Frontiers in Life Sciences and Related Technologies 5(1) (2024) 1-5

Contents lists available at Dergipark

Frontiers in Life Sciences and Related Technologies

Journal homepage: http://dergipark.org.tr/en/pub/flsrt

Research article

Impacts of PM_{10} exposure on hospitalization for acute bronchitis in Ankara, Türkiye

Hilal Arslan*[1], Adnan Agir[2], Goksel Demir[1]

[1] *University of Health Sciences Türkiye, Hamidiye Faculty of Health Sciences, Department of Occupational Health and Safety, 34668, Istanbul, Türkiye*
[2] *Andes Construction Inc., Deparment of Occupational Health and Safety, 48500, Ankara, Türkiye*

Abstract

The purpose of this study is to investigate the relationship between PM_{10} exposure and acute bronchitis admissions in Ankara, Türkiye. PM_{10} data and daily acute bronchitis admissions were obtained in Ankara for 2020-2021. A generalized additive model was applied to estimate the effects of daily PM_{10} concentration on hospital admissions for acute bronchitis. The Distributed Lag Non-linear Model was utilized to evaluate the lagged effects of PM_{10} concentration. Additionally, the model was adjusted for stratified analyses according to gender and age groups. Relative risks with corresponding 95% confidence intervals (CIs) were obtained for each 10 $\mu g/m^3$ increment in PM_{10} values. A rise of 10 $\mu g/m^3$ in PM_{10} concentrations was significantly linked with an elevated risk of acute bronchitis with relative risks observed at lag3 (RR: 1.010, 95% CI: 1.001-1.019) and lag4 (RR: 1.010, 95% CI: 1.002-1.019). There were associations for middle-aged individuals (45 to 64 years), with a 0.5% increase in risk at lag3 (RR: 1.005; 95% CI: 1.001-1.009) and lag4 (RR: 1.005; 95% CI: 1.001-1.010). PM_{10} exposure could increase the risk of acute bronchitis and better air quality would be beneficial to human health.

Keywords: *Acute bronchitis; Ankara; generalized additive model; PM_{10}; Türkiye*

1. Introduction

Air pollution refers to the presence of various chemical, physical, or biological substances that lead to contamination of both outdoor and indoor atmosphere (WHO, 2021). Air pollution originates from a range of sources, both anthropogenic and naturally occurring. Natural sources of air pollution include desert dust, wildfires, and volcanic emissions (Baltaci et al., 2022; Arslan, 2023), whereas anthropogenic sources of air pollution include industrial sites, power plants, transportation, agriculture, residential and commercial heating, cooking, waste disposal, construction, mining, and oil and gas production (Castagna et al., 2021; Zhou et al., 2021; Lestari et al., 2022; Arslan and Toltar, 2023). Air pollution can also be transported over long distances by winds, which can make it difficult to identify the sources of certain pollutants in a specific location (National Oceanic and Atmospheric Administration, 2021). This has numerous adverse impacts on human health and harms the environment by reducing visibility, causing acid rain, and damaging forests (Mohajan, 2018; Saxena and Sonwani, 2019; Shammas et al., 2020; Savita, 2021).

Particulate matter (PM) is one of the criteria for air pollutants that can pose risks to human health (Arslan et al., 2022; Baltaci et al., 2022; Chung et al., 2023; He et al., 2023; Zhang et al., 2023). Different sizes and types of PM can have varying health impacts, and the duration and level of exposure can also affect the severity of health problems. For instance, PM_{10} is identified as inhalable particles which can cause health issues. Epidemiological studies have revealed that being exposed to PM_{10} may result in increased incidence of hospital

* Corresponding author.
E-mail address: hilal.arslan@sbu.edu.tr (H. Arslan).
https://doi.org/10.51753/flsrt.1322260 Author contributions
Received 03 July 2023; Accepted 03 March 2024
Available online 30 April 2024
2718-062X © 2024 This is an open access article published by Dergipark under the CC BY license.

