

Time series analysis of the admission to the emergency department due to respiratory and cardiovascular diseases between 2010 and 2014 in Kırklareli, Turkey

Time series analysis of the admission to emergency department

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"The relationship between the meteorological parameters and air pollution, and the deaths and emergency department admissions because of cardiovascular diseases and respiratory diseases in Kırklareli in 2010-2014."
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Abstract

Aim: The aim of this study was to estimate the admissions to the emergency department due to cardiovascular and/or respiratory diseases for the next twelve months. **Material and Method:** This research was characterized as an ecological study. The data were obtained from the hospital database between years 2010 and 2014. Emergency department admissions (N=148.169) from ≥ 15 years due to cardiovascular and/or respiratory diseases were evaluated according to the monthly average. Multiplicative Seasonal Auto-Regressive Integrated Moving Average (SARIMA) modeling method was used for the research. **Results:** It is observed that the emergency department admissions display seasonal changes. ARIMA(1,1,2)(1,0,1)₁₂ model (MAPE=98,039) was ascertained to be the most suitable model with the success of 99.6% in the predictions. It was predicted that the admissions would be higher in the winter period. Model success for admissions according to disease groups vary between 75.2% and 89.2% and was estimated the highest level of admissions in January and February. The most suitable models used to estimate the number of admissions were the ARIMA(2,1,3)(1,0,0)₁₂ for respiratory diseases, the ARIMA(2,1,2)(1,0,0)₁₂ for cardiovascular diseases and the ARIMA(1,1,1)(1,0,0)₁₂ for both for cardiovascular and respiratory diseases. It was estimated that the admissions due to cardiovascular diseases which had a conjuncture structure would increase mostly in April and the admissions due to respiratory diseases and both of the diseases would be higher mostly in the winter period. **Discussion:** SARIMA models are a good prediction model that can be used to estimate emergency department admissions due to cardiovascular and/or respiratory diseases. The estimations derived comprise a good evidence-based source for policymakers and health service providers.

Keywords

Emergency Department Admissions; Cardiovascular Diseases Admissions; Respiratory Diseases Admissions; Time Series; SARIMA Models

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Introduction

Epidemiological studies have shown the association between air pollution and climate change and health effects over the past decade. Many of these studies examined the effects of air pollution and climate change on daily mortality, emergency department visits, and hospital admissions for particularly cardiovascular and respiratory diseases in many parts of the world [1-6]. These studies provide evidence for the negative effects of urban air pollution on health and a better understanding of biological mechanisms; and in addition to creating an important field of research, they have allowed decision-makers to understand the effects of pollutants and the benefits that can be achieved by control measures [6-8]. In the studies conducted in America, Canada, and Europe, it was determined that there would be a possible rise in emergency admissions due to cardiovascular and respiratory reasons, and related hospitalization cases and health expenses [7, 9-11]. In studies conducted in Turkey, it has been shown an increase in emergency room visits and hospitalizations due to changes in air pollution and meteorological parameters. The majority of these admissions was from the elderly and was mostly seen in winter period [12-14]. Because of these diseases which intimidate the sustainability of health care service, it is needed to carry out accurate strategic planning and prepare proper infrastructure taking into consideration all the dynamics [10, 15, 16]. Depending on these reasons, it is aimed to predict emergency admissions for the next twelve months due to cardiovascular and/or respiratory diseases at the Kırklareli State Hospital between January 2010 and December 2014.

Material and Method

Study design and settings

The study is characterized as ecological research conducted in the center of a north-western Turkish city - Kırklareli between January 2010 and December 2014.

Study population

Among 602.792 admissions to Kırklareli State Hospital Emergency Department, a total of 148.169 individuals aged 15 years and older who have cardiovascular diseases and/or respiratory diseases were included in the research between the pre-mentioned dates. Admissions more than once for each person were recorded separately to the database and each admission was considered to be a new case. Daily obtained emergency department admission numbers were organized as monthly mean values and time series of 60 months were created.

