

THE RELATIONSHIP BETWEEN THE NUMBER OF PATIENTS ADMITTED TO THE EMERGENCY DEPARTMENT WITH ACUTE EXACERBATION OF COPD AND CERTAIN METEOROLOGICAL PARAMETERS

KOAH AKUT ALEVLENMESİ İLE ACİL SERVİSE BAŞVURAN HASTA SAYISININ METEOROLOJİK PARAMETRELER İLE İLİŞKİSİ

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ABSTRACT

AIM: This study, we aimed to determine the relationship between the number of patients admitted to the emergency department with acute exacerbation of Chronic Obstructive Pulmonary Disease (COPD) and certain meteorological parameters, including temperature, humidity, and air pressure.

MATERIAL AND METHOD: This study is a retrospective study. It was performed to determine the effect of temperature, air pressure and humidity factors in evaluating the frequency of attacks in patients admitted to the emergency department with COPD acute exacerbation. The subject group included patients who were admitted to the secondary public hospital emergency Department between 01.01.2017 and 31.12.2019.

RESULTS: According to the research findings, as the average temperature, maximum and minimum temperature decreased, the number of hospital admissions due to COPD attack increased. Seasonal change was found to be significant on the number of COPD admissions. Also, the COPD admissions made at the weekend were found to be significantly higher than during the week. A significant correlation was found between mean temperature and COPD attack frequency. There was no statistically significant relationship between humidity and pressure and the presentation of COPD attacks.

CONCLUSION: We determined the effect of climatic factors on the frequency of COPD attacks and that this effect was related with temperature. We found that as the temperature decreased, the admission to the emergency department increased with COPD exacerbation.

Key Words: COPD; Meteorological parameters; Emergency medicine; temperature; humidity; and air pressure.

ÖZET

AMAÇ: Biz çalışmamızda acil servise Kronik Obstrüktif Akciğer Hastalığı (KOAH) akut alevlenme ile gelen hastaların meteorolojik parametrelerden olan sıcaklık, nem ve hava basıncı etkisiyle hastaneye başvuru sayıları arasındaki ilişkiyi ortaya koymayı amaçladık.

GEREÇ VE YÖNTEM: Bu çalışma retrospektif bir çalışmadır. Acil servise KOAH akut alevlenme ile başvuran hastaların atak sıklığını değerlendirmede sıcaklık, hava basıncı ve nem faktörünün etkisini tespit etmek için yapıldı. Hasta grubu ikinci basamak bir devlet hastanesi acil servisine 01.01.2017-31.12.2019 tarihleri arasında başvuran hastalardan oluşturuldu.

BULGULAR: Araştırma bulgularına göre ortalama sıcaklık, maksimum ve minimum sıcaklık azaldıkça KOAH atak nedeni ile hastane başvuru sayısı artmıştır. Mevsimsel değişimin KOAH başvuru sayısı üzerinde anlamlı olduğu görülmüştür. Ayrıca hafta sonu yapılan KOAH başvuruları hafta içine göre anlamlı yüksek bulundu. Ortalama sıcaklık ile KOAH atak sıklığı arasında anlamlı ilişki tespit edilmiştir. Nem ve basınç ile KOAH atak başvurusu arasında istatistiksel olarak anlamlı ilişki gözlenmedi.

SONUÇ: Çalışmamızda iklimsel faktörlerin KOAH atak sıklığı üzerine etkisinin olduğunu gördük ve bu etkinin sıcaklıkla bağlantılı olduğunu tespit ettik. Sıcaklık azaldıkça KOAH alevlenme ile acil servise başvurunun arttığını bulduk. İklim değişikliklerinin etkisi nedeniyle bu konuda geniş çaplı çalışmalara ihtiyaç olduğu kanaatindeyiz.

Anahtar Kelimeler: KOAH; meteorolojik parametreler; acil servis; sıcaklık; basınç; nem

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INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a significant, preventable, and treatable public health issue (1). COPD is a leading cause of morbidity and mortality worldwide, and causes significantly increasing economic and social burden (2).