admissions for respiratory disease (Leung et al., 2021; WHO, 2021; Arslan et al., 2022; Baltaci et al., 2022; Shams et al., 2023). Guo et al. (2014) found that every 10 μg/m^3 increment in PM_{10} values corresponded to a rise of 0.94% (95% CI:0.83%-1.05%) in hospitalizations for acute bronchitis at lag6 in Shanghai, China. Similarly, in southwestern China, Zhang and Zhou (2022) found that $PM_{2.5}$ and PM_{10} exposure was found to contribute to increased hospital admissions for acute bronchitis. In another study, Capraz and Deniz (2021) found that a 10 μg/m^3 increment in $PM_{2.5}$ values led to an 8.06% rise (95 % CI: 3.36-19.4 %) in admission rates for acute bronchitis at lag9 in Istanbul, Türkiye.

Ankara is among the largest cities in Türkiye and is reported to experience high levels of PM_{10} due to vehicular emissions and industrial activities. High levels of particulate matter concentration pose significant threats to both the environment and public health. This research aims to examine the correlation between PM_{10} exposure and hospitalizations due to acute bronchitis in Ankara from 2020 to 2021.

2. Materials and methods

2.1. Study area

Due to the low preference for public transportation and the use of fossil fuel-consuming public vehicles, high pollutant concentrations are found in Ankara. Almost 50% of public vehicles use fossil fuels, which significantly contributes to the problem. Furthermore, compared to larger cities such as Istanbul and Izmir, Ankara has a high rate of vehicle ownership per 100 people, exacerbating the issue. As a result, the city's air quality is significantly compromised (Dark Report, 2019).

Ankara has a semi-arid central Anatolian climate characterized by hot and arid summers and cold, snowy winters. The mean temperature during summer is around 23°C, while in winter, the mean temperature drops to around 2.1°C. The hottest month is July-August, and the coldest is January. Most precipitation falls during the spring and fall months, with relatively low rainfall during the summer and winter (Akkose et al., 2021).

2.2. Hospital admissions and air quality data

Hourly PM_{10} concentrations data were provided by the National Air Quality and Monitoring database for 2020-2021. Additionally, hourly temperature and relative humidity data were obtained from the Turkish State Meteorological Service (TSMS). Hospital admission numbers for acute bronchitis, based on the International Classification of Diseases-Tenth Revision, were obtained from the Etimesgut State Hospital database for 2020-2021. The daily respiratory hospital admission numbers (ICD-10: J20 for acute bronchitis) were derived by each patient's age (18-44, 45-64, and >64 years) and gender. The relationship between PM_{10} values and hospital admissions for acute bronchitis was investigated using data from the Etimesgut air quality station (Fig. 1), as it is the nearest station to the hospital.

2.3. Statistical analysis

A generalized additive model was constructed using a quasi-Poisson link to estimate the effects of daily PM_{10} concentration on hospital admissions related to acute bronchitis. The lagged effects of PM_{10} concentration were assessed with the Distributed Lag Non-linear Model.

The following model is fitted:

$$\text{Log } E(Y_t) = \alpha + \beta X_{t,l} + ns\,(\text{time}_t\,,\,\text{df}) + ns\,(\text{temperature}_t\,,\,\text{df}) + ns\,(\text{humidity}_t\,,\,\text{df}) + \text{factor (DOW)} + \text{factor (holiday)}, \quad (1)$$

Log $E(Y_t)$ is the expected number of hospitalized patients due to acute bronchitis on day *t*, α is the intercept, β is the vector of regression coefficients, X_t is the cross-basis matrix of PM_{10} concentration on day *t*, and *l* is lag days. A single-day lag between lag 0 (day of occurrence) and lag 7 (which indicated the value on the 7th day succeeding the occurrence) was used. The model is controlled for the meteorological elements, i.e., temperature and humidity, by using the natural spline (*ns*) function with 3 degrees of freedom (*df*). Time represents the date variable, which was defined with *ns* with 7 df per year to check for long-term trends and seasonality (Liu and Zhai, 2022). Day of the week (DOW) (1, 2, …,7) and an indicator of public holiday (0/1) were used in the model as factor variables. The model was also fitted for stratified analyses according to gender and age groups. The adjusted relative risks (RRs) were calculated along with their 95% CIs per 10 μg/m^3 increase in the PM_{10} value. The statistical analyses were performed utilizing the *dlnm* package in the R 4.2.1 edition (Gasparrini et al., 2011).