Definition

WHO International Statistical Classification of Diseases and Related Health Problems 10th Revision was utilized in the research as the diagnostic tool. According to the related classification, the total number of emergency department admissions (EDA) was constituted by the sum of all individuals who have received at least one of the I00-I99 and/or J00-J99 diagnosis codes. Among them, individuals with I00-I99 were diagnosed for cardiovascular diseases (CVD) admissions, J00-J99 diagnosed were for respiratory diseases (RD) admissions and the ones who received minimum one diagnosis from both codes at

the same time were treated for CVD and RD (CVD&RD) admissions.

Ethical consideration

The Research was conducted according to the ethical principles and was approved by The Ethics Committee of the Istanbul University Faculty of Medicine -Clinical Researches Ethical Committee in 2015, reference number: 2015/863-09.

Statistical analysis

Total EDA, CVD, RD, and CVD&RD time series which are obtained from the monthly averages between January 2010 and December 2014 together with the Seasonal Auto-Regressive Integrated Moving Average (SARIMA) models were used to predict the next twelve months data. Multiplicative SARIMA model was used to capture the seasonal and non-seasonal scene that arise synchronously in time series and was represented as $ARIMA(p,d,q)(P,D,Q)_s$. In this formula, "d" indicates the non-seasonal difference as "D" stands for the seasonal difference, "p" for non-seasonal autoregressive process (AR), "q" for moving average (MA), "P" seasonal autoregressive process (SAR), "Q" seasonal moving average (SMA) and finally "s" for periodic (s=12) seasonality [17].

The stability control and autocorrelation structure of time series were visually examined using autocorrelation function (ACF) and partial autocorrelation function (PACF) graphs. Trend effect in time series was controlled by using Hodrick-Prescott Filters Method ($\lambda=14400$). For the formation of models and predictions, Least Squares Method was used. For the determination of the most suitable SARIMA model, Akaike Information Criterion (AIC) was utilized. In the evaluation of prediction results depending on the static prevision, Mean Absolute Percentage Error (MAPE) and Theil's Inequality Coefficient (Theil's UC) were used. For the analysis of the data, EViews 7.0 statistic package program was used and statistically significant value was considered to be $p<0.05$.

Results

In the study, between January 2010 and December 2014, 148.169 admissions were received to the emergency department, 52.7% of whom were males and 52.0% were aged between 15-39 years. Among the total admissions, 75.1% were due to RD, 23.9% were CVD and 1.0% was both due to RD and CVD. The majority of the admissions were collected from females (52.7%). For RD, CVD, and RD&CVD the admission rates of females were respectively found to be 50.3%, 60.0%, and 53.7%. RD admissions aged between 15-39 years were 65.0%, CVD aged between 40-64 years were 45.1% and CVD&RD admissions aged between 65-84 years were 47.7% (Table 1). EDA and RD admissions which are observed to be increased in the pre-mentioned period were also presenting a seasonal characteristic. CVD, together with CVD&RD admissions were observed to have a conjuncture structure. The amount of EDA, RD, and CVD&RD admissions was highest in February 2011, CVD in November 2010 among all other months. It is observed that the time series comprise no-trend (Figures 1).

For the time series which primary differences are taken and the stability is verified, the most suitable SARIMA models are iden-

tified according to the AIC criteria. EDA, RD, CVD, CVD&RD admissions, and AIC were found to be 8.162, 8.357, 4.663, -0.131 respectively. The models chosen were found to affirm all the assumptions (Table 2).

According to the prediction results which are performed via the static foresight of the time series, the most suitable model for EDA time series was found to be ARIMA(1,1,2)

Table 1. Descriptive characteristics of emergency department admissions, 2010-2014.

	EDA n (%)	RD n (%)	CVD n (%)	CVD&RD n (%)
Gender				
Male	70 146 (47.3%)	55 283 (49.7%)	14 148 (40.0%)	715 (46.3%)
Female	78.023 (52.7%)	55.981 (50.3%)	21 212 (60.0%)	830 (53.7%)
Age				
15-39	77 110 (52.0%)	72 266 (65.0%)	4 705 (13.3%)	139 (9.0%)
40-64	45 028 (30.4%)	28 545 (25.7%)	15 931 (45.1%)	552 (35.7%)
65-84	23 188 (15.6%)	9 501 (8.5%)	12 950 (36.6%)	737 (47.7%)
85 +	28 43 (1.9%)	952 (0.9%)	1 774 (5.0%)	117 (7.6%)
Total	148 169 (100.0)*	111 264 (75.1%)*	35 360 (23.9%)*	1 545 (1.0%)*

*Percentage of row. EDA: Emergency Department Admissions, RD: Respiratory Diseases admissions, CVD: Cardiovascular Diseases admissions, CVD&RD: At least one diagnosis was made at the same time from RD and CVD admissions.

