Research Article

Pamukkale Medical Journal
doi:https://dx.doi.org/10.31362/patd.1320033

The relationship between COPD attack applications and air pollution in the emergency department

Acil serviste KOAH atağı başvuruları ile hava kirliliği arasındaki ilişki

Hülya Yılmaz Başer, Hale Nur Can

Posted date:26.06.2023 Acceptance date:21.08.2023

Abstract

Purpose: We aimed to investigate the relationship between air pollution, temperature and COPD attacks in two different centers.

Materials and methods: Two centers, Bandırma and Van, were included in the study. In addition, temperature grouping was also done. Air pollution and temperature values were obtained from official sites. COPD data were scanned retrospectively from hospital information management systems.

Results: In the first 3 months (Group 1) included in the study, the PM10 value, the number of COPD treatment in the emergency department (ED) and the number of COPD hospitalizations in the ED were also found to be high in Van (p=0.05, p=0.05 and p=0.034, respectively). In the last 3 months (Group 2) period included in the study, it was observed that the mean temperature was lower in Van, and the rate of hospitalizations and hospitalizations due to COPD were higher in Van (p=0.05, p=0.05, and p=0.05, respectively). In the correlation analysis, a strong positive correlation was found between PM10 value and COPD treatment and hospitalization for COPD in Group 1 (r;0.986, p<0.001 and r;0.885, p=0.019, respectively). In Group 2, a strong negative correlation was found between the decrease in air temperatures and COPD treatment in the ED, hospitalization due to COPD and hospitalization rates (r;-0.905, p=0.013, r;-0.966, p=0.002 ve r;-0.867, p=0.025, respectively).

Conclusion: COPD attacks are associated with temperature and air pollution. For COPD attacks in ED, possible increases in intensity can be estimated by closely monitoring air pollution parameters as well as temperature.

Keywords: Chronic obstructed pulmonary disease, COPD attack, air pollution, temperature, emergency medicine.

Yilmaz Baser H, Can HN. The relationship between COPD attack applications and air pollution in the emergency department. Pam Med J 2024;17:17-25.

Öz

Amaç: Çalışmamızda hava kirliliği, sıcaklık ve KOAH atakları arasındaki ilişkiyi iki farklı merkezde araştırmayı amaçladık.

Gereç ve yöntem: Bandırma ve Van olmak üzere iki merkez çalışmaya dâhil edildi. Ayrıca sıcaklık gruplandırması da yapılmıştır. Hava kirliliği ve sıcaklık değerleri resmi sitelerden alınmıştır. KOAH verileri geriye dönük olarak hastane bilgi yönetim sistemlerinden tarandı.

Bulgular: Çalışmaya alınan ilk 3 aylık dönemde (Grup 1) de Van' daki hava kirliliği ölçütü olan PM10 değeri Bandırma'ya göre daha yüksek saptanmıştır (p=0,05). Benzer şekilde acil serviste COPD tedavisi ve acil servisten COPD yatış sayıları da Van'da yüksek saptanmıştır (sırasıyla p=0,05 ve p=0,034). Çalışmaya alınan son 3 aylık periyodda sıcaklık ortalamasının Van' da daha düşük ve acil servisten COPD nedenli yatışların ve yatış oranının daha fazla olduğu gözlenmiştir (sırasıyla p=0,05, p=0,05 ve p=0,05). Yapılan korelasyon analizinde Grup 1' de PM10 değeri arttıkça acil serviste COPD tedavisi alma ve COPD nedenli yatışta kuvvetli bir pozitif korelasyon saptanmıştır (sırasıyla r;0,986, p<0,001 ve r;0,885, p=0,019). Grup 2' de hava sıcaklıklarının düşmesi ile acil serviste COPD tedavisi alma, COPD nedenli yatışta ve yatış oranlarında kuvvetli bir negatif korelasyon saptanmıştır (sırasıyla r;-0,905, p=0,013, r;-0,966, p=0,002 ve r;-0,867, p=0,025).

