Faridi, Sasan, Niaziesfyani, Sadegh, Shamsipour, Mansour, & Hassanvand, Mohammad Sadegh
(2019)
Comments on: 'Meteorological correlates and AirQ+ health risk assessment of ambient fine particulate matter in Tehran, Iran'.
Environmental Research, *174*, pp. 122-124.

https://doi.org/10.1016/j.envres.2019.04.026

Comments on: “Meteorological correlates and AirQ$^+$ health risk assessment of ambient fine particulate matter in Tehran, Iran”

Sasan Faridi, Sadegh Niazi, Mansour Shamsipour, Mohammad Sadegh Hassanvand

PII: S0013-9351(19)30242-7

DOI: https://doi.org/10.1016/j.envres.2019.04.026

Reference: YENRS 8459

To appear in: *Environmental Research*

Received Date: 21 December 2018

Revised Date: 13 March 2019

Accepted Date: 23 April 2019

Comments on: "Meteorological correlates and AirQ$^+$ health risk assessment of ambient fine particulate matter in Tehran, Iran"

Sasan Faridi [a, b], Sadegh Niazi [c], Mansour Shamsipour [d], Mohammad Sadegh Hassanvand [a, b]*

[a] Center for Air Pollution Research (CAPR), Institute for Environmental Research (IER), Tehran University of Medical Sciences, Tehran, Iran.

[b] Department of Environmental Health Engineering, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran.

[c] International Laboratory for Air Quality and Health, Queensland University of Technology (QUT), Brisbane, Australia.

[d] Department of Research Methodology and Data Analysis, Institute for Environmental Research, Tehran University of Medical Sciences, Tehran, Iran.

***Corresponding author: Mohammad Sadegh Hassanvand**

*Corresponding author at: 8th Floor, No. 1547, North Kargar Avenue, Tehran, Iran. E-mail address: hassanvand@tums.ac.ir.

1. Introduction

The recently published article (https://doi.org/10.1016/j.envres.2018.11.046), authored by Mohsen Ansari and Mohammad Hassan Ehrampoush (2019), was read with keen interest and in detail. The article aimed to investigate the correlation between ambient fine particulate matter ($PM_{2.5}$, particulate matter with aerodynamic diameter 2.5 μm and smaller) and meteorological parameters, such as temperature, humidity, precipitation and wind speed. Additionally, the World Health Organization AirQ+ software, updated in 2016 by WHO European Centre for Environment and Health, was applied to estimate all-cause and also five specific causes of death (namely, ischemic heart disease (IHD), cerebrovascular disease (stroke), lung cancer (LC), chronic obstructive pulmonary disease (COPD) and acute lower respiratory infection (ALRI)) due to long-term exposure to $PM_{2.5}$ in Tehran from for the year spanning March 2017 to March 2018. It was reported that the authors obtained hourly concentrations of ambient $PM_{2.5}$ from Air Quality Monitoring Stations (AQMSs) operated by the Tehran Air Quality Control Company (TAQCC). Other required data also were gathered from governmental organizations, including the Statistical Center of Iran (SCI), the Civil Registration Office of Tehran, and the Ministry of Health and Medical Education.

We believe there are a number of controversial issues that should be brought to the attention of readers, especially within the materials and methods sections, including "Description of Study Area", "Air Pollution Data Monitoring and Exposure Assessment" and "AirQ^{+} Software"; and in subsequent sections, we also highlight some issues impacting the interpretability of the article.

2. Arguments

Our comments are as follows.

2.1. For introduction

In the introduction section, it was reported that Faridi et al. (2018) estimated 3-year health effects, including all-cause and cause-specific mortality attributable to $PM_{2.5}$ and $O_{3.}$ However, Faridi et al. (2018) report estimated long-term health effects of ambient $PM_{2.5}$ and O_3 over a 10-year period from 2006 to 2015 (Faridi, Shamsipour et al. 2018). Furthermore, it was stated that Faridi et al. (2018) observed a statistically significant correlation between meteorological parameters and the hourly $PM_{2.5}$ concentrations in 2016. This does not align with statements within their methodology, in which Faridi and colleagues investigated the overall correlation of these parameters with hourly air pollutant concentrations, $PM_{2.5}$ and O_3, over the period of 2006 to 2015; specifically including the year 2016 (Faridi, Shamsipour et al. 2018).

2.2 For materials and methods

2.2.1 Description of Study Area

In the section of materials and methods "Description of Study Area", it was stated that Tehran city has 14 million residents (without referencing), according to census data, Tehran city has approximately 9 million inhabitants, as reported on the website of the SCI (https://www.amar.org.ir/english/Population-and-Housing-Censuses) (Heger and Sarraf 2018, Taghvaee, Sowlat et al. 2018, Yousefian, Mahvi et al. 2018). Utilized population by Ansari and Ehrampoush in order to estimate all-cause mortality is therefore in significant variation to the SCI-reported population numbers. The estimated number of attributable mortalities to ambient $PM_{2.5}$ exposure would therefore be skewed. In summary, the overstated population for Tehran city may result in a considerably greater mortality attributed to ambient $PM_{2.5}$ exposure in their article.