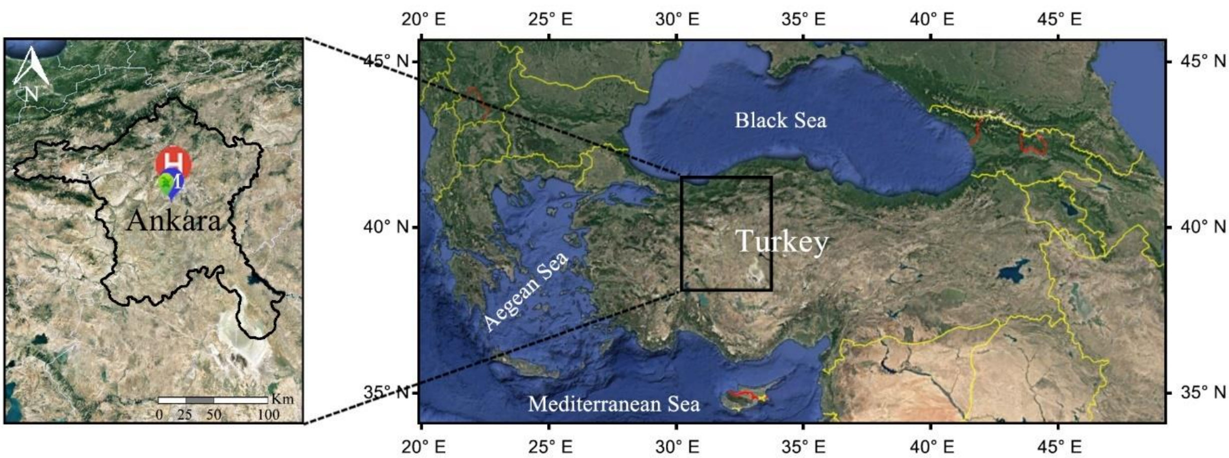

Fig. 1. The distribution of air quality monitoring station (green circle), meteorological station (blue circle) and hospital in Ankara (red circle) (Google Maps, 2024).

3. Results and discussion

This research aimed to examine the association between PM_{10} exposure and the risk of being hospitalized with acute bronchitis in Ankara from 2020 to 2021. Table 1 and Figure 2 show the relative risks (RRs), along with their corresponding 95% CIs, for hospital admissions due to acute bronchitis associated with a 10μg/m^3 increment in PM_{10} values.

The significant effects of PM_{10} on hospital admission were found at lag3, lag4 and lag5. Although RRs are not much different than the other lag days, the RR peak of PM_{10} is lag5, which was associated with a 1.1% (RR:1.011, 95% CI: 1.001-1.021) increase in the risk of hospitalization for acute bronchitis. An increase of 10 μg/m^3 in PM_{10} value increased the risk of acute bronchitis related hospital admission by 1.0% at lag3 (RR:1.010, 95% CI: 1.001-1.019) and lag4 (RR:1.010, 95% CI: 1.002-1.019).

Table 1
Relative risk and 95% CIs of hospitalizations due to acute bronchitis with an increment of 10 μg/m^3 in PM_{10} value.

	PM_{10}	
Lag Days	**RR**	**95% CI**
lag0	1.009	(0.992-1.027)
lag1	1.010	(0.996-1.023)
lag2	1.010	(0.999-1.021)
lag3	**1.010**	**(1.001-1.019)**
lag4	**1.010**	**(1.002-1.019)**
lag5	**1.011**	**(1.001-1.021)**
lag6	1.011	(0.997-1.025)
lag7	1.011	(0.994-1.029)