Sonuç: KOAH atakları sıcaklık ve hava kirliliği ile ilişkilidir. Acil servislerde KOAH atakları için sıcaklık yanı sıra hava kirliliği parametreleri yakından takip edilerek yoğunluktaki olası artışlar tahmin edilebilir.

Anahtar kelimeler: Kronik obstrüktif akciğer hastalığı, KOAH atağı, hava kirliliği, sıcaklık, acil tıp.

Yılmaz Başer H, Can HN. Acil serviste KOAH atağı başvuruları ile hava kirliliği arasındaki ilişki. Pam Tıp Derg 2024;17:17-25.

Hülya Yılmaz Başer, Assist. Prof. Bandirma Onyedi Eylül University, Department of Emergency Medicine, Balıkesir, Türkiye, e-mail: ylmz_hly_35@yahoo.com (https://orcid.org/0000-0002-1416-1521) (Corresponding Author)

Hale Nur Can, M.D. Van Yüzüncü Yıl University, Faculty of Medicine, Department of Emergency Medicine, Van, Türkiye, e-mail: halenurcan@gmail.com (https://orcid.org/0000-0002-8107-3986)

Introduction

Chronic obstructive pulmonary disease (COPD); It is characterized by progressive limitation of airflow that is completely irreversible. It is an important disease in both high-income and low-income countries worldwide. [1]. Several factors for the occurrence of COPD are well documented, such as genetics, smoking, occupational exposure, and chronic asthma, but the nature of exacerbations is not fully elucidated, although various aetiologies have been suggested for COPD exacerbations. [2, 3]. Although the role of air pollution in the development of COPD is still controversial in current studies, adverse effects of air pollution, particularly particulate matter (PM) and nitrogen oxides (NOx) on COPD risk, have been demonstrated [4-7]. Particularly, particulate matter with an aerodynamic diameter of less than 2.5 μm ($PM_{2.5}$) is an important risk factor for COPD [8]. Although regular measurements of each parameter are made at air measurement stations, PM_{10} values are usually measured. One important variable in COPD exacerbations is seasonal variation. Wise et al. [9] in the Tiotropium Safety and Performance In Respimat (TIOSPIR) study conducted by them, it was observed that exacerbations peaked in December, whereas severe attacks peaked in January, regardless of severity.

In our study, it was aimed to compare the relationship between air pollution, temperature and COPD attacks in two different centers between August and January.

Materials and methods

The study was approved by the health science Non-Interventional Research Ethics Committee of Bandırma Onyedi Eylül University.

Two centers, Bandırma and Van, were included in the study to better evaluate conditions such as air pollution and temperature difference. Both centers had a tertiary education and research hospital. Only adult emergency service (≥18 years old) applications were evaluated in the study. PM10 values of the air pollution data of the centers between August 2022 and January 2023 were taken from the air quality monitoring system of The Ministry of Environment, Urbanization and Climate (http://www.havaizleme.gov.tr) [10]. Air temperature measurements were obtained from the website of the General Directorate of Meteorology at https://www.mgm.gov.tr and from the website https://tr.weatherspark.com as the monthly average temperature [11, 12]. The parameters presented below were obtained from the hospital information management system retrospectively monthly.

- Number of admissions to the emergency department (ED)

- Number of patients treated for COPD in the ED

- Number of patients hospitalized with COPD from the ED

Statistical analysis

SPSS 22 program was used for statistical analysis. The normal distribution of data was tested with the Kolmagorov-Smirnow / Shapiro-Wilks test. Number, percentage, mean, median, standard deviation, and minimum-maximum expressions were used for descriptive statistics. Mann Whitney-U tests were used to compare the mean between 2 independent groups. Pearson correlation analyses or Spearman's correlation analyzes were used in the correlation between centers, air pollution parameters, temperature averages, number of admissions to the ED, number of patients treated for COPD in the ED, number of patients hospitalized with COPD from the ED, and rate of hospitalization from the ED. $P<0.05$ was accepted for statistical significance.