COPD exacerbation or flare-up is an acute worsening of respiratory symptoms that requires additional treatment. COPD exacerbations are often complex events associated with increased airway inflammation and increased mucus production. Exacerbations are usually caused by viral infections of the respiratory tract, but can also be triggered and/or aggravated by bacterial infections and environmental factors, such as pollution and ambient temperature (3).

Acute COPD exacerbations become more common during the cold season and summer heatwaves. COPD patients represent the highest risk group for climate-related exacerbations (4).

Global climate change is currently a paramount topic of discussion due to its various effects on human health (5,6). The impact of temperature and meteorological parameters, including relative humidity, wind, and air pressure, on respiratory diseases has been reported in recent studies (7,8).

Meteorological factors are one of the many external effectors of respiratory conditions. Various meteorological factors affect the respiratory tract to varying degrees, but the most significant are ambient temperature and humidity (9-13). Changes in weather conditions can commonly affect the respiratory system and increase the incidence of bronchial asthma, tracheitis, pneumonia, and other respiratory ailments (17). Weather conditions are thought to influence the respiratory system via two mechanisms: reducing immune resistance to infection and facilitating the spread of infections (15,16).

In the present study, it was aimed to determine the relationship between the number of patients admitted to the emergency department with acute exacerbation of COPD and certain meteorological parameters, including temperature, humidity, and air pressure.

MATERIAL AND METHOD

In this retrospective study's ethical approval was given by the Ethics Committee of Abdurrahman Yurtaslan Training and Research Hospital with the number 2020-08 / 747. The study aimed to evaluate the effect of temperature, air pressure, and humidity on the frequency of acute exacerbations among COPD patients admitted to the emergency department. The subject group included patients who were admitted to the secondary public hospital emergency Department between 01.01.2017 and 31.12.2019. Area of study is 795 meters above sea level. There is

more rainfall in the winter than in the summer. The annual average temperature of area study is 11.9 ° C. The annual average rainfall is 455 mm. The inclusion criteria were as follows: COPD diagnosis, being over 40 years of age, forced expiratory volume in 1 s (FEV1) <80%, being conscious and cooperative, not having a psychiatric diagnosis, emergency admission due to shortness of breath, increased cough and wheezing, as well as increased sputum purulence and volume, among other symptoms. The patient anamnesis, physical examination, and laboratory examination findings were reviewed. Concurrent air pressure, temperature, and humidity conditions were determined using regional meteorological data from the Turkish General Directorate of Meteorology. The number of patients admitted to the hospital with COPD exacerbations was compared with the meteorological data.

Statistical Analysis

The normality of data was tested using the Kolmogorov Smirnov test. The Spearman rank correlation coefficient was used to investigate the association between meteorological parameters and admissions for COPD. Generalized additive Poisson regression models were created to investigate the main effect of meteorological parameters on the number of COPD-related admissions, in addition to the effect considering a 5-day lag. The relationship between the number of applicants and the meteorological data on the date of admission and during the 5 days before admission (5-day lag) was examined. Penalized smoothing splines were used in the models to adjust for seasonal patterns and long-term trends in the number of COPD admissions. Day of the week (weekend or workday) was also included in the model to eliminate the travel effect. All univariate statistical analyses were performed using IBM SPSS for Windows 24.0 (IBM Corp., Armonk, NY, USA) and the generalized additive Poisson regression models were created using the mgcv library in R statistical software 3.5.1.(R Core Team, 2013). Regression coefficients (beta ± standard error) were calculated to determine the direction of the correlation.

RESULTS

During the 3-year study period, there were 6514 emergency admissions due to acute COPD exacerbation who met the inclusion criteria. Of these, 3814 were repeated admissions over the years. The mean age of the subjects was 66.1 ± 14.6 years, and 1404 (52%) were males. The mean number of admissions per capita was 2.4.

Overall, there was at least 1 COPD-related admission on 1082 out of 1095 days. There were 6 COPD-related admissions per day, on average. The average temperature was 13.6 degrees. The average humidity was 57 and the average actual pressure was 913 hektopaskal (hPA) (Table 1).

Table 1. General descriptive statistics.