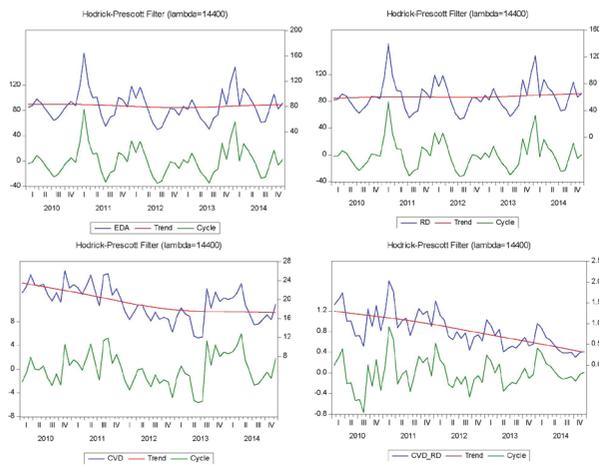


Figure 1. Change of emergency department admissions by monthly average, 2010-2014.

Table 2. Subseries optimal models and parameter estimates for emergency department admissions

	EDA	RD	CVD	CVD&RD
Optimal models	ARIMA(1,1,2)(1,0,1) ₁₂	ARIMA(2,1,3)(1,0,0) ₁₂	ARIMA(2,1,2)(1,0,0) ₁₂	ARIMA(1,1,1)(1,0,0) ₁₂
Subseries*				
AR(1)	-0.644 (0.092)	1.455 (0.147)	-0.460 (0.068)	0.581 (0.108)
AR(2)		-0.726 (0.125)	-0.773 (0.060)	
SAR(12)	0.965 (0.086)	0.417 (0.048)	0.274 (0.131)	0.373 (0.104)
MA(1)	0.217 (0.076)	-2.277 (0.155)	0.374 (0.061)	-0.981 (0.009)
MA(2)	-0.262 (0.080)	2.029 (0.262)	0.957 (0.030)	
MA(3)		-0.751 (0.132)		
SMA(12)	-0.946 (0.066)			
AIC	8.162	8.357	4.663	-0.131

Parameter estimates are displayed with standard error in parentheses.*p<0.01. EDA: Emergency Department Admissions, RD: Respiratory Diseases admissions, CVD: Cardiovascular Diseases admissions, CVD&RD: At least one diagnosis was made at the same time from RD and CVD admissions.

(1,0,1)₁₂ (MAPE=98.039, Theil's UC=0.996). For RD admissions time series, ARIMA(2,1,3)(1,0,0)₁₂ (MAPE=106.209, Theil's UC=0.892); for CVD, ARIMA(2,1,2)(1,0,0)₁₂ (MAPE=247.525, Theil's UC=0.752); for CVD&RD, ARIMA(1,1,1)(1,0,0)₁₂ (MAPE=128.541, Theil's UC=0.803) models were found to be the most suitable models for the prediction (Table 3).

According to the models obtained, it is determined that the real and predicted values of the time series were compatible (Figures 2).

Depending on the next twelve-months prediction of time series which are converted into real values, the mean EDA and RD admission mean values were predicted to be the highest in January, while CVD to be the highest in April and both CVD&RD in February (Table 4).

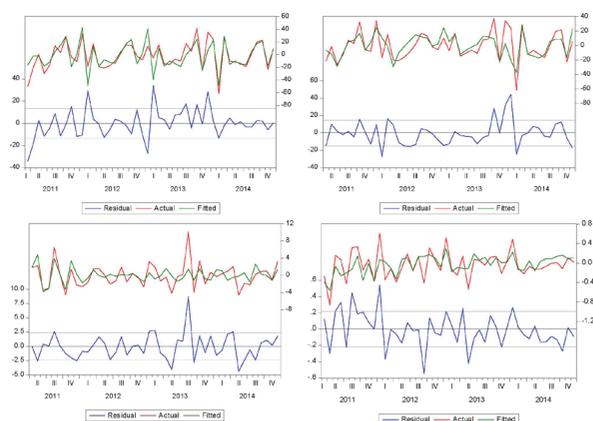


Figure 2. Static estimates of time series according to obtained models for emergency department admissions, 2010M01-2014M12.

