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„Analysis of hospitalizations and primary healthcare visits connected with air pollution in five Polish cities”

Abstract

Introduction: Even today, at global level, one of the most important environmental risk is represented by air pollution. WHO is estimating that “more than 6 million premature deaths were caused by air pollution exposure in 2012” (WHO, 2013). Large Longitudinal Studies were able to demonstrate that exposure to long-term air pollution is associated with cause-specific, non-accidental mortality rate. A recent (2018) catalog and synthesis review of the relationships between air pollution and mortality and long-term morbidity listed 489 publications in which CVD, respiratory tract, cancerous, and CNS (central nervous system) effects, as well as diabetes, and birth related effects have been associated to 12 different air pollutants. Nearly half of these publications have shown that a statistically significant relationship exists and although they often studied endpoints of lesser severity (e.g. blood pressure, respiratory disease symptoms and lung-function parameters) instead of higher severity endpoints (e.g. cancer incidence, COPD - chronic obstructive pulmonary disease, CVD or diabetes). The author infers that further “longitudinal studies are needed to link the progression of pollution-related morbidity to mortality, especially for the cardiovascular system”. Today, in parallel with the increased availability of healthcare systems provider electronic-record data, studying the potential association between different environmental measurements (e.g. air pollutants, meteorological data) and hospitalizations - or (in general) mortality and/or morbidity is becoming much more readily accessible. This research was aimed to verify such associations using a large database comprising a large number of hospitalizations in Poland.

Methods: This time-series analysis studies 5 cities Polish cities (Warszawa, Kraków, Gdańsk, Białystok, Bielsko-Biała) through a time-period of roughly 4 years (from 2014 to 2017), and it covered more than 20 million hospitalizations, ER/specialist visits as well as PHC visits. The National Health Fund (NFZ) provided daily-summary of the electronic-registries. A correlation analysis and DLNMs has been utilized for the investigation of any relevant and statistically significant potential association between air pollution parameters and patient hospitalizations, utilizing several different methodologies to lower the bias. The data sample, using a time-series

setting investigation, has been normalized per week-day, bank holidays and temperature, to account for the large value oscillations during the study period, i.e. a ratio between the observed patient number divided by the mean patient number in the specific day of the week and/or bank holiday has been calculated. The dataset has been further normalized by Temperature, as for many parameters a strong correlation was found with the temperature values (seasonality). A combination of linear regression and DLNM (Distributed Lag Non-linear Model) has been used to statistically analyze the data sample.

Results and Discussion: Particulate matter concentration peaks have triggered an increase in the number of hospitalizations for respiratory disease. For PM_{2.5}, - the increase ranged between 0.9%-4.5% increase for each 10 units of air pollution concentration increase. For PM₁₀, - the increase was between 0.9%-3.5% for each 10 units of air pollution concentration increase). A typical time lag occurred between the air pollutant concentration peak and the hospitalization event between 2-6 days. Other air pollutants and other hospitalizations ICD-10 codes (e.g. cardiovascular events, eye and skin diseases, etc.), have shown a lesser and non-uniform correlation. The percentage increase of hospital admissions for respiratory disease per each 10 units of pollutant increase is reported in Table 19.

Table 18 - % Increase of Hospital Admissions

Variable	All cities
	%
NO (ppb)	0.3
NO _x (ppb)	0.4
NO ₂ (ppb)	2.4
O ₃ (ppb)	-1.2
SO ₂ (ppb)	1.6
PM _{2.5} (mg/m ³)	1.3
PM ₁₀ (mg/m ³)	0.6
PM _{10_24} (mg/m ³)	1.9
PM _{2.5_24} (mg/m ³)	2.3

Conclusions: Increases in exposure to air pollutants have been positively associated with an increased number of hospitalizations for respiratory tract diseases. The strongest effect was

displayed by PM_{2.5} and PM₁₀ concentration increases. A weaker evidence on short-term associations between air pollutant concentration increases and hospitalizations has been recorded for CVD. The information that was obtained could be utilized further to predict better the patterns of hospitalisation and the healthcare system costs while also triggering additional vigilance for pollution of particulate matter in these cities.

Keywords: air pollution; respiratory health; hospital admissions; multi-city Time-Series Analysis; particulate matter