	Days	Mean ± SD	Median (min-max)
COPD	1082	6.02 ± 3.2	6 (1-24)
Mean temperature	1095	13.64 ± 8.51	13.4 (-7.7-31.9)
Max temperature	1095	19.51 ± 9.74	20 (-5.3-38.9)
Min temperature	1095	8.28 ± 7.29	7.7 (-12-25.5)
Mean humidity	1095	57.28 ± 17.6	56 (17.6-98)
Mean pressure	1095	913.43 ± 4.64	913.4 (896.2-928.5)

Reduced mean, maximum, and minimum temperature values were associated with increased hospital admissions for acute exacerbation of COPD. Mean temperature, maximum temperature, and minimum temperature values were found to be weakly but significantly negatively correlated with COPD-related admissions ($r = -0.289, -0.289, -0.272$, respectively; $p = 0.001$). Furthermore, COPD admissions increased with increasing air pressure and humidity. There was a very weak but significant positive correlation between the mean pressure and COPD admissions ($r = 0.114$, $p = 0.001$) and a weak positive correlation between the mean humidity and COPD admissions ($r = 0.227$, $p = 0.001$). COPD admissions were found to have a weak negative correlation with the temperature (Table 2).

Seasonal changes were found to have a significant impact

on the number of COPD admissions. Moreover, COPD admissions were significantly higher during the weekend than during the week.

During the period of mean temperature, COPD-related admissions were higher on the day of admission (day 0) and after a 5-day lag. This finding was statistically significant ($p = 0.001, p < 0.05; p = 0.015, p < 0.05$) (Table 3). During the period of minimum temperature, COPD-related admissions were higher on the day of admission (day 0) and after a 5-day lag. This finding was statistically significant ($p = 0.012, p < 0.05; p = 0.019, p < 0.05$). However, during the period of minimum temperature, COPD-related admissions were significantly reduced after a 1-day lag ($p = 0.001, p < 0.05$). (Table 4) During the period of maximum temperature, COPD-related admissions were significantly lower on the day of admission ($p = 0.011, p < 0.05$) (Table 3).

Table 2. Correlations between the number of COPD admissions and meteorological parameters.

n = 1082		Mean temperature	Max temperature	Min temperature	Mean humidity	Mean pressure
COPD	r	-0.289*	-0.289*	-0.272*	0.227*	0.114*
	P-value	0.001	0.001	0.001	0.001	0.001

*Significance at $P < 0.05$; r: Spearman rank correlation coefficient.

Table 3. Correlations between the meteorological parameters.

		Max temperature	Min temperature	Mean humidity	Mean pressure
Mean temperature	R	0.985*	0.969*	-0.748*	-0.315*
	P-value	0.001	0.001	0.001	0.001
Max temperature	R	1.000	0.925*	-0.776*	-0.256*
	P-value		0.001	0.001	0.001
Min temperature	R		1.000	-0.628*	-0.389*
	P-value			0.001	0.001
Mean humidity	R			1.000	0.077*
	P-value				0.011

*Significance at $P < 0.05$; r: Spearman rank correlation coefficient.

Table 4. Average humidity and actual air pressure models.

	Average humidity		Average actual pressure	
	Beta ± standard error	P-value	Beta ± standard error	P-value
Day of the week	0.189 ± 0.026	0.001*	0.186 ± 0.026	0.001*
Day 0	0.001 ± 0.001	0.567	-0.0001 ± 0.005	0.979
1-day period before admission	0.002 ± 0.002	0.145	-0.001 ± 0.007	0.870
2-day period before admission	-0.0007 ± 0.002	0.705	-0.007 ± 0.007	0.320
3-day period before admission	-0.0001 ± 0.002	0.923	0.004 ± 0.007	0.501
4-day period before admission	0.001 ± 0.002	0.426	0.003 ± 0.007	0.876
5-day period before admission	-0.007 ± 0.001	0.618	-0.001 ± 0.005	0.994
Seasonality		0.001*		0.001*
	$R^2 = 28.9\%$		$R^2 = 29.2\%$	

*Significance at $P < 0.05$. R^2 values at the bottom of the Table show percent changes in the number of COPD admissions that are explained by significant changes in the model.

There was no statistically significant relationship between humidity and air pressure, and COPD exacerbation admissions (**Table 4**).