2.2.2 Air Pollution Data Monitoring and Exposure Assessment

It was mentioned that there were 44 AQMSs across Tehran city; however, there are only 39 AQMSs in Tehran operated by TAQCC and Department of Environment (Heger and Sarraf 2018). The authors stated that they obtained hourly concentrations of ambient $PM_{2.5}$ from TAQCC; conversely according to our knowledge and that published on the TAQCC website, only 23 active AQMSs are operated by TAQCC (http://airnow.tehran.ir/home/station.aspx).

2.2.3 AirQ$^+$ Software (The most notable issues)

The linear-log function, which was shown in equation 1 within the materials and methods section "AirQ$^+$ Software", was used to estimate all-cause mortality. The reported function in equation 1 is inaccurate and would have been improved by using the correct linear-log function as follows (Faridi, Shamsipour et al. 2018):

$$\text{Relative Risk}_{\text{linear}-\text{log}} = e^{\beta\{[\ln(X+1)-\ln(X_0+1)]\}}$$

The five specific causes of death (IHD, stroke, LC, COPD and ALRI) within the study's period of interest (March 2017 to March 2018) were estimated using their inaccurate linear-log function. It has been previously reported in that the linear-log function should only be used to estimate all-cause mortality attributable to long-term $PM_{2.5}$ exposure (Faridi, Shamsipour et al. 2018). However, in order to correctly estimate the aforementioned specific causes of death due to the long-term ambient $PM_{2.5}$ exposure, the Integrated Exposure-Response (IER) function, which has explicitly been constructed by Burnett and colleagues for this purpose, could have provided more realistic and appropriate results (Burnett, Pope III et al. 2014, Organization 2014, Faridi, Shamsipour et al. 2018). The aforementioned IER function is as following (Burnett, Pope III et al. 2014, Organization 2014, Faridi, Shamsipour et al. 2018):

$$\text{Relative Risk}_{\text{IER}} = 1 + \alpha\left\{1 - \exp\left[-\gamma(X - X_0)^{\delta}\right]\right\}$$

Where X is the annual $PM_{2.5}$ concentrations, and X_0 is the reference level concerning air pollutants (10 µg m^{-3} for $PM_{2.5}$). ß is the empirical parameter that denotes the change in the RR for a one-unit change in concentration X. The parameters of α, γ and δ are estimated by nonlinear regression methods and determine the overall shape of the nonlinear concentration-response relationship.

2.3 For results and discussion

Regarding section 3.3 “Association between $PM_{2.5}$ and death”, a simple linear regression model was utilized for the analysis; however, no particular rationale was provided for use of that model. Herein, we highlight concerns towards the model applied and subsequent reported results. Firstly, “the type of data is time series and there is a considerable body of the literature regarding to the selected model in time series studies of ambient air pollution and its mortality ”; although such a dispersed count time series of data is commonly analyzed using log-linear Poisson regression, and generalized additive distributed lag models with the number of deaths as outcome, the daily level of pollutants as a predictor, and confounding adjustments made for seasonal and long□term trends (Dominici, McDermott et al. 2002, Armstrong 2006, Peng, Dominici et al. 2006, Chen, Kan et al. 2012). In contrast, the applied data involved a non-linear time series, and analyses did not include adjustments for confounding issues or distributed lag. Secondly, with respect to the description of regression results in section "3.3 Association between $PM_{2.5}$", it was mentioned that "An increase in one unit of the standard deviation in the $PM_{2.5}$ concentrations leads to the increase of 0.71 standard deviation in mortality" this interpretation of linear regression output is overstated, as such conclusions cannot be made through the linear regression predictions. This data would benefit from a more appropriate statistical test in order to draw such conclusions.

Regarding "Total Mortality" in section 3.4.1, the authors presented baseline mortality (BLM) or baseline incidence (BI) for all-cause and five major specific causes of death (IHD, stroke, COPD, LC, and ALRI) in Fig. 5 in the study of M. Ansari and M.H. Ehrampoush (2019). Although baseline BI is crucial to calculate the number of attributable mortalities, there are several inconsistencies with the results presented. Surprisingly, it was reported that BI for all-cause mortality (42) was considerably lower than that estimated for IHD (approximately 112), which represents just one of the five specific causes of death. It is the lead issue for concern that BI for "Natural mortality" is 42, while the BI for IHD is 112. It is impossible for the BI for all-cause mortality to be less than that for IHD and other causes of death. In addition, the unit provided for BI values was not sufficiently clear (BI/1000 or BI/100000). In view of the aforementioned points an incorrectly adjusted BI leads to overestimated/underestimated numbers of attributable mortality.

