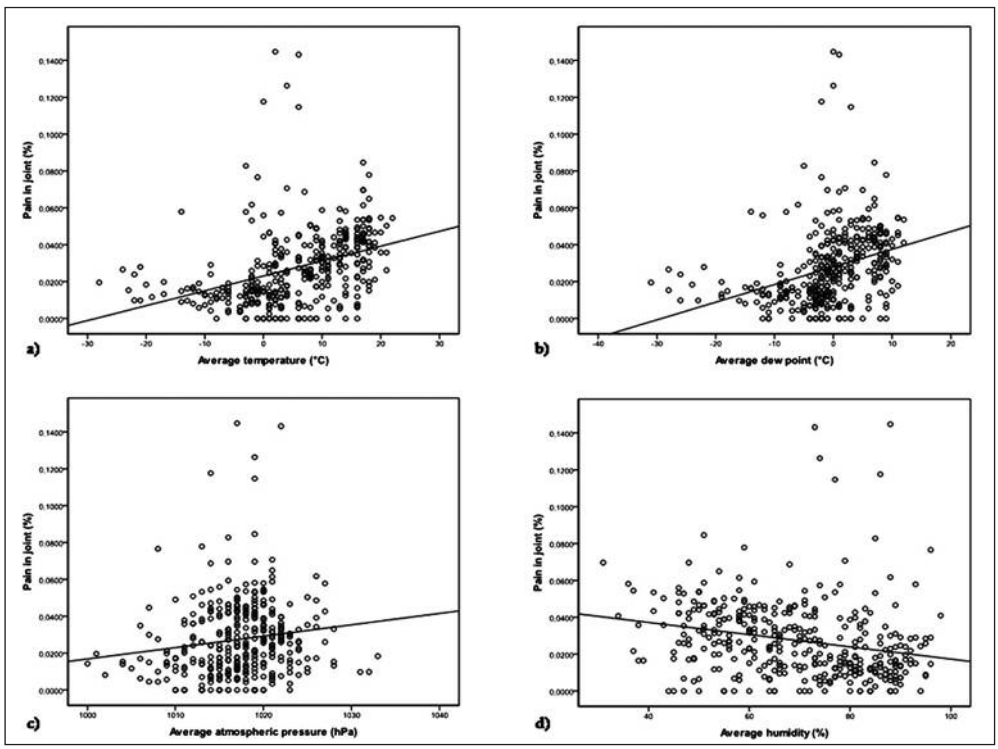

FIGURE 1: a) Correlation between average daily frequency of M25.5 (pain in joint) and average temperature. **b)** Correlation between average daily frequency of M25.5 and average dew point. **c)** Correlation between average daily frequency of M25.5 and average atmospheric pressure. **d)** Correlation between average daily frequency of M25.5 and average humidity.

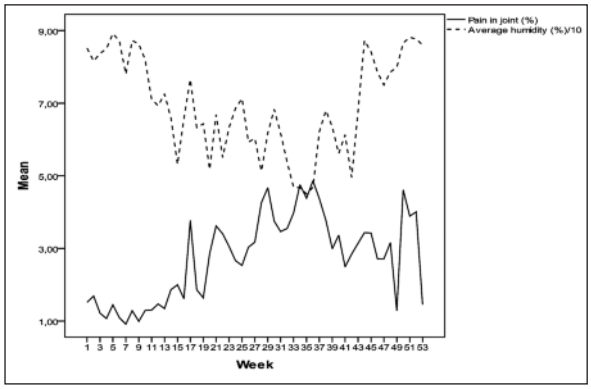

FIGURE 2: Line-graph of average M25.5 (Pain in joint) proportion and average humidity with regard to the time of the year.

quencies of each disease (dependent variables). Temperature, dew point, humidity and atmospheric pressure were used as independent variables. This model was able to predict 25.2% of the variables effecting admission frequencies for M25.5. In a stepwise analysis, temperature was entered the model first with a Beta of 0.474 and $p< 0.001$, and I was followed by atmospheric pressure with a Beta of 0.168 and $p= 0.002$. Models for R07.3 and R51 as the dependent variables were not significant ($p>0.05$).

DISCUSSION

This study revealed a relationship between meteorological values and the frequency of daily admissions with a diagnosis of "Pain in joint - M25.5". The other most frequent diagnoses ("Other chest pain - R07.3" and "Headache - R51") did not have such a correlation.

According to a review of United States hospitals, the most common three principal diagnoses are "Coronary atherosclerosis", "Acute myocardial infarction" and "Congestive heart failure" making 12% of the total admissions.[17] Osteoarthritis ranks as the fifth in that list. Although the proportion of the first three most common diagnoses are similar in our study, the specific diagnoses are different. Diagnoses in our hospital are more symptom-based. We attributed this difference to the difficulty of ICD coding and the relatively recent application of this coding system in Turkey (ICD coding was introduced to Turkish hospitals in 2005).

As expected, ICD code R07.3 was more common among males while R51 and M25.5 were more common among females.[18-20] Probably due to their nature of sudden onset and potential seriousness, patients with R07.3 and R51 were admitted more frequently during the weekends while those with M25.5 applied usually during the weekdays.

An interesting finding of this study was the negative correlation between the number of daily cases with "Pain in joint" and average daily humidity. According to the classical knowledge, rheumatic symptoms worsen in response to climatic factors, especially falling barometric pressure and rising humidity.[21] However, we observed completely opposite results; the number of daily admissions due to "Pain in joint" increased with increased atmospheric pressure but decreased with average humidity. The exact mechanisms how climatic changes precipitate or aggravate the rheumatic symptoms are not fully understood.[22] High altitude, thus relatively low atmospheric pressure in Erzurum might have contributed to this result.

Another interesting finding is increased admissions due to "Pain in joint" with increased atmospheric pressure. Similarly here, the classical knowledge indicates a negative correlation between pressure and pain.[22] A possible explanation of this apparently contradicting finding might be related with the silent receptors in tissues, which do not respond to stimuli under normal conditions. It can be postulated that increased atmospheric pressure may sensitize these unmyelinated neurons, leading to pain.

The results of the linear regression model support the aforementioned findings to some extent. Among the climatic variables included in the model, only temperature and atmospheric pressure are independent predictors of the number of daily admissions due "Pain in joint". Thus, we conclude that the interaction of the climatic variables, i.e.temperature, dew point, humidity and atmospheric pressure,are different at 1900 m compared to other places with lower altitudes.

CONCLUSION

Meteorological variables affect daily admissions to hospital outpatient clinics with the diagnosis of "Pain in joint - M25.5" although they are not related to the number of admissions due to "Other chest pain - R07.3" and "Headache - R51". Contrary to classical knowledge, daily number of admissions due to "Pain in joint" has a negative correlation with humidity and a positive correlation with atmospheric pressure at the studied altitude. Exact mechanisms behind the effect of atmospheric pressure to joint pain need further elaboration.

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