Table 3. Estimation levels of models derived from time series for emergency department admissions

	Optimal Modals	MAPE	Theil's U	Theil's U ^C
EDA	ARIMA(1,1,2)(1,0,1) ₁₂	98.039	0.305	0.996
RD	ARIMA(2,1,3)(1,0,0) ₁₂	106.209	0.398	0.892
CVD	ARIMA(2,1,2)(1,0,0) ₁₂	247.535	0.498	0.752
CVD&RD	ARIMA(1,1,1)(1,0,0) ₁₂	128.541	0.460	0.803

EDA: Emergency Department Admissions, RD: Respiratory Diseases admissions, CVD: Cardiovascular Diseases admissions, CVD&RD: At least one diagnosis was made at the same time from RD and CVD admissions.

Table 4. Estimates of time series by monthly average for emergency department admissions, 2015M01-2015M12.

Times	EDA	RD	CVD	CVD&RD
M01	94.8	90.7	18.8	0.5
M02	58.6	67.6	18.3	0.6
M03	81.4	73.1	19.0	0.5
M04	66.5	65.4	19.8	0.5
M05	58.6	65.4	18.0	0.5
M06	43.5	58.2	17.5	0.4
M07	29.3	47.9	17.1	0.4
M08	32.6	48.2	17.0	0.4
M09	48.4	58.3	17.1	0.4
M10	69.5	69.7	17.6	0.4
M11	53.3	58.8	17.3	0.4
M12	59.6	61.6	18.1	0.4

M: Month, EDA: Emergency Department Admissions, RD: Respiratory Diseases admissions, CVD: Cardiovascular Diseases admissions, CVD&RD: At least one diagnosis was made at the same time from RD and CVD admissions.

Discussion

In this research, the monthly mean values of the admissions to the Emergency Department of a hospital which are received from the individuals aged older than 15 years and who had CVD and/or RD in a total period of five years were predicted with SARIMA models for the next twelve months.

Studies for the foresight of EDA demonstrated that the request of admissions due to demographical changes would increase in the future [10, 15]. It is also indicated that the global morbidity and mortality cause mostly stem from environmental problems especially the changes of the parameters about climate and air pollution influence CVD and/or RD-based EDA [18, 19]. It is found that the air pollution parameters raise the admission percentage by 0.4-8.0% and changes in temperature by 1.1-3.0% [19, 20]. Due to the complications of related diseases, in which the majority of individuals are composed of a disadvantaged group of children and elderly, it is thought that there would be a decline in the life expectancy due to discretion loss and an increase in mortality. The health expenditures, in general, are expected to be higher [20, 21]. Increased EDA in winter months can be explained by the quantity of elderly population in our time series composed of different characteristics in terms of time, place and person.

In the admissions regarding to RD, behavioral risk factor such as smoking [22], besides higher vehicle emissions in the cities, often and synchronously ascending amount of pollutants in the atmosphere, meteorological parameters, and exposed allergens were reported to be the reasons of increased emergency department admissions due to asthma and respiratory allergies specifically for the atopic individuals [4, 20]. Rosychuk et al. demonstrated that in Canada, the asthma-based admissions are expected to increase in spring months [23] and COPD admissions are expected to rise much more in winter and autumn period [17]. Khakban et al. found that COPD hospitalization would increase in the next 15 years approximately one and a half times and they emphasized to take new precautions for COPD burden, cure and strategies in the future [10]. Research conducted in Turkey supports the evidence of increased RD-

based emergency department admission due to change in air pollution and meteorological parameters [13, 14]. RD emergency department admission mean values were predicted to increase in winter and spring months in Turkey. Simple differences observed in our generally literature-compatible research [17, 23], were expounded by the poor quality fossil fuel consumption as a heating tool, the fluctuations in natural gas prices and increased traffic-caused emissions.

