Orginal Article

International Journal of Basic and Clinical Studies (IJBCS)

2020; 9(2): 68-75 Akis Yildiz Z. Et all.

The Association Between Meteorological Factors and the Incidence of Spontaneous Pneumothorax in Adolescents

Zeliha Akis Yildiz[1*], Ceyhan Sahin[1], Nihan Ayyildiz[1], Mehmet Arpacik[1], Tugba Guvenc[1], Semih Mirapoglu[1], Aytekin Kaymakci[1], Zekeriya Ilce[1]

[1] Universty of Health Sciences Istanbul Umraniye Training and Research Hospital, Istanbul, Turkey

[*]Corresponding Author: Zeliha Akis Yildiz, Adress: Universty of Health Sciences Istanbul Ümraniye Training and Research Hospital, Istanbul, Turkey, email:zelihaakis@gmail.com

In the research, the association between the meteorological factors, and the incidence of primary spontaneous pneumothorax (PSP) in childhood were examined.

The data related to 103 patients who were in their childhood and had PSP were analyzed retrospectively by using the software of IBM SPSS Statistics 22. The meteorological data, which was obtained from the 1st Regional Directorate of Istanbul Meteorology, including the means of monthly atmospheric pressure (AP), temperature, wind speed, humidity, sunshine duration were compared with the data related to the days when PSP occurred. Shapiro Wilk test was used to determine the suitability of the data, while the Mann Whitney U test, Friedman test and Kruskal Wallis tests were used to compare the data. Significance was evaluated based on $p<0.05$.

It was determined that PSP occurred more frequently in the summer months (June, July, August). Besides, it was found out that the AP was statistically significantly lower at 3 days before the occurrence of PSP compared to the days when PSP didn't occur ($p <0.05$). Moreover, it was identified that there was no correlation between the PSP, and the data comprising of temperature, humidity, wind speed, and duration of sunshine ($p>0.05$).

It was found that PSP was associated with a decrease in atmospheric pressure 72 hours before the occurrence of pneumothorax in children, whereas it was not associated with temperature, wind speed, humidity, duration of sunny and cloudy weather.

Key words: Spontaneous Pneumothorax, Meteorology, Adolescent, Incidence

IJBCS
ISSN: 2147-1428

Orginal Article

International Journal of Basic and Clinical Studies (IJBCS)

2020; 9(2): 68-75 Akis Yildiz Z. Et all.

Introduction

Spontaneous pneumothorax (SP) is an abnormal accumulation of air in the pleural space, which could occur due to a trauma or any overt precipitating factor.
It is considered to develop due to the alveolar rupture of subpleural emphysematous bullae that is located in the apex of the lung, but the pathogenesis of the bullae and the exact cause of the rupture are not yet known. Spontaneous pneumothorax is sub-classified as primary and secondary spontaneous pneumothorax (SSP). PSP develops in the absence of any underlying lung disease. Whereas, SSP occurs with an underlying lung illness or pleural condition such as emphysema, asthma, bronchitis, and tumor (1,2,3). PSP mostly occurs among thin, tall adolescents and young adults (3). Recent studies have revealed that PSP might be associated with meteorological changes and air pollution (4,5,6,7). However, when we reviewed the English literature, we did not find any related meteorological studies, population of which consist of children. Our research intends to reveal whether the SP among the child age group is affected by meteorological factors.

Materials and Methods

Records, which were obtained from the electronic registry system of the hospital and belong to 780 patients who had been diagnosed with pneumothorax at the Ümraniye Training and Research Hospital (ÜTRH) between January 2010 and December 2019, were analyzed retrospectively. A total of 103 adolescents, who were admitted to the emergency department due to the onset of dyspnea and chest pain between the ages of 13 and 18 years, and who had been diagnosed with pneumothorax through physical examination and chest radiography, were included in the research. Cases of traumatic pneumothorax, and the pneumothorax (secondary pneumothorax), which were caused by lung diseases, were excluded from the study, as well as the recurrent cases, and the cases, which occurred outside the districts of Ümraniye and Sancaktepe.
The distribution of the cases related to their ages, genders, seasons, and months were examined. Meteorological data, which was based on the measurements of Samandıra Airport, about 10 km to UTRH, were obtained from the 1st Regional Directorate of Istanbul Meteorology. Means of the monthly meteorological data related to each case, which was induced by pneumothorax, were recorded on the day of application (D0), the previous 3 days (D1, D2, D3) and on the days of absence. Meteorological data were recorded as hectopascal (hPa), centigrade (ºC), percent (%), meter/second (m/sec), and hours (h), in terms of atmospheric pressure, temperature, humidity, wind speed, and duration of sunny weathers, respectively.
Our research was approved by the Ethical Committee of UTRH and was performed in compliance with the Helsinki Declaration.

