Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Environmental Pollution 274 (2021) 116576

Contents lists available at ScienceDirect

Environmental Pollution

journal homepage: www.elsevier.com/locate/envpol

Re: Links between air pollution and COVID-19 in England☆

Letter to the editor:

Re: Links between air pollution and COVID-19 in England.

We read with interest the recently published paper by Travaglio and colleagues that showed positive associations between ambient concentrations of air pollution and COVID-19 mortality and infectivity in England (Travaglio et al., 2020). This is one of a series of papers that have investigated possible links between ambient air pollution and the incidence or mortality from COVID-19, and we have recently published a detailed critique of research on this topic (Villeneuve and Goldberg, 2020). As a whole these studies, are fraught with several methodological challenges that likely introduce importance sources bias that ultimately calls into question the validity of their findings. Many of these limitations were not discussed within the paper.

Most of the studies conducted to date have relied on an ecological study design. In the Travaglio et al. paper, there were in fact two different analyses. The first used ecological data to estimate associations between air pollution and the incidence and mortality from COVID. The second analysis examined associations between air pollution and the risk of infectivity using individual level data from the UK Biobank.

The use of ecologically-based incidence and mortality data do not provide the opportunity to adequately adjust for the confounding influence of other factors when attempting to characterize associations between air pollution and COVID. For this reason, the ecological study design has a limited ability to provide insights on causal associations (Greenland and Robins, 1994), and in some cases it has provided contrary findings to superior longitudinal study designs having individual-level data (Lagarde and Pershagen, 1999). The use of ecological mortality data for COVID-19 poses more of a concern relative to studies of other chronic disease outcomes, because deaths from COVID-19 are inevitably substantially undercounted due to limitations in screening and diagnosis particularly at the early stages of the pandemic (Weinberger et al., 2020). In our methodological paper (Villeneuve and Goldberg, 2020), we highlighted that the availability of these tests are likely to vary by sociodemographic characteristics of geographical areas, and the variation of these characteristics among individuals who live within them. It is not difficult to envisage that concentrations of air pollution vary substantially between areas of high and low socioeconomic status (Villeneuve and Goldberg, 2020). As a result, the presented risk estimates in the Travaglio et al. paper cannot account for these possible biases. It is also well recognized that the implementation and adherence to public health measures play an important role in reducing the spread of the disease, and thus subsequent mortality. These measures can include things such as the wearing of face masks, hand washing, stay at home measures, and other physical distancing practices. The Travaglio et al. study was unable to adequately control these factors using either individual-level or small-area data, and these are likely the strongest predictors of COVID-19 incidence.

In addition to the mortality analyses that were performed, the authors made use of individual-level data from the UK Biobank. We recognize that the use of individual-level data can mitigate some of the sources of bias in ecological study designs, and indeed we have argued that individual-level data are ultimately required to provide insight on whether air pollution may increase the risk of death or incidence of COVID (Villeneuve and Goldberg, 2020). That said, the presented analyses are still subject to a number of important limitations. Specifically, the authors regressed the diagnosis of a COVID-19 test (yes or no) against ambient concentrations of several pollutants including NO_x, NO_2, $PM_{2.5}$, PM_{10}, and ozone using a binomial regression model. Their presented risk estimates are based on these models. Should the availability of COVID-19 tests vary across the jurisdictions, or should some areas apply different criteria for testing for COVID-19 in individuals (e.g., only testing those who are sympomatic) this could introduce bias. Although the UK Biobank contains data for approximately 500,000 individuals, who were between the ages of 40–69 years in 2006, it is unclear to us whether this dataset reflects the general population given the narrow age range at entry, as well as factors that may have led some individuals to participate in the Biobank study compared to those who chose not to. Unfortunately, the paper does not provide descriptive data that allows the reader to appreciate the distributions of age, gender, and socioeconomic status of incident cases of COVID-19 that formed the basis of their analyses. Nonetheless, within the entirety of the UK Biobank there were only a relatively small number of individuals (1464; 0.2%) who were tested for COVID-19. As a result, findings from these analyses may be driven by a much smaller number of sources of infection which may bias the reported associations. Data from Canada, the USA, and elsewhere have also shown that a large number of cases in certain areas are often linked to the same outbreak, or even primary case. Examples include clusters of COVID-19 in nursing homes for the elderly (Coletta, 2020), or in meatpacking plants (Dyal et al., 2020), or from weddings or political rallies (O'Grady et al., 2020). In Ottawa, Canada, for example, one person at a small gathering at a cottage led to 40 confirmed cases (Canadian Broadcasting Corporation, 2020). The inability to account for these correlations in the analyses of data from England are problematic for two reasons. First, they overstate the precision of the risk estimates because the events are not independent. Second, they are

☆ This paper has been recommended for acceptance by Da Chen.

https://doi.org/10.1016/j.envpol.2021.116576

concerning because the risk estimates may reflect a common source of exposure, or infection, rather than air pollution per se. Even though individual level data were used to model incidence (or infectivity), the authors were not able to account for source of exposure, adherence to public health measures (masking, social distance, work at home), and the availability of COVID-19 testing, and all of the factors can be associated with concentrations of air pollution and thus confound the associations.