DISCUSSION

In the current study, after the data were adjusted to remove seasonal trends and day-of-the-week effect on emergency admissions due to acute COPD exacerbation, it was found that a 1°C decrease in the minimum temperature on the day of admission and after a 5-day lag was associated with a decrease of 0.01 cases. Moreover, a 1°C decrease in the mean temperature after a 5-day lag was associated with a decrease of 0.01 cases. Meteorological parameters other than temperature were not significantly associated with the number of COPD admissions.

Changes in weather conditions can commonly affect the respiratory system, frequently in the form of bronchial asthma, tracheitis, pneumonia, and other respiratory ailments (17). Climatic temperature stress affects membrane permeability and capillary resistance, in addition to perspiration, which renders the skin vulnerable to infection. Meteorological factors can change the structure of the nasal mucosa. The vasoconstriction of peripheral vessels leads to hypoxia, and the reduced ciliary movement in the respiratory tract impairs immunity (18). Cold weather can trigger excessive mucus production (19). An English study demonstrated that FEV1 was reduced in colder weeks when compared to warmer weeks (20). Numerous studies have shown that the incidence of respiratory infections increased with reduced air temperature (21–23). Ferrari et al. reported a 1% increase in outpatient COPD admissions associated with a temperature change of 0.56 °C (24). A study from Taiwan found that every 1 °C decrease in temperature was associated with a 0.8% increase in outpatient consultations for COPD exacerbations, and that emergency consultations increased during the colder months (25). Similarly, Tseng et al. reported a 0.8% increase in the exacerbation rate with each 1 °C decrease in air temperature. (26) Moreover, mean temperatures were closely and independently associated with the number of COPD-related hospitalizations. (27) Low temperatures have been associated with an increased risk of hospitalization due to COPD. (28) A large-scale study from Korea concluded that the lowest temperature was associated with acute exacerbations (29). Another cohort study from London from between 1995 and 2009 estimated that low-temperature exposure was associated with more severe COPD exacerbations (30). Similarly herein, it was found that hospital admissions due to COPD exacerbations significantly increased with decreasing average and minimum temperature values. The current finding was similar and consistent with previously reported results from different climatic regions.

In their study, Liu et al. noted that atmospheric pressure was positively correlated with the number of hospitalizations due to lower respiratory tract

infections (31). Lam et al. found that increased atmospheric pressure was associated with COPD-related hospitalizations (32). Tseng et al. similarly reported an association between increased air pressure and increased COPD exacerbations (26). Mann et al. reported that increased temperature and barometric pressure predicted the deterioration of respiratory status among patients with chronic lung disease (33). A study from Bavaria, Germany, demonstrated a positive correlation between barometric pressure and daily COPD-related consultations (24). In the present study, there was a weak positive correlation between the mean pressure and COPD admissions, but this finding was not statistically significant.

Another study investigated the relationship between climate factors, including humidity, and clinical diseases, and found that upper and lower respiratory tract infections were negatively correlated with relative humidity. (34) Yang et al. emphasized that people should be careful about respiratory infections on hot and humid days. (35) Tseng et al. found that humidity and sunshine duration were negatively associated with the rate of exacerbation. (26) Increased humidity can eliminate the risk of triggering a COPD flare-up. Rea et al. reported that long-term humidification therapy significantly reduced exacerbation days, increased time to first exacerbation, and improved lung function and quality of life in patients with COPD and bronchiectasis. They concluded that humidity may be a natural remedy against COPD flare-ups [36]. In the current study, although there was a weak positive correlation between humidity and the frequency of COPD flare-ups, this correlation was not statistically significant.

This study lacked data concerning factors that may influence the frequency of acute exacerbations, such as smoking, air-conditioning, or indoor activities. Moreover, the subjects were identified using ICD codes for COPD with acute exacerbation, and patient files. Hence, possible misdiagnoses may represent another limitation of the study.

CONCLUSION

It was concluded that climatic factors are associated with the frequency of COPD exacerbations and this effect is due to air temperature. It was determined herein that decreasing temperature was associated with increased emergency admissions due to COPD exacerbations. It is our belief that further large-scale studies are needed to investigate the impact of climate change.

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