In a similar study, a connection between increased exposure to $PM_{2.5}$ and heightened risk of bronchitis-related hospitalizations was established (Hertz-Picciotto et al., 2007). Additionally, a positive correlation between NO_2, PM_{10}, $PM_{2.5}$, and SO_2 levels and hospital admissions linked to acute bronchitis and COPD was identified (Muñoz and Carvalho, 2009). Furthermore, evidence supporting an increased risk of hospitalization due to bronchitis in association with $PM_{2.5}$ exposure was provided (Ostro et al., 2009). Studies also showed that 10 μg/m^3 rise in PM_{10} led to 4% increase in hospitalizations due to acute bronchitis/bronchiolitis (Meszaros et al., 2015) and 10 μg/m^3 increment in $PM_{2.5}$ resulted in 25% and 1% increase in the rates of hospitalization due to acute bronchitis and asthma, respectively (Jo et al., 2017). Additionally, hospitalizations for childhood acute bronchitis were reported to be significantly increased by an interquartile range rise in the NO_2, $PM_{2.5}$, and CO concentrations, with 4-day cumulative effect estimates (RR: 1.03, 95% CI: 1.01-1.05; 1.09, 95% CI: 1.07-1.11; 1.07, 95% CI: 1.05- 1.09) (Bai et al., 2018) and 10 μg/m^3 rise in $PM_{2.5}$ values resulted in 8.06 % increment (95% CI: 3.36–19.4%) in admission rates for acute bronchitis at lag 9 (Capraz and Deniz, 2021). Moreover, particulate matter concentrations were associated with increased number of hospitalizations as 10 μg/m^3 increase in $PM_{2.5}$ was reported to cause 25% increment in acute bronchitis, 14% in allergic rhinitis, and 1% in asthma (Jo et al., 2017). Relationship between PM_{10} exposure and the prevalence of the chronic bronchitis was also observed (Hooper et al., 2018).

The stratified analysis for gender revealed that, females were significantly at higher risk of acute bronchitis related hospital admissions from an increment in PM_{10} at lag3 (RR: 1.009; 95% CI:1.001-1.017), lag4 (RR: 1.010; 95% CI:1.002-

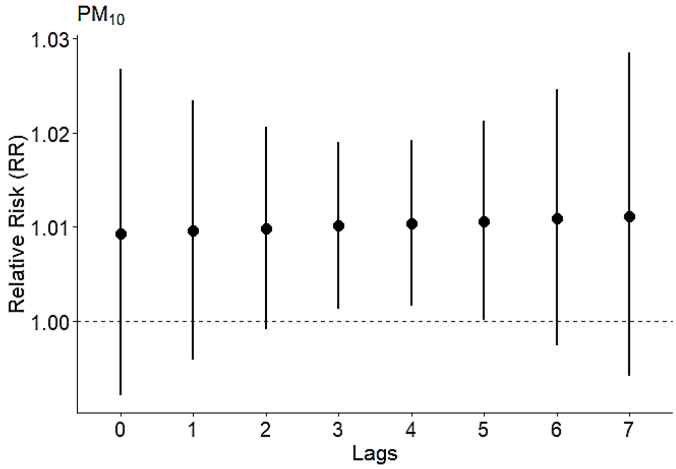

Fig. 2. Relative risk and 95% CIs of hospitalizations due to acute bronchitis for 10 μg/m^3 increment in PM_{10} concentration across the different time periods.

1.017), and lag5 (RR: 1.010; 95% CI:1.001-1.020) as shown in Table 2 and Fig. 3. In a similar study, 10 μg/m^3 increment in PM_{10}, SO_2 and NO_2 values were found to correspond to 0.94% (95% CI: 0.83% to 1.05%), 11.12% (95% CI: 10.76% to 11.48%), and 4.84% (95% CI: 4.49% to 5.18%) rise in hospital admissions attributed to acute bronchitis at lag6, respectively and these correlations were significantly higher for females than males (Guo et al., 2014). Correlation between particulate matter and increased risk of respiratory hospitalizations attributed to conditions such as asthma, chronic bronchitis, and COPD was also reported in another study and their findings similarly indicated that females faced 1.5 times greater risk than males when exposed to both PM_{10} and $PM_{2.5}$ (Shakerkhatibi et al., 2021).

Table 2
Relative risk and 95% CIs of hospitalizations due to acute bronchitis for 10 μg/m^3 increment in PM_{10} concentration across genders.

