Indoor and outdoor concentration of PM2.5 Vanadium, Nickel and Sulphur in three Mediterranean areas

F. Cibella, MD[1]; C. Perrino[2]; M. Balzan, MD[3]; S. Ruggieri, Ph.D[1]; D. Bilocca, MD[3]; G. Drago, Ph.D[1]; C. Zammit, MD[3]; R. Minardi, MD[4]; G. Cuttitta, MD[1]; M. Melis, MD[1]; S. Montefort, MD[3]; G. Viegi, MD[1]

[1]National Research Council of Italy, Institute of Biomedicine and Molecular Immunology, Palermo; [2]National Research Council of Italy, Institute for Atmospheric Pollution, Rome; [3]Mater Dei Hospital, Dept. of Medicine, Malta; [4]ASP Caltanissetta, Health District of Gela, Italy

No. 853821

Abstract

Pollutants in particulate matter (PM) are associated with respiratory disorders. Data on indoor concentration of elemental chemical pollutants in highly polluted areas is scanty. In the context of RESPIRA Project, we evaluated both outdoor and indoor concentrations of air pollutants in the Mediterranean area. Gravimetric samples of PM with aerodynamic diameter<2.5 μm were collected on Teflon filters. Concentration of ICP-MS extracted component was measured in 84 sites of South of Sicily (41 in Gela, close to a petrochemical complex, 43 in rural area) and 54 in Malta. Similarly. Indoor measures were performed in 73 houses in Sicily (35 in Gela, 38 in rural area) and in 46 in Malta. Outdoor Vanadium (V) concentrations (median and interquartile range, ng/m^3) were: 1.96 (0.60-4.10) in Malta, 1.20 (0.46-2.43) in Gela, and 0.25 (0.16-0.44) in Rural Area (p<.0001); Nickel (Ni): 1.37 (0.65-2.74), 0.82 (0.45-1.37), and 0.29 (0.17-0.55, p<.0001); Sulphur (S) 209.6 (73.4-683.1), 705 (334-1,078), 203 (148-384, p=.0004). Home Indoor V concentrations were 1.34 (0.38-6.70) in Malta, 1.03 (0.44-2.04) in Gela, and 0.16 (0.10-0.44) in Rural Area (p<.0001); Ni: 1.10 (0.52-3.35), 0.61 (0.40-1.16), and 0.28 (0.19-0.35, p<.0001); S: 324 (71-728), 662 (379-1,090), and 257 (187-437, p=.0007). Outdoor/indoor concentrations for the investigated elements were tested. V: R^2=.665, p<.0001. Ni: R^2=.750, p<.0001. S: R^2=.587, p<.0001. In conclusion, significantly higher indoor concentration of atmospheric pollutants exists in highly polluted areas. These, in absence of indoor sources, depend on outdoor concentrations.

Introduction

Air pollution is a worldwide problem and influences the health of human populations. The anthropogenic impact on the environment, especially in the form of atmospheric pollution, is one of the important concerns throughout the world. A rapid growth in urban population, increasing industrialization, rising demands for energy, increased vehicular traffic, and poor maintenance of vehicles increase air pollution levels. Among the main pollutants in the air, particulate matter (PM) plays a crucial role. PM is associated with respiratory disease. Data on indoor concentration of PM elemental chemical pollutants in highly polluted area are scanty. In the context of RESPIRA Project, we evaluated both outdoor and indoor PM content in heavy metals in the Mediterranean area. Outdoor sources contribute to and affect the concentration and composition of particles in indoor air.

Methods

Air quality monitoring was carried out to collect data on the levels of PM with aerodynamic diameter<2.5 μm ($PM_{2.5}$). Sampling was conducted simultaneously indoors and outdoors at 84 sites of South of Sicily (41 in Gela, close to a petrochemical complex, 43 in surrounding rural area), and 54 in Malta (Fig. 1), between March 2012 and February 2013.