It is reported that the size and content of particle matter which have an important role in RD emergency department admission may cause systemic inflammation thus, yield to CVD [7, 24]. Related literature indicates that air pollution parameters were associated with increased admissions due to IHD, myocardial infarction (MI) and coronary cases. However, if the exposure is decreased, IHD, arrhythmia and related diseases hospitalization costs could be diminished [25]. Our research, in which the monthly changes of CVD has a conjuncture structure, similar findings are obtained in the study by Pintaric et al. [5] which was conducted in Croatia. Because there is a difference in higher estimations of admissions during winter and spring, our results may be due to increased air-pollutant concentration in Turkey. The studies conducted in the literature [4, 18, 26], in contrary indicate that emergency department admission and hospitalizations are increasing in summer due to myocardial infarction (MI), heart failure etc. In admissions which are affected by climate change, heatwaves, maximum temperatures and changes in day-time temperatures are found to increase CVD risk in the short-term [4,18, 21, 27]. In the admissions among the elderly population observed due to CVD, the registered excessive mortality rates were indicated to have relation with atmospheric conditions [26-29].

In our research, it is estimated that the monthly emergency department admissions mean values of CVD&RD with conjuncture structure would be significantly lower than the other admissions. Expected CVD&RD admissions would be higher in winter than in other seasons. Peel et al. found that hypertension, COPD or diabetes diagnosed individuals with CVD were much more sensitive to environmental conditions and this situation was associated with an increase in the number of admissions [30]. Other researches demonstrated that disadvantaged groups and individuals with specific health disorders have a higher risk for CVD and RD-based emergency department admissions [31, 32]. In America, between 2010 and 2030, two of every five individuals are expected to have CVD and related diseases and thus, the estimated health costs would triple [9]. In literature, there was not found any prevision studies including individuals with CVD&RD. However, the evidences of the current research are valuable to form a basis for future studies.

It is determined that the SARIMA model which we used for the future foresight of emergency department admissions has been used in many researches with the similar purposes and successful results were obtained [17, 23, 33, 34]. The time intervals of our time series which are organized according to monthly average values were also suitable for the predictions [35]. In the case of season-dependent admissions, these factors should be considered for the model selections. And prevision studies are proposed to be a fast method for strategic planning, human resources, and resource distribution [16, 34, 35]. In our research,

all the predictions with medium and high efficiency were made through SARIMA models that demonstrate the suitability of SARIMA models in this field.

Conclusion

It was determined that the mean number of admissions was affected by climate and air pollution parameters. According to 2015 estimates, seasonal features were determined in EDA, RD and CVD&RD admissions and the admissions were estimated to be the highest in January and February, whereas the mean number of admissions to the CVD which have a conjuncture structure was predicted to be the highest in April. In the estimations which yielded successful results, it was determined that the ARIMA(1,1,2)(1,0,1)₁₂ model was the most suitable model for the EDA, and that given the disease groups, the ARIMA(2,1,3)(1,0,0)₁₂ model was the most suitable model for RD, the ARIMA(2,1,2)(1,0,0)₁₂ model for the CVD and the ARIMA(1,1,1)(1,0,0)₁₂ model for the CVD&RD.

SARIMA models that we used in our research were successful for the predictions of the CVD and/or RD emergency department admissions and they can be used in other prevision studies for similar purposes. Predicting the changes efficiently in emergency department admissions in future gives a good database to both policymakers and health service providers to perform their strategic plans in a better way.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest

None of the authors received any type of financial support that could be considered potential conflict of interest regarding the manuscript or its submission.

