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Evaluation of Chronic Obstructive Pulmonary Disease (COPD) attributed to atmospheric O_3, NO_2, and SO_2 using Air Q Model (2011–2012 year)

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ABSTRACT

Chronic obstructive pulmonary disease (COPD) is an important disease worldwide characterized by chronically poor airflow. The economic burden of COPD on any society can be enormous if not managed.

We applied the approach proposed by the World Health Organization (WHO) using the AirQ2.2.3 software developed by the WHO European Center for Environment and Health on air pollutants in Tabriz (Iran) (2011–2012 year). A 1h average of concentrations of ozone (O_3), daily average concentrations of nitrogen dioxide (NO_2) and sulfur dioxide (SO_2) were used to assess human exposure and health effect in terms of attributable proportion of the health outcome and annual number of excess cases of Hospital Admissions for COPD (HA COPD).

The results of this study showed that 2% (95% CI: 0.8–3.1%) of HA COPD were attributed to O_3 concentrations over 10 μg/m^3. In addition, 0.7 % (95% CI: 0.1–1.8%) and 0.5% (95% CI: 0–1%) of HA COPD were attributed to NO_2 and SO_2 concentrations over 10 μg/m^3 respectively. In this study, we have shown that O_3, NO_2 and SO_2 have a significant impact on COPD hospitalization. Given these results the policy decisions are needed in order to reduce the chronic pulmonary diseases caused by air pollution and furthermore better quantification studies are recommended.

1. Introduction

Exposure to air pollution can cause both acute (short-term) and chronic (long-term) health effects (Pascal et al., 2013; Schnell et al., 2015; Wang et al., 2015). The acute effects of air pollution on human health were amply proven in the 20th century, when severe air pollution in Europe (Meuse Valley and London) and in the United States (Donora, Pa) caused deaths and disease in hundreds of thousands of people. These episodes have demonstrated that high concentrations of air pollutants cause an increase in mortality and morbidity (Hassanvand et al., 2015).

Chronic obstructive pulmonary disease (COPD) is an important worldwide disease in both high-income and low-income countries (Polosa et al., 2013; Buist et al., 2008; Ko and Hui, 2012; Ko et al., 2008; Menezes et al., 2008) characterized by chronically poor airflow. The main symptoms include shortness of breath, cough, and sputum production (Vestbo, 2014; Vestbo and Wedzicha, 2013). By the year 2020, it has been estimated that COPD will rank fifth among the conditions with a high burden to society (Murray and Lopez, 1997) and third among the most important causes of death humans worldwide (Chapman et al., 2006; Vestbo, 2014). Air pollution has been recognized as a trigger for intensification of COPD (Ko et al., 2008) and has led to the development of air quality standards in many countries resulting in substantially decreased of levels of various atmospheric pollutants derived from the burning of different fossil fuels (Adar et al., 2015;

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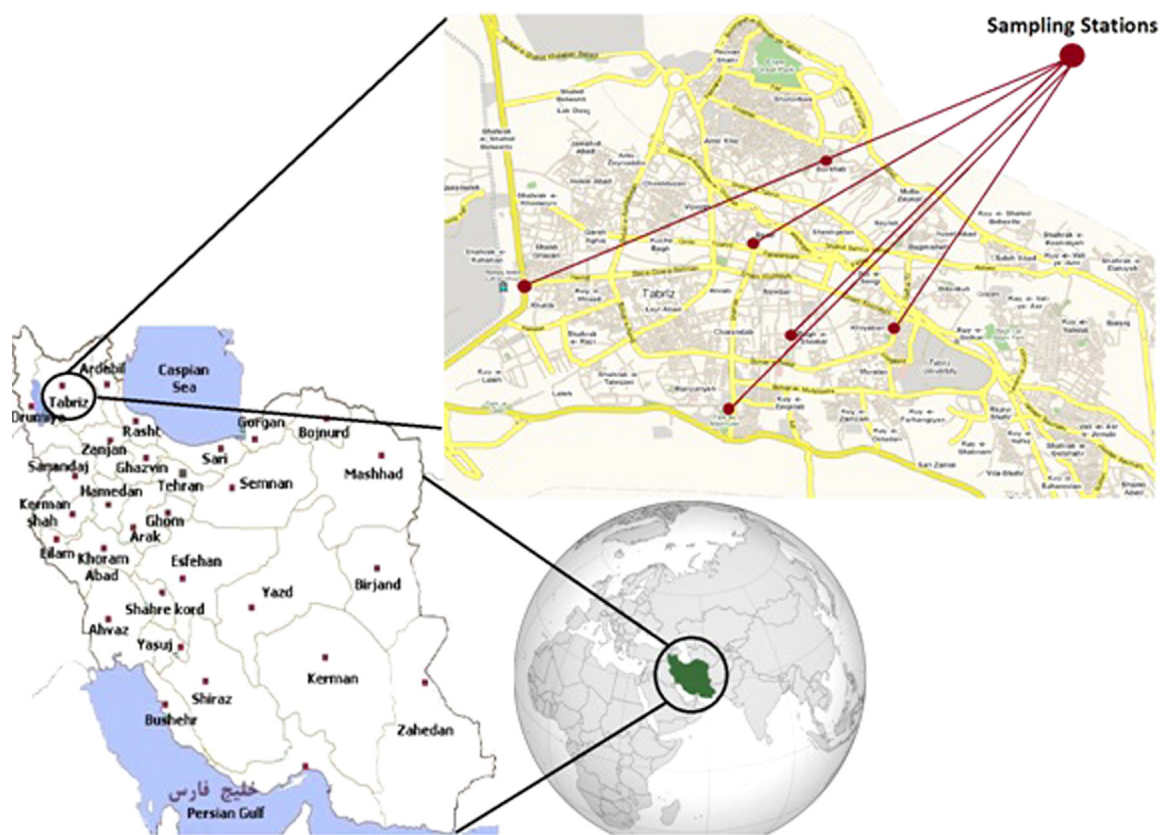E-mail address: olivericonti@unict.it (G. Oliveri Conti).