In respect to section 3.4.2 "Stroke attributable cases", the authors reported that mortality from stroke was 825 in 2015, reference to the work of Faridi and colleagues (Faridi, Shamsipour et al. 2018). However, Faridi et al. (2018) stated that the figure for attributable deaths from stroke declined from 825 in 2006 to 604 in 2015. Secondly, they reported stroke as the highest contributor to specific causes of mortality in the work of Faridi et al. (2018), but Faridi and colleagues indicated that deaths from IHD accounted for the majority of mortality attributable to long-term $PM_{2.5}$ exposure in Tehran during the period of 2006 to 2015 (Faridi, Shamsipour et al. 2018).

Regarding section 3.4.3 "IHD attributable cases", the authors cited that the number of mortalities from IHD was 1558 in 2015 in the study of Faridi et al (2018), but in fact Faridi and colleagues demonstrated that attributable deaths from IHD decreased from 1558 in 2006 to 1286 in 2015 (Faridi, Shamsipour et al. 2018).

Furthermore, M. Ansari and M.H. Ehrampoush in results and discussions section "ALRY attributable cases" (in fact, ALRI is the correct abbreviation) stated that the number of deaths due to ALRI in the under five age group was 13 cases in 2015 in the study of Faridi et al (2018); while that figure was reported at 7 cases in 2015 , with the figure for 2006 at 13 cases (Faridi, Shamsipour et al. 2018).

Further, in the results and discussions section "COPD attributable cases" the authors mentioned that deaths attributable to LC were 123 cases in 2015 in the study of Faridi et al (2018). Indeed, this figure is that attributable to mortality from COPD, not LC (Faridi, Shamsipour et al. 2018).

3. Conclusion

Based on the above-discussed controversies, we conclude that the results published by the article of M. Ansari and M.H. Ehrampoush are likely flawed. Discrepancies, as discussed earlier in detail, are observed for the number of exposed population and the mathematical functions utilized to estimate the number of all-cause and cause-specific mortality due to long-term $PM_{2.5}$ exposure. Additionally, the use of BI to estimate all-cause mortality attributable to ambient $PM_{2.5}$ requires reconsideration. Consequently, we highlight the reader's caution of these issues; and suggest appropriate judgement is applied when interpreting the results and the impact/outcomes outlined in the article.

Conflict of Interest

The authors declare that they have no actual or potential financial competing interests.

References

Armstrong, B. (2006). "Models for the relationship between ambient temperature and daily mortality." Epidemiology: 624-631.

Burnett, R. T., C. A. Pope III, M. Ezzati, C. Olives, S. S. Lim, S. Mehta, H. H. Shin, G. Singh, B. Hubbell and M. Brauer (2014). "An integrated risk function for estimating the global burden of disease attributable to ambient fine particulate matter exposure." Environmental health perspectives **122**(4): 397.

Chen, R., H. Kan, B. Chen, W. Huang, Z. Bai, G. Song and G. Pan (2012). "Association of particulate air pollution with daily mortality: the China Air Pollution and Health Effects Study." American journal of epidemiology **175**(11): 1173-1181.

Dominici, F., A. McDermott, S. L. Zeger and J. M. Samet (2002). "On the use of generalized additive models in time-series studies of air pollution and health." American journal of epidemiology **156**(3): 193-203.

Faridi, S., M. Shamsipour, M. Krzyzanowski, N. Künzli, H. Amini, F. Azimi, M. Malkawi, F. Momeniha, A. Gholampour and M. S. Hassanvand (2018). "Long-term trends and health impact of PM 2.5 and O 3 in Tehran, Iran, 2006–2015." Environment international **114**: 37-49.

Heger, M. and M. Sarraf (2018). Air Pollution in Tehran: Health Costs, Sources, and Policies, World Bank.

Organization, W. H. (2014). "WHO Expert Meeting: Methods and tools for assessing the health risks of air pollution at local, national and international level." Copenhagen: WHO Regional Office for Europe.

Peng, R. D., F. Dominici and T. A. Louis (2006). "Model choice in time series studies of air pollution and mortality." Journal of the Royal Statistical Society: Series A (Statistics in Society) **169**(2): 179-203.

Taghvaee, S., M. H. Sowlat, A. Mousavi, M. S. Hassanvand, M. Yunesian, K. Naddafi and C. Sioutas (2018). "Source apportionment of ambient PM 2.5 in two locations in central Tehran using the Positive Matrix Factorization (PMF) model." Science of The Total Environment **628**: 672-686.

Yousefian, F., A. H. Mahvi, M. Yunesian, M. S. Hassanvand, H. Kashani and H. Amini (2018). "Long-term exposure to ambient air pollution and autism spectrum disorder in children: A case-control study in Tehran, Iran." Science of The Total Environment **643**: 1216-1222.