PM_{10}	**Male**		**Female**	
Lag Days	**RR**	**95% CI**	**RR**	**95% CI**
lag0	1.012	(0.989-1.035)	1.007	(0.991-1.023)
lag1	1.012	(0.994-1.030)	1.008	(0.995-1.020)
lag2	1.011	(0.997-1.026)	1.008	(0.999-1.018)
lag3	1.011	(1.000-1.023)	**1.009**	**(1.001-1.017)**
lag4	1.011	(0.999-1.023)	**1.010**	**(1.002-1.017)**
lag5	1.011	(0.997-1.025)	**1.010**	**(1.001-1.020)**
lag6	1.011	(0.993-1.029)	1.011	(0.999-1.023)
lag7	1.011	(0.988-1.034)	1.011	(0.996-1.027)

On the other hand, there are also studies that show no significant gender difference in the correlation between PM_{10} exposure and acute bronchitis related hospitalizations (He et al., 2022).

While epidemiological research has primarily concentrated on the health impacts of PM exposure on children (Muñoz and Carvalho, 2009; Zhang and Zhou, 2021; He et al., 2022), effects of PM_{10} on chronic bronchitis, asthma, emphysema, and COPD were reported to show no significant difference between age groups, however, there was a significant increase in health problems among the 18-60 and >60 age groups associated with $PM_{2.5}$ exposure (Shakerkhatibi et al., 2021). This study reveals negative impacts on the middle-aged group. Stratified analysis based on age groups at various lags was presented in Table 3 and Fig. 4. In the middle-aged group (45 to 64 years), 10 μg/m^3

Table 3
Relative risk and 95% CIs of hospitalizations due to acute bronchitis for 10 μg/m^3 increment in PM_{10} concentration across age groups.

PM_{10}	18-44 years		45-64 years		>64 years	
Lag Days	**RR**	**95% CI**	**RR**	**95% CI**	**RR**	**95% CI**
lag0	1.003	(0.991-1.015)	1.002	(0.993-1.012)	1.005	(0.990-1.021)
lag1	1.003	(0.994-1.013)	1.003	(0.996-1.010)	1.005	(0.993-1.017)
lag2	1.004	(0.996-1.011)	1.003	(0.998-1.009)	1.005	(0.995-1.014)
lag3	1.004	(0.998-1.010)	1.004	(1.000-1.009)	1.004	(0.996-1.013)
lag4	1.005	(0.999-1.010)	**1.005**	**(1.001-1.009)**	1.004	(0.995-1.013)
lag5	1.005	(0.998-1.012)	**1.005**	**(1.001-1.010)**	1.004	(0.993-1.016)
lag6	1.005	(0.996-1.014)	1.006	(0.999-1.013)	1.004	(0.989-1.019)
lag7	1.006	(0.994-1.017)	1.006	(0.998-1.015)	1.004	(0.985-1.022)

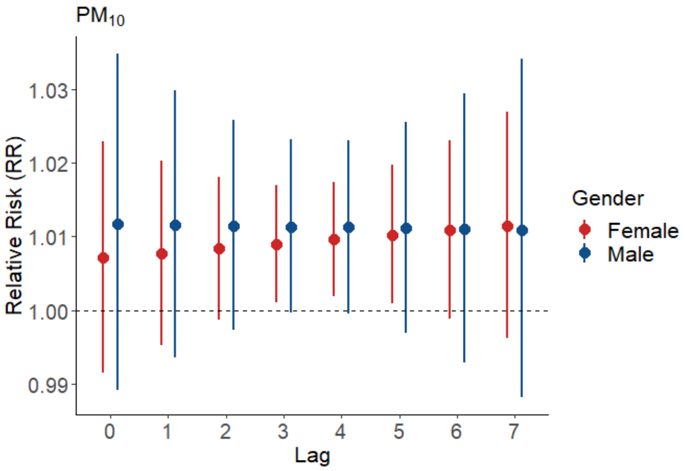

Fig. 3. Relative risk and 95% Cls of hospitalizations due to acute bronchitis for 10 μg/m^3 increment in PM_{10} concentration across genders at the different time periods.