Outdoor and indoor $PM_{2.5}$ mass concentration measurements were carried out for 48 hours by gravimetric samplers (Silent Sampler, FAI Instruments Srl, Fonte Nuova, Italy) with 47 mm Teflon filters. Filters were then analyzed for PM metal content by ICP-OES (inductively coupled plasma optical emission spectrometry) and ICP-MS (inductively coupled plasma mass spectrometry).

Results

Outdoor Vanadium (V) concentrations (median and interquartile range, ng/m^3) were: 1.96 (0.60-4.10) in Malta, 1.20 (0.46-2.43) in Gela, and 0.25 (0.10-0.49) in Rural Area (p<.0001, Fig. 2A); Nickel (Ni): 1.20 (0.63-2.60), 0.74 (0.35-1.35), and 0.25 (0.16-0.44, p<.0001, Fig. 2B); Sulphur (S) 216.2 (86.9-659), 705 (334-1,078), 203 (148-384, p=.0004, Fig. 2C). Home Indoor V concentrations were 1.31 (0.36-6.20) in Malta, 1.03 (0.44-2.04) in Gela, and 0.16 (0.10-0.44) in Rural Area (p<.0001); Ni: 0.96 (0.51-3.15), 0.61 (0.40-1.16), and 0.28 (0.19-0.35, p<.0001); S: 318 (71-726), 662 (379-1,090), and 257 (187-437, p=.0007). Outdoor/indoor concentrations for the investigated elements were highly significant, V: R^2=0.665, p<.0001 (Fig. 3A); Ni: R^2=0.750, p<.0001 (Fig. 3B); S: R^2=0.587, p<.0001 (Fig. 3C).

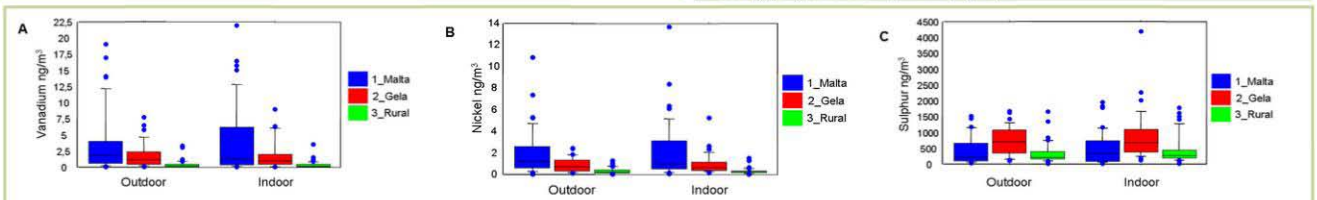

Figure 2 - Vanadium (A), Nickel (B), and Sulphur (C) levels among different centers

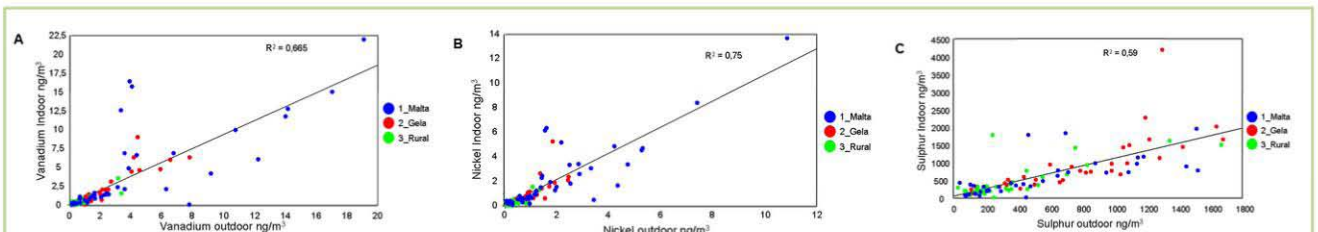

Figure 3 - Correlation between indoor/outdoor levels of Vanadium (A), Nickel (B), and Sulphur (C).