We are not alone in our criticism of the studies of air pollution and COVID-19 (Heederik et al., 2020). There have been significant challenges in characterizing COVID-19 incident, prevalent and mortality outcomes since the beginning of the pandemic. For example, recent studies have shown clearly that incidence and mortality are underestimated (Kontis et al., 2020; Russell et al., 2020). The clustered nature of these outcomes, along with differential abilities to identify COVID-19 based on availability of health care resources, and sociodemographic status are likely sources of bias. During the study period examined by Travaglio et al. public health measures such as hand washing, physical distancing, and face masking represented the most effective tools to mitigate against the spread of COVID-19. It is our view that despite the best intentions of the authors, the biases inherent in the data at this time preclude the authors from generating valid measures of associations between air pollution and COVID-19.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

Canadian Broadcasting Corporation, 2020. Cottage Party a Cautionary Tale about Rampant Spread of COVID-19. In: Cottage Party a Cautionary Tale about Rampant Spread of COVID-19. Canada, Ottawa.

Coletta, A., 2020. Canada's Nursing Home Crisis: 81 Percent of Coronavirus Deaths Are in Long-Term Care Facilities (Washington Post. Washington Post, Washington, D.C).

Dyal, J.W., Grant, M.P., Broadwater, K., Bjork, A., Waltenburg, M.A., Gibbins, J.D., Hale, C., Silver, M., Fischer, M., Steinberg, J., Basler, C.A., Jacobs, J.R., Kennedy, E.D., Tomasi, S., Trout, D., Hornsby-Myers, J., Oussayef, N.L., Delaney, L.J., Patel, K., Shetty, V., Kline, K.E., Schroeder, B., Herlihy, R.K., House, J., Jervis, R., Clayton, J.L., Ortbahn, D., Austin, C., Berl, E., Moore, Z., Buss, B.F., Stover, D., Westergaard, R., Pray, I., DeBolt, M., Person, A., Gabel, J., Kittle, T.S., Hendren, P., Rhea, C., Holsinger, C., Dunn, J., Turabelidze, G., Ahmed, F.S., deFijter, S., Pedati, C.S., Rattay, K., Smith, E.E., Luna-Pinto, C., Cooley, L.A., Saydah, S., Preacely, N.D., Maddox, R.A., Lundeen, E., Goodwin, B., Karpathy, S.E., Griffing, S., Jenkins, M.M., Lowry, G., Schwarz, R.D., Yoder, J., Peacock, G., Walke, H.T., Rose, D.A., Honein, M.A., 2020. COVID-19 among workers in meat and poultry processing facilities - 19 states, april 2020. MMWR Morb. Mortal. Wkly. Rep. 69.

Greenland, S., Robins, J., 1994. Invited commentary: ecologic studies–biases, misconceptions, and counterexamples. Am. J. Epidemiol. 139, 747–760.

Heederik, D.J.J., Smit, L.A.M., Vermeulen, R.C.H., 2020. Go slow to go fast: a plea for sustained scientific rigour in air pollution research during the COVID-19 pandemic. Eur. Respir. J. 56.

Kontis, V., Bennett, J.E., Rashid, T., Parks, R.M., Pearson-Stuttard, J., Guillot, M., Asaria, P., Zhou, B., Battaglini, M., Corsetti, G., McKee, M., Di Cesare, M., Mathers, C.D., Ezzati, M., 2020. Magnitude, demographics and dynamics of the effect of the first wave of the COVID-19 pandemic on all-cause mortality in 21 industrialized countries. Nat. Med. 26, 1919–1928.

Lagarde, F., Pershagen, G., 1999. Parallel analyses of individual and ecologic data on residential radon, cofactors, and lung cancer in Sweden. Am. J. Epidemiol. 149, 268–274.

O'Grady, S., Llati, M., Beachum, L., Villegas, P., Denham, H., Knowles, H., Itkowitz, C., 2020. Fauci Says White House Had Superspreader Event as Trump to Resume Public Events (Washington Post, Washington).

Russell, T.W., Golding, N., Hellewell, J., Abbott, S., Wright, L., Pearson, C.A.B., van Zandvoort, K., Jarvis, C.I., Gibbs, H., Liu, Y., Eggo, R.M., Edmunds, W.J., Kucharski, A.J., group, C.C.-w., 2020. Reconstructing the early global dynamics of under-ascertained COVID-19 cases and infections. BMC Med. 18, 332.

Travaglio, M., Yu, Y., Popovic, R., Selley, L., Leal, N.S., Martins, L.M., 2020. Links between air pollution and COVID-19 in England. Environ. Pollut. 268, 115859.

Villeneuve, P.J., Goldberg, M.S., 2020. Methodological considerations for epidemiological studies of air pollution and the SARS and COVID-19 coronavirus outbreaks. Environ. Health Perspect. 128, 95001.

Weinberger, D.M., Chen, J., Cohen, T., Crawford, F.W., Mostashari, F., Olson, D., Pitzer, V.E., Reich, N.G., Russi, M., Simonsen, L., Watkins, A., Viboud, C., 2020. Estimation of excess deaths associated with the COVID-19 pandemic in the United States, march to may 2020. JAMA Intern Med 180, 1336–1344.

Paul J. Villeneuve[a,*], Mark S. Goldberg[b]

[a] *School of Mathematics and Statistics, Carleton University, Ottawa, Canada*

[b] *Department of Medicine, McGill University, Montreal, Canada*

[*] Corresponding author. School of Mathematics and Statistics and Department of Neuroscience, Faculty of Science, Carleton University, Herzberg Building, Room 5413, 1125 Colonel By Drive, Ottawa, ON, K1S 5B6, Canada.
E-mail address: Paul.Villeneuve@carleton.ca (P.J. Villeneuve).

5 November 2020
Available online 27 January 2021