References

- Phosri A, Ueda K, Phung VLH, Tawatsupa B, Honda A, Takano H. Effects of ambient air pollution on daily hospital admissions for respiratory and cardiovascular diseases in Bangkok, Thailand. *Sci Total Environ.* 2019; 651(1): 1144-53.
- Zhong H, Shu Z, Zhou Y, Lu Y, Yi B, Tang X, et al. Seasonal Effect on Association between Atmospheric Pollutants and Hospital Emergency Room Visit for Stroke. *J Stroke Cerebrovasc Dis.* 2018; 27(1): 169-76.
- Guo P, Feng W, Zheng M, Lv J, Wang L, Liu J, et al. Short-term associations of ambient air pollution and cause-specific emergency department visits in Guangzhou, China. *Sci Total Environ.* 2018; 613-614:306-13.
- Lam HC, Li AM, Chan EY, Goggins WB. The short-term association between asthma hospitalizations, ambient temperature, other meteorological factors and air pollutants in Hong Kong: a time-series study. *Thorax.* 2016; 71(12): 1097-1109.

- Pintarić S, Zeljković I, Pehnc G, Nesek V, Vrsalović M, Pintarić H. Impact of meteorological parameters and air pollution on emergency department visits for cardiovascular diseases in the city of Zagreb, Croatia. *Arh Hig Rada Toksikol.* 2016; 67(3): 240-46.
- Dastoorpoor M, Khanjani N, Bahrapour A, Goudarzi G, Aghababaeian H, Idani E. Short-term effects of air pollution on respiratory mortality in Ahvaz, Iran. *Med J Islam Repub Iran.* 2018; 32: 30.
- Basagaña X, Jacquemin B, Karanasiou A, Ostro B, Querol X, Agis D, et al. Short-term effects of particulate matter constituents on daily hospitalizations and mortality in five South-European cities: Results from the MED-PARTICLES Project. *Environ Int.* 2015; 75: 151-8.
- DeVries R, Kriebel D, Sama S. Outdoor Air Pollution and COPD-Related Emergency Department Visits, Hospital Admissions, and Mortality: A Meta-Analysis. *COPD.* 2017; 14(1): 113-21.
- Heidenreich PA, Trogdon JG, Khavjou OA, Butler J, Dracup K, Ezekowitz MD, et al. Forecasting the Future of Cardiovascular Disease in the United States, A Policy Statement From the American Heart Association. *Circulation.* 2011; 123(8): 933-44.
- Khakban A, Sin DD, FitzGerald JM, McManus BM, Ng R, Hollander Z, et al. The Projected Epidemic of Chronic Obstructive Pulmonary Disease Hospitalizations over the Next 15 Years. A Population-based Perspective. *Am J Respir Crit Care Med.* 2017; 195(3): 287-91.
- Sun BC, Hsia RY, Weiss RE, Zingmond D, Liang LJ, Han W, et al. Effect of Emergency Department Crowding on Outcomes of Admitted Patients. *Ann Emerg Med.* 2013; 61(6): 605-11.
- Tasci SS, Kavalci C, Kayipmaz AE. Relationship of Meteorological and Air Pollution Parameters with Pneumonia in Elderly Patients. *Emerg Med Int.* 2018; 2018: DOI: 10.1155/2018/4183203.
- Kara E, Özdilek HG, Kara EE. Ambient Air Quality and Asthma Cases in Niğde, Turkey. *Environ Sci Pollut Res Int.* 2013; 20(6): 4225-34.
- Hapcioglu B, Issever H, Kocuyigit E, Disci R, Vatansever S, Ozdilli K. The Effect of Air Pollution and Meteorological Parameters on Chronic Obstructive Pulmonary Disease at an Istanbul Hospital. *Indoor Built Environ.* 2006; 15(2): 147-53.
- Mai Q, Aboagye-Sarfo P, Sanfilippo FM, Preen DB, Fatovich DM. Predicting the number of emergency department presentations in Western Australia: A population-based time series analysis. *Emerg Med Australas.* 2015; 27(1): 16-21.
- Sun Y, Heng BH, Seow YT, Seow E. Forecasting daily attendances at an emergency department to aid resource planning. *BMC Emerg Med.* 2009; 9:1.
- Rosychuk RJ, Youngson E, Rowe BH. Presentations to Alberta Emergency Departments for COPD: A Time Series Analysis. *Can Respir J.* 2016; 2016: DOI: 10.1155/2016/1382434.