Statistical Analysis

In order to evaluate the findings of the research, the software of IBM SPSS Statistics 22 was used in statistical analysis (IBM SPSS, Turkey). The Shapiro Wilk test was used to determine the normality of the distribution related to data of the research. When analyzing the data of research, the Mann Whitney U test was used for comparing the descriptive statistical data (mean, standard deviation, frequency) as well as the parameters that did not conform to the normal distribution in the comparison of quantitative data. Friedman test was used to compare the levels of parameters, when it did not conform to a normal distribution as well as for the levels of the 1 day before, 2 days before and 3 days before the occurrence of pneumothorax. Kruskal Wallis Test (post hoc Mann Whitney U Test) was used to evaluate the changes in pressure, temperature, and wind data of consecutive months. Significance was evaluated at $p<0.05$.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study has received no financial support.

Results

The study was performed on 103 cases consisting of 13 (12,6%) females and 90 (87,3%) males, whose ages ranged between 13 and 18. The mean age of patients was 16.67±1.05 years.
Upon the examination of the distribution of the patients with regard to seasons, it was determined that the summer season (June, July, August) had the uppermost number of admitted patients and it was followed by the spring (March, April, May) season. Whereas, winter (December, January, February) and autumn (September, October, November) seasons had fewer patients who had applied to the hospital (Graphic 1).

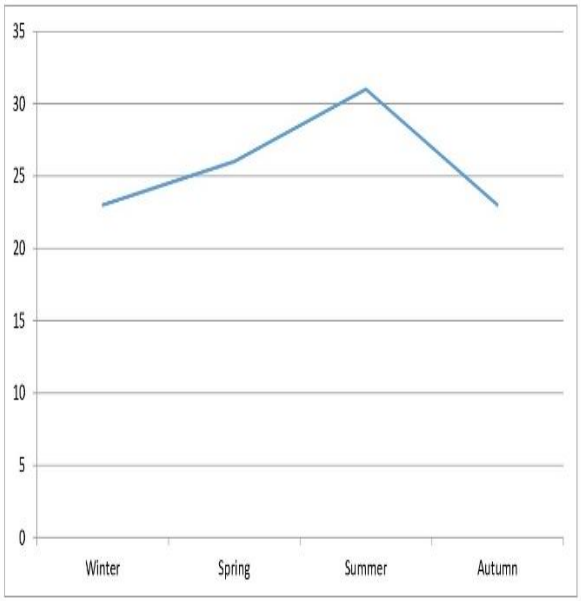
Based on the analysis of the distribution of patients per month, it was found out that the highest number of patients who applied to hospital was in June, whereas October had the lowest number of patients. There were more patient admissions in June than in other months (Graphic 2).

IJBCS
ISSN: 2147-1428

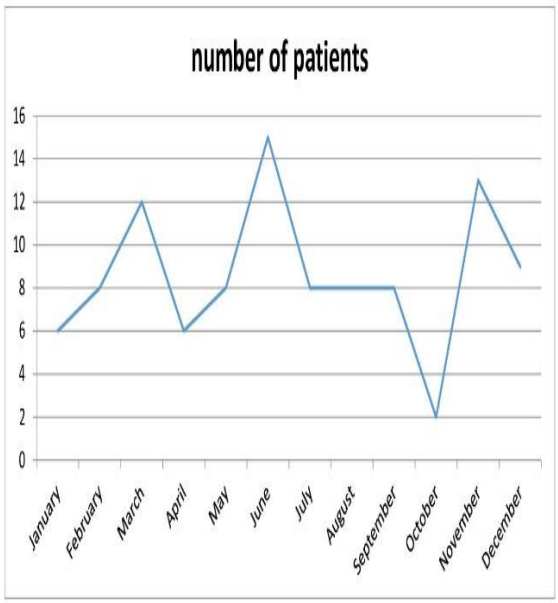
Orginal Article

International Journal of Basic and Clinical Studies (IJBCS)

2020; 9(2): 68-75 Akis Yildiz Z. Et all.