Results

The total number of ED admissions, the number of COPD patients treated in the ED, the number of patients hospitalized with COPD from the ED, and hospitalization rates were evaluated in both centers over 6 months. In Bandırma, the total number of applications to the ED 6 months period was 140141 people, the number of patients with COPD treated in the ED was 46 people, and the number of hospitalizations from the ED due to COPD was 15 people. Similar parameters were determined for Van as 96532 people, 87 people, and 48 people, respectively. In addition to ED information, basic information about air temperature and air pollution parameters is shown in Table 1.

Table 1. Basic information of the centers

Centers	Months	Air Pollution Parameter	Average Monthly Temperature (°C)	Number of admissions to the ED	Number of patients treated for COPD in the ED	Number of patients hospitalized with COPD from the ED	Hospitalization rate from the ED (%)
		PM_{10}					
Bandirma	August	32.90	24.0	20568	3	1	33.33
	September	31.29	20.5	20006	2	1	50.00
	October	36.51	16.0	21096	4	1	25.00
	November	46.17	10.5	23535	9	3	33.33
	December	49.04	7.5	29037	17	5	29.41
	January	45.46	6.0	25899	11	4	36.36
Van	August	44.52	21.0	16552	8	3	37.50
	September	43.58	17.0	15252	7	5	71.43
	October	44.99	11.0	16302	9	5	55.56
	November	49.61	5.0	15712	15	8	53.33
	December	46.25	1.0	18007	23	12	52.17
	January	53.07	-3.0	14707	25	15	60.00

ED; Emergency department, COPD; Chronic obstructive pulmonary disease, PM_{10}; Particulate Matter, SO_2; Sulfur Dioxide, NO_2; Nitrogen Dioxide

According to the seasonal grouping of Group 1 (August-September-October) and Group 2 (November-December-January), the comparison of air pollution parameters, temperature variables, and emergency parameters of the centers is shown in Table 2. In the first 3 months period (Group 1) included in the study, the PM_{10} value, which is the measure of air pollution in Van, was found to be statistically significantly higher than in Bandırma (p=0.05). Similarly, the number of COPD treatments in the ED and the number of COPD hospitalizations in the ED were also found to be high in Van (p=0.05 and p=0.034, respectively). No statistically significant difference was found between Bandırma and Van between PM_{10} values in the last 3 months period (Group 2) included in the study (p=0.127). It was observed that the mean temperature in Van was lower than in Bandırma, and the number of hospitalizations due to COPD from the ED and hospitalization rate was higher in Van than in Bandırma (p=0.05, p=0.05, and p=0.05, respectively).

In seasonal grouping, correlation analysis between institutional variation, PM_{10} value, average air temperature, number of admissions to the ED, number of patients treated for COPD in the ED, number of patients hospitalized with COPD from the ED and hospitalization rates in the results; In the first 3 months of the study (Group 1), a strong correlation was found between the PM_{10} value and the institutional relationship in favor of Van province (rho;0.878, p=0.021). As the PM_{10} value increased, a strong positive correlation was found between the number of patients treated for COPD in the ED and the number of patients hospitalized with COPD from the ED (r;0.986, p<0.001 and r;0.885, p=0.019, respectively). A similar relationship was not observed for air temperature averages (Table 3). In the last 3 months of the study (Group 2), no statistically significant relationship was observed between the PM_{10} value and the centers (p=0.135). It was observed that the air temperature decreased in Van as the center (rho;-0.878, p=0.021). Similarly, a strong negative correlation was found between the decrease in air temperatures and the number of patients treated for COPD in the ED, the number of patients hospitalized with COPD from the ED, and the hospitalization rate (r;-0.905, p=0.013, r;-0.966, p=0.002 and r;-0.867, p=0.025, respectively).