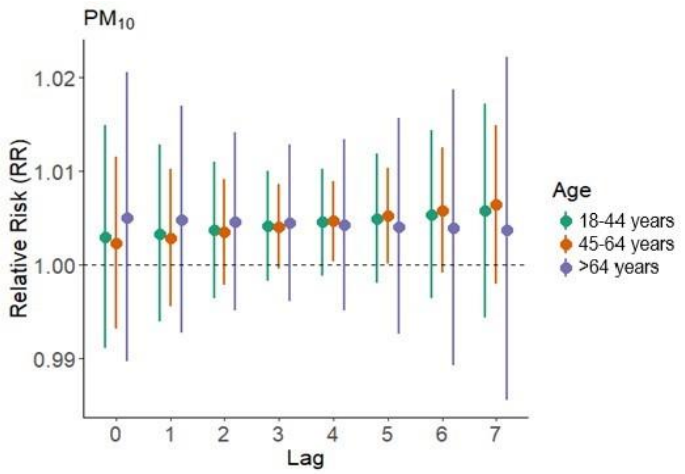

Fig. 4. Estimated relative risk (RR) and 95% CIs of hospitalizations due to acute bronchitis for a 10 μg/m^3 increment in PM_{10} concentration across age groups at the different time periods.

increment in PM_{10} significantly raised the risk of acute bronchitis-related hospital admission by 0.5% at lag3 (RR: 1.005; 95% CI:1.001-1.009) and lag4 (RR: 1.005; 95% CI: 1.001-1.010). However, no significant correlation was found between PM_{10} and acute bronchitis admissions in the age group of 18 to 45 years or over 64 years.

4. Conclusion

The findings of this study indicate a substantial correlation between PM_{10} exposure and hospitalizations due to acute bronchitis. The significant impacts of PM_{10} on hospital admission were observed at lag3, lag4, and lag5. At lag3 (RR:1.010, 95% CI: 1.001-1.019) and lag4 (RR:1.010, 95% CI: 1.002-1.019), a 10 μg/m^3 rise in PM_{10} concentration increased the risk of acute bronchitis-related hospital admission by 1.0%. Also, a 10% increase in PM_{10} concentration in the middle-aged (45 to 64 years) group substantially increased the risk of acute bronchitis-related hospital admission by 0.5% on lag 3 (RR: 1.005; 95% CI:1.001- 1.009) and lag4 (RR: 1.005; 95% CI: 1.001-1.010).

Air pollution is a significant environmental risk, posing a substantial threat to human health. The WHO Air Quality Guidelines serve as a cornerstone in setting objectives to safeguard human health against the harmful effects of air pollution. These objectives involve reducing activities such as incineration of agricultural waste and forest fires, which are prominent contributors to air pollution. Furthermore, these objectives entail enhancing the handling of household, industrial, and municipal waste, investing in power generation methods that prioritize energy efficiency, constructing environmentally conscious, energy-efficient, and compact urban areas, and establishing secure and affordable public transportation systems along with pedestrian and cyclist-friendly networks.

The findings of this study are anticipated to offer valuable insights into the health impacts of air pollution, providing policymakers with guidance for improving both health outcomes and air quality. Reducing air pollution levels has the potential to decrease the incidence of various serious health conditions, including acute bronchitis, asthma, pneumonia, lung cancer, stroke, and COPD.

Conflict of interest: The authors declare that they have no conflict of interests.

Informed consent: The authors declare that this manuscript did not involve human or animal participants and informed consent was not collected.

References

Akkose, G., Akgul, C. M., & Dino, I. G. (2021). Educational building retrofit under climate change and urban heat island effect. *Journal of Building Engineering*, *40*, 102294.

Arslan H. (2023). Impacts of Meteorological Parameters on Tropospheric Ozone Concentrations in Çanakkale, *International Journal of Advances in Engineering and Pure Sciences*, *35* (1). 10-17.

Arslan, H., & Toltar, A. (2023). The influence of meteorological parameters on PM2. 5 and PM10 values in Ümraniye and Silivri districts of İstanbul. *Environmental Research and Technology*, *6*(4), 288-301.