Graphic 1. Frequencies of Patients per Seasons



Graphic 2: Prevalence of pneumothorax per months

From the occurrence day of PSP backward, a repeated measurement test was performed to compare the temperature, wind, and pressure values of the D0, D1, D2, and D3. A repeated measurement test was conducted to compare the temperature, wind, and pressure values of each day. Based on the results of the test it was determined that the variation in the related data was not statistically significant.

The day, on which patients applied with PSP, was described as D0, while the previous day of the occurrence was considered as D1, 2 days before it as D2 and 3 days before as D3. Based on the results of the analysis it was found out that there was no statistically significant difference between the temperatures of D0, D1, D2, D3; daily temperature difference of D0, D0 sunshine time, wind values of D0, D1, D2, D3; daily average humidity of D0; air pressures of D0, D1, D2, D3, and related values of the PSP occurrence days. However, the pressure values of D3 were found to be lower than days with the absence of any PSP occurrence and the difference between them was statistically significant (Table 1).

IJBCS ISSN: 2147-1428

Orginal Article

International Journal of Basic and Clinical Studies (IJBCS)

2020; 9(2): 68-75 Akis Yildiz Z. Et all.

Table 1. Meteorological data for days with and without the incidence of pneumothorax

	Days with the Incidence of Pneumothorax **Mean ± SD**	Days without the Incidence of Pneumothorax **Mean ± SD**	P significance
Temperature 0 (^{0}C)	15.21±7.49	15.16±6.81	0.810
Temperature 1(^{0}C)	15.18±7.47	15.16±6.81	0.865
Temperature 2 (^{0}C)	14.89±7.27	15.16±6.81	0.872
Temperature 3 (^{0}C)	14.91±7.13	15.16±6.81	0.928
Sunshine Duration (hour)	5.46 ± 4.77	4.11 ± 3.93	0.271
Wind 0 (m/s)	3.70±1.51	3.34±0.64	0.104
Wind 1 (m/s)	6.62±1.68	3.34±0.64	0.411
Wind 2 (m/s)	3.65±1.83	3.34±0.64	0.967
Wind 3 (m/s)	3.41±1.39	3.34±0.64	0.648
Mean of Daily Humidity (%)	74.58±713.17	75.64±6.46	0.373
Pressure 0 (hPa)	1003.13±12.79	1003.92±11.39	0.347
Pressure 1 (hPa)	1002.4±7.44	1003.92±11.39	0.535
Pressure 2 (hPa)	1001.83±7.65	1003.92±11.39	0.190
Pressure 3 (hPa)	992.35±88.19	1003.92±11.39	0.018*

D0: PSP application day D1:1 day before the application, D2:2 days before the application, D3:3 days before the application. *Statistically significant at the level of p<0,05.

Discussion

PSP cases mostly consist of tall and skinny male adolescents. Even though PSP occurs due to apical blebs or bullae without any underlying lung illness, the exact cause is still unknown. Smoking history is very uncommon in childhood, though it has been revealed in the etiology that smoking is the main factor in adults (8). It has been argued that seasons and meteorological changes could impact the incidence of PSP. However, these researches were performed either with adult patients or were conducted with a population, which consists of adult patients and a small number of children (6,9,10).

Only PSP cases among children are included in our batch. Upon the review of English literature, no related researches, which investigates the correlation between the meteorological changes and the occurrence of PSP in childhood, were detected. The incidence of PSP in childhood is 3.4 / 100 000 (9). Meanwhile, the incidence rate of males to females ranges between 4/1 and 7.7/1 in different studies, and PSP is more common in males (8,11). In our study, the male to female incidence rate of PSP was determined to be 6.6/1.