Table 2. Comparison of air pollution parameters, temperature variables, and emergency parameters of the centers according to the grouping of the months

		Group 1 (August, September, October)		*p*	Group 2 (November, December, January)		*p*
		Bandirma	**Van**		**Bandırma**	**Van**	
Air Pollution Parameters	**PM_{10} [median (min.; max.)]**	32.9 (31.29; 36.51)	44.52 (43.58; 44.99)	0.05	46.17 (45.46; 49.04)	49.61 (46.25; 53.07)	0.127
Average Monthly Temperature (°C) [median (min.; max.)]		20.5 (16; 24)	17 (11; 21)	0.513	7.5 (6; 10.5)	1 (-3; 5)	0.05
Number of admissions to the ED [median (min.; max.)]		20568 (20006; 21096)	16302 (15252; 16552)	0.05	25899 (23535; 29037)	15712 (14707; 18007)	0.05
Number of patients treated for COPD in the ED [median (min.; max.)]		3 (2; 4)	8 (7; 9)	0.05	11 (9; 17)	23 (15; 25)	0.127
Number of patients hospitalized with COPD from the ED [median (min.; max.)]		1 (1; 1)	5 (3, 5)	0.034	4 (3;5)	12 (8; 15)	0.05
Hospitalization rate from the ED (%) [median (min.; max.)]		33.33 (25; 50)	55.55 (37.50; 71.43)	0.127	33.33 (29.41; 36.36)	53.33 (52.17; 60)	0.05

ED; Emergency department. COPD; Chronic obstructive pulmonary disease, PM_{10}; Particulate Matter, Min.; Minimum, Max.; Maximum

Table 3. Results of correlation analysis groups and parameters

			Centers	Air Pollution Parameter PM_{10}	Average Monthly Temperature (°C)	Number of patients treated for COPD in the ED	Number of patients hospitalized with COPD from the ED	Hospitalization rate from the ED (%)
Gruop 1	Centers	Correlation Coefficient	1.000	0.878	-0.293	0.878	0.949	0.683
		Sig. (2-tailed)	-	0.021	0.573	0.021	0.004	0.135
		N	6	6	6	6	6	6
	Air Pollution Parameter PM_{10}	Correlation Coefficient	0.878	1.000	-0.572	0.986	0.885	0.433
		Sig. (2-tailed)	0.021	-	0.235	<0.001	0.019	0.391
		N	6	6	6	6	6	6
	Average Monthly Temperature (°C)	Correlation Coefficient	-0.293	-0.572	1.000	-0.595	-0.633	-0.365
		Sig. (2-tailed)	0.573	0.235	-	0.213	0.177	0.477
		N	6	6	6	6	6	6
Group 2	Centers	Correlation Coefficient	1.000	0.683	-0.878	0.683	-0.878	-0.878
		Sig. (2-tailed)	-	0.135	0.021	0.135	0.021	0.021
		N	6	6	6	6	6	6
	Air Pollution Parameter PM_{10}	Correlation Coefficient	0.683	1.000	-0.614	0.621	0.649	0.578
		Sig. (2-tailed)	0.135	-	0.195	0.188	0.164	0.229
		N	6	6	6	6	6	6
	Average Monthly Temperature (°C)	Correlation Coefficient	-0.878	-0.614	1.000	-0.905	-0.966	-0.867
		Sig. (2-tailed)	0.021	0.195	-	0.013	0.002	0.025
		N	6	6	6	6	6	6

ED; Emergency department. COPD; Chronic obstructive pulmonary disease, PM_{10}; Particulate Matter, Min; Minimum, Max; Maximum