Arslan, H., Baltaci, H., Sahin, U. A., & Onat, B. (2022). The relationship between air pollutants and respiratory diseases for the western Turkey. *Atmospheric Pollution Research*, *13*(2), 101322.

Bai, L., Su, X., Zhao, D., Zhang, Y., Cheng, Q., Zhang, H., ... & Su, H. (2018). Exposure to traffic-related air pollution and acute bronchitis in children: season and age as modifiers. *Journal of Epidemiology and Community Health*, *72*(5), 426-433.

Baltaci, H., Arslan, H., & Akkoyunlu, B. O. (2022). High PM 10 source regions and their influence on respiratory diseases in Canakkale, Turkey. *International Journal of Environmental Science and Technology*, *1*-10.

Capraz, O., & Deniz, A. (2021). Assessment of hospitalizations from asthma, chronic obstructive pulmonary disease and acute bronchitis in relation to air pollution in İstanbul, Turkey. *Sustainable Cities and Society*, *72*, 103040.

Castagna, J., Senatore, A., Bencardino, M., & Mendicino, G. (2021). Concurrent influence of different natural sources on the particulate matter in the central mediterranean region during a wildfire season. *Atmosphere*, *12*(2), 144.

Chung, H. W., Hsieh, H. M., Lee, C. H., Lin, Y. C., Tsao, Y. H., Feng, M. C., & Hung, C. H. (2023). Air pollution after acute bronchiolitis is a risk factor for preschool asthma: a nested case-control study. *Environmental Health*, *22*(1), 83.

Dark Report, (2019). Air Pollution and Health Impacts, https://www.temizhavahakki.org/wp-content/uploads/2019/08/Hava-Kirlilig%CC%86i-ve-Sag%CC%86l%C4%B1k-Etkileri-Kara-Rapor-2019.pdf, Last Accessed on March 18, 2024.

Gasparrini A. (2011). Distributed lag linear and non-linear models in r: The package dlnm. *Journal of Statistical Software*, *43*(8):1-20.

Guo, L. J., Zhao, A., Chen, R. J., Kan, H. D., & Kuang X. Y. (2014). Association between ambient air pollution and outpatient visits for acute bronchitis in a Chinese City. *Biomedical and Environmental Sciences*, *27*(11), 833-840.

He, Y., Jiang, W., Liao, J. Q., Jing, L., Li, J., & Yang, L. (2022). Short-term effects of air pollutants on hospital admissions for acute bronchitis in children: a multi-city time-series study in Southwest China. *World Journal of Pediatrics*, *18*(6), 426-434.

He, Y., Jiang, W., Gao, X., Lin, C., Li, J., & Yang, L. (2023). Short-term effects and economic burden of air pollutants on acute lower respiratory tract infections in children in Southwest China: a time-series study. *Environmental Health*, *22*(1), 6.

Hertz-Picciotto, I., Baker, R. J., Yap, P. S., Dostál, M., Joad, J. P., Lipsett, M., ... & Šrám, R. (2007). Early childhood lower respiratory illness and air pollution. *Environmental Health Perspectives*, *115*(10), 1510-1518.

Hooper, L. G., Young, M. T., Keller, J. P., Szpiro, A. A., O'Brien, K. M., Sandler, D. P., ... & London, S. J. (2018). Ambient air pollution and chronic bronchitis in a cohort of US women. *Environmental Health Perspectives*, *126*(2), 027005.

Jo, E. J., Lee, W. S., Jo, H. Y., Kim, C. H., Eom, J. S., Mok, J. H., ... & Park, H. K. (2017). Effects of particulate matter on respiratory disease and the impact of meteorological factors in Busan, Korea. *Respiratory Medicine*, *124*, 79-87.

Lestari, P., Arrohman, M. K., Damayanti, S., & Klimont, Z. (2022). Emissions and spatial distribution of air pollutants from anthropogenic sources in Jakarta, *Atmospheric Pollution Research*, *13*, 9.

Leung, S. Y., Lau, S. Y. F., Kwok, K. L., Mohammad, K. N., Chan, P. K. S., & Chong, K. C. (2021). Short-term association among meteorological variation, outdoor air pollution and acute bronchiolitis in children in a subtropical setting. *Thorax*, *76 (4)*: 360-369.