In most of the previous studies, it has been revealed that the incidence of PSP is not associated with the seasons (7,12,13,14). However, in research performed in Japan, it has been put forward that the incidence of PSP was fewest in the winter months (15). Similarly, it was found in our study that it occurred most frequently in summer and at least in winter. However, contrary to these studies, there are also studies suggesting that the prevalence of PSP is higher in winter months (16,17). In a study performed in Spain, the incidence of PSP in spring is higher, whereas, in another study conducted in China, the rate of incidence of PSP in autumn is higher (18,19). The fact that the higher incidence rates of PSP differ in various studies, which have been performed in different seasons, could be due to the variability of the seasonal conditions of the countries where the studies are conducted. Even in different cities of the same country, the seasons during which PSP occurs more frequently might vary depending on the climatic conditions.

Likewise, it was determined in our research that there was a decline in atmospheric pressure 3 days before the admission of PSP cases compared to non-PSP days. This may be due to the rupture of the bullae in the lung as a result of the decrease in atmospheric pressure, as it has been revealed by Bence. In his study, Bence found that admission to the hospital increased due to PSP 2 days after atmospheric pressure dropped by 10 mbar (20). When compared to AP levels of the days, on which PSP didn't occur, AP was found to be lower, on D0 and D1 by Haga et al.; on D1 and D2 by Özpolat et al., and on D0 by Zhang et. al (6,7,19). Meanwhile, Diaz et al. put forward that the incidence of PSP is correlated with the increase in the levels of AP (21). However, contrary to these researches, there are also researches claiming that the incidence of PSP is not correlated with the levels of AP (9,12,14,18). The cases of adulthood and childhood were included in these researches, which were performed in various countries under different climatic conditions. Besides, it is evident that other meteorological factors impact the incidence of PSP as well. Therefore, it is hard to make any precise comparison.

On the other hand, many researches have studied merely the relationship between the AP and PSP. The number of researches, which examine the temperature, wind speed, humidity, and duration of sunny times apart from the AP, like our study, is quite a few. In addition to that, likewise our study, no correlation was found between the incidence of PSP and the temperature, wind speed, humidity, and duration of sunny times in the majority of researches (6,13,22). However, there are also studies revealing that there is an inverse correlation between them (9,12,19,23). Furthermore, Bertolaccini and Smit have put forward in their research that air pollution, viral infections, physical stress, and allergens could also lead to PSP (12,15). But these factors are not included in our research.

There were several limitations in our study due to the fact that though we performed our study in Istanbul, where around 15 million people live, it only involved the child cases who live in the vicinity of Ümraniye, in addition to it was a retrospective research.

It is unambiguous that various parameters impact the PSP. Moreover, it is very challenging to reach an accurate conclusion by merely making comparisons, since the studies have been designed differently and the number of cases is often inadequate as well as they are performed in various climatic conditions. Therefore, the studies, which include a greater number of cases, should be performed.

References

(1) Light RW, Lee YCG. Pneumothorax, Chylothorax, Hemothorax, and Fibrothorax. In: Broaddus VC editor. Murray and Nadel's Textbook of Respiratory Medicine, 6th Ed. Philadelphia: Elsevier Sounders; 2016:1439-1460.
(2) Asa M. Margolis and Thomas D. Kirsch. Tube Thoracostomy. In: Roberts JR editor. Roberts and Hedges' Clinical Procedures in Emergency Medicine and Acute Care,7th Ed. Philadelphia: Elsevier Sounders; 2019:196-220.
(3) Glenna B. Winnie, Steven V. Lossef .Pneumothorax. In: Kliegman RM, St Geme JW, Blum NJ, Shah SS, Tasker RC, Wilson KM editors. Nelson Textbook of Pediatrics, 20th Ed. Philadelphia: Elsevier Sounders; 2016:2135-2138.
(4) Akyıl M, Tezel Ç, Evman S et al. Correlation between meteorological changes and primary spontaneous pneumothorax: Myth or fact? Turkish Journal of Thoracic and Cardiovascular Surgery 2018;26(3):436-440.