Discussion

In our study, there is a positive relationship with air pollution and a negative relationship with air temperatures between COPD treatment in the emergency room and the number of COPD hospitalizations in the emergency room. COPD is a life-threatening progressive lung disease that obstructs airflow from the lung, predisposing to exacerbations and serious illness [13]. COPD attacks, one of the most common causes of hospitalization, pose the greatest burden on the health system in developed countries [14]. Environmental factors and air pollution are thought to be the second most common cause of COPD attacks after infections. In studies conducted in the USA and Europe, it has been shown that the rate of admission to the hospital for COPD attacks increases when the number of respirable particles (<10μm) and the amount of "ozone" in the air increase [15]. Although epidemiological data show that increased air pollution is associated with a slight increase in COPD attacks and hospital admissions, its mechanism is not well known [16]. As a mechanism, air pollution particles induce proinflammatory immune responses in multiple immune cell classes by affecting different types of immune cells such as macrophages, inflammatory neutrophils, as well as mucosal irritation [17]. The clinical effects of air pollution, particularly the known association between high ambient pollution and attacks of asthma and COPD, are consistent with these identified immunological mechanisms [17].

Air pollution; can be defined as the presence of pollutants such as particulate matter (PM), sulfur dioxide (SO_2), and nitrogen oxides (NOx) in the outdoor air we breathe at levels that will have negative effects on the environment and health [18]. According to the World Health Organization (WHO) studies, upper limits have been determined for the annual average density values of these gases that cause air pollution. WHO has stated that the annual average value of 40 μg/m3 for NO_2, the ratio of SO_2 concentration in the air to 500 μg/m3 for 10 minutes on average, and that for PM_{10} this value exceeds the annual average of 25 μg/m3, the ambient air is polluted and inhaled [19]. Shehu et al. [14] showed that there is a relationship between COPD and environmental pollution. Wang et al. [20] showed in their study that long-term exposure to air pollution, including $PM_{2.5}$, PM_{10}, NOx, and NO_2, was positively associated with the risk of COPD. The proven effects of air pollution include chronic obstructive pulmonary disease and exacerbations of pre-existing obstructive airway disease, as well as lung cancer [20, 21].

The relationship between air pollution and COPD attacks is also stated in the literature. In studies conducted in İzmir and Eskişehir, an increased relationship was found between PM and SO2 levels and increased nasal resistance, and increased COPD emergency hospital admissions [22, 23]. In the study conducted by Fişekçi et al. [24] from Denizli, a correlation was observed between the average SO_2 and PM of the previous week and emergency hospital admissions due to COPD. In the same study, it was stated that the relative risk ratio in emergency admissions due to COPD increased with the increase in daily SO_2 and PM amounts [24]. In our study, we observed that the number of patients treated for COPD in the ED increased with air pollution (PM_{10}) in group 1. Jenkins et al. [25] In the TORCH (TOwards a Revolution in COPD Health) study, it is stated that while attacks are seen in 9% of patients in the northern hemisphere between November and February, this rate drops to 5% between June and August. Similarly, Wise et al. [9] reported that COPD exacerbations peaked in December in the TIOSPIR study. This may explain the difference between air pollution and the number of patients admitted to the emergency department for COPD treatment between the centers (Bandırma and Van) in August, September, and October in our study. Extremely cold temperatures, together with increases in mortality and morbidity in people with COPD, have an impact on lung function and COPD attack risk [26]. A large study using national health insurance registry data in Taiwan found a 0.8% increase in COPD episodes for every 1°C decrease in mean daily temperature [27]. This pathogenesis is explained in the literature by considering mucus hypersecretion as a potential mediator of the cold response of COPD, in addition to the bronchoconstriction and inflammation that may occur with cold exposure [28, 29]. The difference in the number of patients treated for COPD in the ED, number of patients hospitalized with COPD from the ED, and hospitalization rates, which includes

November, December, and January, in which air pollution between centers was observed in our study, supports this situation in the literature. In addition, the negative correlation between temperature and the number of patients treated for COPD in the ED, the number of patients hospitalized with COPD from the ED, and hospitalization rates in the same seasonal period supports this situation.

As a result, COPD attacks are associated with seasonal temperature and air pollution. Although seasonal changes can be taken into account in the provision of emergency services, possible increases in intensity can be predicted by closely monitoring air pollution parameters. There is a need for large randomized controlled multicenter studies on this subject.

Conflict of interest: The authors declare that there is no conflict of interest.

