Atmospheric particulate matter effects on SARS-CoV-2 infection and spreading dynamics: A spatio-temporal point process model

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ABSTRACT

Particulate matter (PM) may play a role in differential distribution and transmission rates of SARS-CoV-2. For public health surveillance, identification of factors affecting the transmission dynamics concerning the endemic (persistent sporadic) and epidemic (rapidly clustered) component of infection can help to implement intervention strategies to reduce the disease burden. The aim of this study is to assess the effect of long-term residential exposure to outdoor PM $\leq$ 10 μm (PM$_{10}$) concentrations on SARS-CoV-2 incidence and on its spreading dynamics in Marche region (Central Italy) during the first wave of the COVID-19 pandemic (February to May 2020), using the endemic-epidemic spatio-temporal regression model for individual-level data. Environmental and climatic factors were estimated at 10 km^2 grid cells.

10-years average exposure to PM$_{10}$ was associated with an increased risk of new endemic (Rate Ratio for 10 μg/m^3 increase 1.14, 95%CI 1.04–1.24) and epidemic (Rate Ratio 1.15, 95%CI 1.08–1.22) infection. Male gender, older age, living in Nursing Homes and Long-Term Care Facilities residence and socio-economic deprivation index increased Rate Ratio (RR) in epidemic component. Lockdown increased the risk of becoming positive to SARS-CoV-2 as concerning endemic component while it reduced virus spreading in epidemic one. Increased temperature was associated with a reduction of endemic and epidemic infection.

Results showed an increment of RR for exposure to increased levels of PM$_{10}$ both in endemic and epidemic components. Targeted interventions are necessary to improve air quality in most polluted areas, where deprived populations are more likely to live, to minimize the burden of endemic and epidemic COVID-19 disease and to reduce unequal distribution of health risk.

1. Introduction

Coronavirus disease (COVID-19) spread rapidly from China in December 2019 to the rest of the world and was declared pandemic by the World Health Organization (WHO) in March 2020. The COVID-19 was caused by a novel coronavirus, named Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2) (WHO, 2020a).

Transmission rates and host's susceptibility to influenza and other viral diseases are influenced by several factors, such as demography,

age, gender, socio-economic status, education, and comorbidities. These elements can explain the differential distribution and transmission rates of SARS-CoV-2 (Arsalan et al., 2020; Wu et al., 2020). It has been recently shown how contaminated surfaces, in particular in hospital wards, and environmental factors, including atmospheric particulate matter (PM), temperature, humidity and pollution may play an important role in SARS-CoV-2 differential distribution and transmission (Croft et al., 2020; Ficetola and Rubolini, 2021; Seif et al., 2021; Zhang et al., 2020). Meteorological conditions like temperature and humidity

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