(5) Scott GC, Berger R, Mckean HE. The role of atmospheric pressure variation in the development of spontaneous pneumothoraces. Am Rev Respir Dis 1989; 139:659-662.
(6) Haga T, Kurihara M, Kataoka H, Ebana H. Influence of weather condition on the onset of primary spontaneous pneumothorax: positive association with decreased atmospheric pressure. Ann Thorac Cardiovasc Surg 2013;19:212–215.
(7) Ozpolat B, Gözübüyük A, Koçer B, Yazkan R, Dural K, Genç O. Meteorological conditions related to the onset of spontaneous pneumothorax. Tohoku J Exp Med 2009;217:329–334.
(8) Shih CH, Yu HW, Tseng YC, Chang YT, Liu CM, Hsu JW. Clinical Manifestations of Primary Spontaneous Pneumothorax in Pediatric Patients: An Analysis of 78 Patients. Pediatrics and Neonatology 2011;52:150-154.
(9) Obuchi T, Miyoshi T, Miyahara S et al. Does pneumothorax occurrence correlate with a change in the weather? SurgToday 2011;41:1380–1384.
(10) Aljehani Y, Niaz R, Almajid F, Elbawab H. Influence of meteorological factors on the onset of primary spontaneous pneumothorax. Ann R Coll Surg Engl 2018;00:1–6.
(11) Lopez ME, Fallon SA, Lee TC, Rodriguez JR , Brandt ML, Mazziotti MV. Management of the pediatric spontaneus pneumothorax: is primary surgery the treatment of choice? Am J Surg 2014;208:571-576.
(12) Smit HJ, Devillé WL, Schramel FM, Schreurs JM, Sutedja TG, Postmus PE. Atmospheric pressure changes and outdoor temperature changes in relation to spontaneous pneumothorax. Chest 1999;116:676–681.
(13) Bulajich B, Subotich D, Mandarich D, Kljajich RV, Gajich M. Influence of atmospheric pressure, outdoor temperature, and weather phases on the onset of spontaneous pneumothorax. Ann Epidemiol 2005;15:185–190.
(14) Chen CH, Kou YR, Chen CS, Lin HC. Seasonal variation in the incidence of spontaneous pneumothorax and its association with climate: a nationwide population-based study. Respirology 2010; 15: 296–302.

(15) Bertolaccini L, Viti A, Boschetto L et al. Analysis of spontaneous pneumothorax in the city of Cuneo: environmental correlations with meteorological and air pollutant variables. Surg Today. 2015; 45(5):625-9.
(16) Accard JL, Patte F, Combes F, et al. Spontaneous pneumothorax. Clinical study, meteorological correlations, course and treatment. Rev. Tuberc. Pneumol. (Paris) 1972; 36: 431–46.
(17) Macquet V, Lafitte P, Rogeaux Y, Pinchon R. Influence of meteorological conditions on the occurrence of spontaneous pneumothorax. Lille.Med 1974; 19: 901–6.
(18) Suarez-Varel MM, Martinez-Selva MI, Llopis-Gonzalez A, Martinez-Jimeno JL, Plaza-Valia P. Spontaneous pneumothoraxrelated with climatic characteristics in the Valencia area (Spain). Eur J Epidemiol 2000;16: 193–8.
(19) Zhang G-J, Gao R, Fu J-K, Jin X, Zhang Y, Wang Z. Climatic Conditions and the Onset of Primary Spontaneous Pneumothorax: An Investigation of the Influence of Solar Terms. Medical Principles and Practice 21(4), 345–349.
(20) Bense L. Spontaneous pneumothorax related to falls in atmospheric pressure. Eur J Respir Dis 1984; 65: 544-6.
(21) Díaz R, Díez MM, Medrano MJ et al. Influence ofatmospheric pressure on the incidence of spontaneous pneumothorax. Cir Esp.2014;92:415–20.
(22) Alifano M, Forti Parri SN, Bonfanti B et al. Atmospheric pressure influences the risk of pneumothorax: beware of the Storm! Chest 2007;131:1877–82.
(23) Vodicka J, Vejvodova S, Smíd D et al. Do weather phenomena have any influence on the occurrence of spontaneous pneumothorax? Arch Bronconeumol 2016; 52(5): 239–243.