References

1. Ko FWS, Hui DSC. Air pollution and chronic obstructive pulmonary disease. Respirology 2012;17:395-401. https://doi.org/10.1111/j.1440-1843.2011.02112.x
2. Burge AT, Cox NS, Abramson MJ, Holland AE. Interventions for promoting physical activity in people with chronic obstructive pulmonary disease (COPD). Cochrane Database Syst Rev 2020;4:CD012626. https://doi.org/10.1002/14651858.CD012626.pub2
3. Gonlugur U, Gonlugur T. Seasonal variations in exacerbations of chronic obstructive pulmonary disease. Kocaeli Medical J 2020:140-146. https://doi.org/10.5505/ktd.2020.78055
4. Park J, Kim HJ, Lee CH, Lee CH, Lee HW. Impact of long-term exposure to ambient air pollution on the incidence of chronic obstructive pulmonary disease: a systematic review and meta-analysis. Environ Res 2021;194:110703. https://doi.org/10.1016/j.envres.2020.110703
5. Schikowski T, Adam M, Marcon A, et al. Association of ambient air pollution with the prevalence and incidence of COPD. Eur Respir J 2014;44:614-626. https://doi.org/10.1183/09031936.00132213
6. Shin S, Bai L, Burnett RT, et al. Air pollution as a risk factor for ıncident chronic obstructive pulmonary disease and asthma. A 15-year population-based cohort study. Am J Respir Crit Care Med 2021;203:1138-1148. https://doi.org/10.1164/rccm.201909-1744OC
7. Andersen ZJ, Hvidberg M, Jensen SS, et al. Chronic obstructive pulmonary disease and long-term exposure to traffic-related air pollution: a cohort study. Am J Respir Crit Care Med 2011;183:455-461. https://doi.org/10.1164/rccm.201006-0937OC
8. Chen L, Cai M, Li H, et al. Risk/benefit tradeoff of habitual physical activity and air pollution on chronic pulmonary obstructive disease: findings from a large prospective cohort study. BMC Med 2022;20:70. https://doi.org/10.1186/s12916-022-02274-8
9. Wise RA, Calverley PM, Carter K, Clerisme Beaty E, Metzdorf N, Anzueto A. Seasonal variations in exacerbations and deaths in patients with COPD during the TIOSPIR® trial. Int J Chron Obstruct Pulmon Dis 2018;13:605-616. https://doi.org/10.2147/COPD.S148393
10. The air quality monitoring system of the T.C. Ministry of Environment, Urbanization and Climate. Available at: http://www.havaizleme.gov.tr. Accessed February 24, 2023
11. The General Directorate of Meteorology. Available at: https://www.mgm.gov.tr. Accessed February 24, 2023
12. Weather Spark. Available at: https://tr.weatherspark.com. Accessed February 24, 2023
13. Mathers CD, Loncar D. Projections of global mortality and burden of disease from 2002 to 2030. PLoS Med 2006;3:442. https://doi.org/10.1371/journal.pmed.0030442
14. Shehu E, Farruku H, Smaili H. Air pollution and socio-economic determinants of chronic obstructive pulmonary disease in albania. Curr Health Sci J 2022;48:51-56. https://doi.org/10.12865/CHSJ.48.01.07
15. Erdem E. Kronik obstrüktif akciğer hastalığı akut atak etkenleri ve solunum fonksiyon parametreleri ile ilişkisi. Yayınlanmamış Yüksek Lisans Tezi. Fırat Üniversitesi Tıp Fakültesi Göğüs Hastalıkları Anabilim Dalı, Elazığ, 2011.
16. Anderson HR, Spix C, Medina S, et al. Air pollution and daily admissions for chronic obstructive pulmonary disease in 6 European cities: results from the APHEA project. Eur Respir J 1997;10:1064-1071. https://doi.org/10.1183/09031936.97.10051064
17. Glencross DA, Ho TR, Camiña N, Hawrylowicz CM, Pfeffer PE. Air pollution and its effects on the immune system. Free Radic Biol Med 2020;151:56-68. https://doi.org/10.1016/j.freeradbiomed.2020.01.179
18. Bayram H, Dörtbudak Z, Evyapan Fişekçi F, Kargın M, Bülbül B. Hava kirliliğinin insan sağlığına etkileri, dünyada, ülkemizde ve bölgemizde hava kirliliği sorunu" paneli ardından. Dicle Tıp Dergisi 2006;33;105-112.
19. Okan J. İktisadi kalkınma, hava kirliliği ve sağlık ilişkisi: panel veri analizi. Yayınlanmamış Yüksek Lisans Tezi. Yıldız Teknik Üniversitesi Sosyal Bilimler Enstitüsü İktisat Ana Bilim Dalı İktisat Yüksek Lisans Programı, İstanbul, 2017.
20. Wang L, Xie J, Hu Y, Tian Y. Air pollution and risk of chronic obstructed pulmonary disease: the modifying effect of genetic susceptibility and lifestyle. EBioMedicine 2022;79:103994. https://doi.org/10.1016/j.ebiom.2022.103994