- Tsangari H, Paschalidou AK, Kassomenos AP, Vardoulakis S, Heaviside C, Georgiou KE, et al. Extreme Weather and Air Pollution Effects on Cardiovascular and Respiratory Hospital Admissions in Cyprus. *Sci Total Environ.* 2016; 542(Pt. A): 247-53.
- Phung D, Hien TT, Linh HN, Luong LM, Morawska L, Chu C, et al. Air pollution and risk of respiratory and cardiovascular hospitalizations in the most populous city in Vietnam. *Sci Total Environ.* 2016; 557-558: 322-30.
- Zhang S, Li G, Tian L, Guo Q, Pan X. Short-Term Exposure to Air Pollution and Morbidity of COPD and Asthma in East Asian Area: A Systematic Review and Meta-Analysis. *Environ Res.* 2016; 148: 15-23.
- Yoon SJ, Oh IH, Seo HY, Kim EJ. Measuring the burden of disease due to climate change and developing a forecast model in South Korea. *Public Health.* 2014; 128(8): 725-33.
- Galán I, Simón L, Boldo E, Ortiz C, Fernández-Cuenca R, Linares C, et al. Changes in hospitalizations for chronic respiratory diseases after two successive smoking bans in Spain. *PLoS One.* 2017; 12(5): DOI: 10.1371/journal.pone.0177979.
- Rosychuk RJ, Youngson E, Rowe BH. Presentations to Alberta Emergency Departments for Asthma: A Time Series Analysis. *Acad Emerg Med.* 2015; 22(8): 942-9.
- Siponen T, Yli-Tuomi T, Aurela M, Dufva H, Hillamo R, Hirvonen MR, et al. Source-specific fine particulate air pollution and systemic inflammation in ischaemic heart disease patients. *Occup Environ Med.* 2015; 72(4): 277-83.
- Devos S, Cox B, Dhondt S, Nawrot T, Putman K. Cost Saving Potential in Cardiovascular Hospital Costs due to Reduction in Air Pollution. *Sci Total Environ.* 2015; 527-528: 413-9.
- Sheridan SC, Lin S. Assessing Variability in the Impacts of Heat on Health Outcomes in New York City over Time, Season, and Heat-Wave Duration. *Ecohealth.* 2014; 11(4): 512-25.
- Phung D, Chu C, Rutherford S, Nguyen HLT, Do CM, Huang C. Heatwave and risk of hospitalization: A multi-province study in Vietnam. *Environ Pollut.* 2017; 220(Pt. A): 597-607.
- Zhang K, Chen TH, Begley CE. Impact of the 2011 Heat Wave on Mortality and Emergency Department Visits in Houston, Texas. *Environ Health.* 2015; 14: 11.
- Xu Z, FitzGerald G, Guo Y, Jalaludin B, Tong S. Impact of heatwave on mortality under different heatwave definitions: A systematic review and meta-analysis. *Environ Int.* 2016; 89-90: 193-203.
- Peel JL, Metzger KB, Klein M, Flanders WD, Mulholland JA, Tolbert PE. Ambient Air Pollution and Cardiovascular Emergency Department Visits in Potentially Sensitive Groups. *Am J Epidemiol.* 2007; 165(6): 625-33.
- Toloo GS, Guo Y, Turner L, Qi X, Aitken P, Tong S. Socio-demographic vulnerability to heatwave impacts in Brisbane, Australia: a time series analysis. *Aust N Z J Public Health.* 2014; 38(5): 430-5.

32. Kim EH, Lee H, Shin DW, Yun JM, Shin JH, Lim YK, et al. Association between Weight Changes after Smoking Cessation and Cardiovascular Disease among the Korean Population. *Korean J Fam Med*. 2017; 38(3): 122-9.
33. Kadri F, Harrou F, Chaabane S, Tahon C. Time Series Modelling and Forecasting of Emergency Department Overcrowding. *J Med Syst*. 2014; 38(9): 107.
34. Calegari R, Fogliatto FS, Lucini FR, Neyeloff J, Kuchenbecker RS, Schaan BD. Forecasting Daily Volume and Acuity of Patients in the Emergency Department. *Comput Math Methods Med*. 2016; 2016: DOI:10.1155/2016/3863268.
35. Boyle J, Jessup M, Crilly J, Green D, Lind J, Wallis M, et al. Predicting emergency department admissions. *Emerg Med J*. 2012; 29(5): 358-65.

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