Fig. 1. Study area and sampling location.

Schikowski et al., 2010). However, some pollutants such as ozone (O_3), sulfur dioxide (SO_2), and nitrogen dioxide (NO_2) continue to increase because are linked to increased urban traffic (Ferrante et al., 2012; Schikowski et al., 2014).

The ambient air pollutants concentrations however are strictly related to changes in pollutant emissions and to climate conditions (Hassan et al., 2015). Results of several studies show a direct associations between combustion of several fuels and COPD, but also, there is strong evidence of associations between traffic-related air pollution and adverse effect (Bravo et al., 2015) on lung development (Goldizen et al., 2015) in children aged 10–18 years (Thurston and Ito, 1999; Fattore et al., 2011) and on other organs (Dong et al., 2015). Especially O_3, NO_2 and SO_2 pollutants can all produce deleterious effects on the airway (Bayram et al., 2001; Ferrante et al., 2012) such as an increase in bronchial reactivity (Ko and Hui, 2012; Happo et al., 2010), airway oxidative stress (Antus and Kardos, 2015; Patel et al., 2013; Medina-Ramón et al., 2006; Wong et al., 1999; Corradi et al., 2002; Gilmour et al., 2003), pulmonary and systemic inflammation (Ji et al., 2015; Happo et al., 2010; Anderson et al., 1997), amplification of viral infections, (Kesic et al., 2012) and reduction in airway ciliary activity (Ierodiakonou et al., 2015; Gilley et al., 2014).

Stieb et al. (2009) showed how an increase of 18.4 ppb level of O_3 concentration was associated with an increased of emergency room visits for asthma 3.2% (95% CI: 0.3–6.2%) and COPD 3.7% (95% CI: −0.5% to 7.9%). This association are stronger for children (5–17 years) compared with other age groups (Sacks et al. 2014; Delfino et al., 2014).

Tabriz is the fourth most populous city in Iran following Tehran, Mashhad and Isfahan. Tabriz is also the second most polluted city of Iran (Heidarnazhad et al., 2004) and one of the seven most polluted Iranian metropolises since last decades as a result of: population growth, urbanization, substandard gasoline use and increased of urban traffic (Gharehchahi et al., 2013).

The predictive models of concentration and of effect of air pollutants can be useful and these are classified into categorical and statistic groups (Krzyzanowski, 1997; Goudarzi et al., 2013).

AirQ software, developed by the WHO European Center for Environment and Health (WHO, 2004), was proved to be a valid and reliable tool to estimate the potential effects of air pollution, predicts health and points attributed to criteria pollutants and finally allows the examination of different scenarios in which emission rates of pollutants are varied (Colls, 2006). There is only a paper with published data on COPD attributed to O_3, NO_2 and SO_2 in urban air of Tabriz city but related to the year 2008–2009 (Ghozikali et al., 2014).

In our study, carried out in year 2011–2012, we have examined the COPD attributed to O_3, NO_2 and SO_2 in ambient air of Tabriz using Air Q 2.2.3 Software to plot the trend respect to 2009.

This study was aimed to:

1) examine the COPD attributed to O_3, NO_2 and SO_2 in ambient air using Air Q 2.2.3 Software to assess Hospital Admissions for COPD (HA COPD) in people living in Tabriz, where the geographical features make the air quality among the worst in the Iran;

2) plot the trend of this air pollutants and AH COPD between 2009 and 2012;

3) provide the scientific basis for formulating suggestions or policy actions aimed to improve air quality and reduce so the burden of disease associated with air pollution in Tabriz.

2. Materials and methods

2.1. Study area

Tabriz is the capital city of East Azerbaijan Province in North-west of Iran (Fig. 1). It is located in the latitude of 38°04′N and the