21. Khilnani GC, Tiwari P. Air pollution in India and related adverse respiratory health effects: past, present, and future directions. Curr Opin Pulm Med 2018;24:108-116. https://doi.org/10.1097/MCP.0000000000000463
22. Özüer MZ, Günhan Ö, Cura O. Değişik klimatolojik ve hava kirliliği değerlerinin nazal rezistansa etkisi. KBB ve Baş Boyun Cerrahisi Dergisi 1999:7:91-95.
23. Ünsal A, Metintaş M, Öner S, İnan OÇ. Eskişehir'de hava kirliliği ve bazı hastalıklar nedeniyle acil başvuruların incelenmesi. Tüberküloz ve Toraks Dergisi 1999;47:449-455.
24. Fişekçi F, Özkurt S, Başer S, Daloğlu G, Hacıoğlu M. Effect of air pollution on copd exacerbations. Eur Respir J 1999;14:393.
25. Jenkins CR, Celli B, Anderson JA, et al. Seasonality and determinants of moderate and severe COPD exacerbations in the TORCH study. Eur Respir J 2012;39:38-45. https://doi.org/10.1183/09031936.00194610
26. Hansel NN, McCormack MC, Kim V. The effects of air pollution and temperature on COPD. COPD 2016;13:372-379. https://doi.org/10.3109/15412555.2015.1089846
27. Tseng CM, Chen YT, Ou SM, et al. The effect of cold temperature on increased exacerbation of chronic obstructive pulmonary disease: a nationwide study. PLoS One 2013;8:e57066. https://doi.org/10.1371/journal.pone.0057066
28. Koskela HO, Koskela AK, Tukiaineu HO. Bronchoconstriction due to cold weather in COPD. The roles of direct airway effects and cutaneous reflex mechanisms. Chest 1996;110:632-636. https://doi.org/10.1378/chest.110.3.632
29. Li M, Li Q, Yang G, Kolosov VP, Perelman JM, Zhou XD. Cold temperature induces mucin hypersecretion from normal human bronchial epithelial cells in vitro through a transient receptor potential melastatin 8 (TRPM8)-mediated mechanism. J Allergy Clin Immunol 2011;128:626-634. https://doi.org/10.1016/j.jaci.2011.04.032

Ethics committee approval: The study was approved by the health science Non-Interventional Research Ethics Committee of Bandırma Onyedi Eylül University (The approval date: 23.02.2023 and number is 310)

Authors' contributions to the article

H.Y.B constructed the main idea and hypothesis of the study. H.Y.B developed the theory and arranged/edited the material and method section. H.Y.B and H.N.C have done the evaluation of the data in the Results section. Discussion section of the article written by H.Y.B.

H.Y.B and H.N.C reviewed, corrected and approved. In addition, all authors discussed the entire study and approved the final version.