Liu D. J., & Zhai G. (2022). Association between air pollution and hospital admissions for hypertension in Lanzhou, China. *Environmental Science and Pollution Research*, *29*, 11976–1198.

Mészáros, D., Markos, J., FitzGerald, D. G., Walters, E. H., & Wood-Baker, R. (2015). An observational study of PM10 and hospital admissions for acute exacerbations of chronic respiratory disease in Tasmania, Australia 1992-2002. *BMJ Open Respiratory Research*, *2*(1), e000063.

Mohajan, H. (2018). Acid rain is a local environment pollution but global concern. published in: *Open Science Journal of Analytical Chemistry*, 3, 5, 47-55.

Muñoz, F., & Carvalho, M. S. (2009). Effect of exposure time to PM10 on emergency admissions for acute bronchitis. *Cadernos de Saúde Pública*, *25*(3), 529-539.

National Oceanic and Atmospheric Administration. (2021). What is Air Pollution?, Retrieved from https://www.noaa.gov/education/resource-collections/air-quality/, Last Accessed on March 18, 2024.

Ostro, B., Roth, L., Malig, B., & Marty, M. (2009). The effects of fine particle components on respiratory hospital admissions in children. *Environmental Health Perspectives*, *117*(3), 475-480.

Savita, (2021). Impacts of air pollutants on forest ecosystem and role in ecological imbalance. In: Tiwari S., Saxena P. (eds) *Air Pollution and Its Complications* (pp. 129-142). Springer, Cham.

Saxena, P., Sonwani, S., Saxena, P., & Sonwani, S. (2019). Primary criteria air pollutants: environmental health effects. *Criteria Air Pollutants and Their Impact oın Environmental Health*, 49-82.

Shakerkhatibi, M., Seifipour, H., Sabeti, Z., Kahe, D., Asghari Jafarabadi, M., Zoroufchi Benis, K., & Hajaghazadeh, M. (2021). Correlation of ambient particulate matters (PM10, PM2. 5) with respiratory hospital admissions: a case-crossover study in Urmia, Iran. In: *Human and Ecological Risk Assessment: An International Journal*, *27*(8), 2184-2201.

Shammas, N. K., Wang L. K., & Wang M. H. S. (2020). Sources, chemistry and control of acid rain in the environment. In: Hung, Y. T., Wang L. K. (eds) *Handbook of Environment and Waste Management* (pp. 1-26). World Scientific.

Shams, S. R., Kalantary, S., Jahani, A., Shams, S. M. P., Kalantari, B., Singh, D., ... & Choi, Y. (2023). Assessing the effectiveness of artificial neural networks (ANN) and multiple linear regressions (MLR) in forcasting AQI and PM10 and evaluating health impacts through AirQ+ (case study: Tehran). *Environmental Pollution*, *338*, 122623.

WHO, (2021). Official Website of World Health Organization, Air Pollution, Retrieved from https://www.who.int/health-topics/air-pollution#tab=tab_1, Last Accessed on March 18, 2024.

Zhang, P., & Zhou, X. (2022). Pricing air pollution: evidence from short-term exposure to air pollution on hospitalization of acute bronchitis and chronic obstructive pulmonary disease in southwestern China, *International Health*, *14*(6), 572-579.

Zhang, W., Ling, J., Zhang, R. Dong J., Zhang, L., Chen, R., & Ruan, Y. (2023). Short-term effects of air pollution on hospitalization for acute lower respiratory infections in children: a time-series analysis study from Lanzhou, China. *BMC Public Health*, 23(1629), 1-11.

Zhou, M., Jiang, W., Gao, W., Gao, X., Ma, M., & Ma, X. (2021). Anthropogenic emission inventory of multiple air pollutants and their spatiotemporal variations in 2017 for the Shandong Province, China. *Environmental Pollution*, *288*, 117666.

Cite as: Arslan, H., Agir, A., & Demir, G. (2024). Impacts of PM_{10} exposure on hospitalization for acute bronchitis in Ankara, Türkiye. *Front Life Sci RT*, *5*(1), 1-5.