Scoping Review Protocol

TITLE: A Scoping Review of the Association Between Ambient Particulate Matter and Chronic Kidney Disease

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INTRODUCTION

Climate change and environmental pollution have evoked a global concern as the second leading cause of death of non-communicable diseases (NCDs) (1). Particulate matter, primarily the ambient particulate matter (PM; either coarse (i.e., PM_{10}) or fine particulate matter (i.e., $PM_{2.5}$ and PM_{1})), as a classical form of air pollutants, largely draws NCD concerns and has been broadly studied for its adverse impact (2). Amid heightened interest recently, the increasing attention worldwide paid to PM focuses not only on acute health problems such as respiratory and allergy, but also on the associated long-term health conditions such as diabetes, cancer, stroke, chronic kidney disease (CKD) and it's progression. Since 2008, the first four diseases of main burden NCDs (e.g., cardiovascular disease, diabetes, cancer, and chronic respiratory diseases) were prioritized on the Global NCD Action Plan; the renal disease moved into the latest implementation roadmap of WHO's for NCD prevention and control, given CKD has become a worldwide health crisis.

According to the Global Burden of Disease study (2017), around 697.5 million (9.1%) people worldwide have chronic kidney disease, and more than one-third of those are in Asian countries(3). Additionally, the trend has moved upward since 1990(4). Consequently, it has been several years since the evidence for classic kidney disease or a medical kidney condition (i.e., diabetic or hypertensive CKD) is very instructive. However, the incidence of CKD is still increasing. It is clear that there are multi phenomena with multiple causes. So, many countries have increasingly provided insights into other health determinants for key elements that act as CKD risk, particularly the effect of PM. In fact, a previous study has been discovered changing membranous nephropathy and also consequently accelerated kidney function fast declining caused by long-term exposure to $PM_{2.5}$ or may develop to intensify the disease progression(5).
Similarly, a large-scale cohort study undertaken in the United States yielded similar results by demonstrating that the $PM_{2.5}$ concentration increase every ten micrograms per cubic meter was associated with the increased incident as well as progression CKD around 26–28%(6). However, it cannot be generalized because the mean $PM_{2.5}$ concentrations in America seem to be relatively low compared with other regions (e.g., North Africa, South Asia, and East Asia)(7). Additionally, a recent study determined that there was different

CKD risk regarding geographic disparities related to the variation of $PM_{2.5}$ concentration(8).
Therefore, as regards different geographical features, combining them to generate a comprehensive understanding of this environmental health risk is needed. It will be a better way to assist delayed progression or even halt its worsening into an incurable condition. So far as widespread as the problem is, reviews of environmental determinants of health in chronic kidney disease of air pollution origin are limited as well as it is often not reported and even rare broadly available when compared to the main NCDs related to air pollution, i.e., heart or lung disease.
It is not yet twenty years that scoping review has become a buzzword considerably since Arksey and O'Malley have developed the initial framework in 2005(9). There are typically six stages existing in their original framework that should be followed accordingly. It starts with the first step of identifying the research question and continuing steps 2-6, including; identifying relevant studies, studying selection, charting the data, collating, summarizing, reporting the results, and an optional consultation exercise, respectively, until the reviewing is complete.
Scoping reviews are generally recognized as strategies for evidence review and information synthesis that complement other summative reporting types such as systematic review or meta-analysis. Despite broadly similar viewpoints about research synthesis between scoping and systematic reviews, scoping review is employed for this paper to map the broadening evidence base to aggregate the current state-of-knowledge about environmental effects on kidney disorders. Specifically, this scoping review study aims to provide a comprehensive overview of pollution-related impacts on CKD, and more broadly on general human health, by exploring and synthesizing the existing scientific evidence assessing the association between ambient particulate matter ($PM_{2.5}$, $PM_{10,}$ and PM_{1}) and CKD risk.

METHODS

This scoping review is based on methodological guidance developed by the Joanna Briggs Institute (JBI) scoping review methodology together with an outline of the Arksey and O'Malley's framework(9). Thus, the following five-steps are used in the study: (i) establishing the core research question, (ii) identifying related studies, (iii) determining studies that meet the eligibility criteria, (iv) data extraction, and (v) collating, summarizing, and reporting the research finding. Whilst the consultation option might be not implemented.

Thus, according to the Arksey and O'Malley's conceptual framework together with an outline of the JBI manual, the protocol design will be an array of protocol information as following:

i. Identifying the Research Question

Using PCC mnemonic recommended by the Joanna Briggs Institute (JBI) scoping review methodology to formulate research questions including:

a. *Population:* The population burden of chronic kidney disease. Indeed, it will not be required to enter into the contribution of this review as in further detail elsewhere within this protocol.
b. *Concept:* Chronic Kidney disease and its progression,
c. *Context:* Particulate air pollution both $PM_{2.5}$, $PM_{10,}$ and PM_{1}

Therefore, the following questions will be used to guide this review;

1. What is the association between ambient particulate matter ($PM_{2.5}$, $PM_{10,}$ and PM_{1}) and CKD risk-namely what are profiles of CKD progression and mortality risk in terms of its associated with PM?
2. What research methods or techniques are used to determine the association or collect data or carried out in the literature?
3. How are the characteristics of these associations determined according to their geographic origin of particulate matter (i.e., compare and contrast countries using economic categories to distinguish -namely defined as developed countries and developing countries).

ii. Identifying Relevant Studies

The process of performing a literature search will be in collaboration between the researcher and a health sciences informationist.

The search query will be initially done on MEDLINE/PubMed to obtain a broad overview of the mandatory information followed by translation into the other relevant literature databases. The final comprehensive searches were developed by the informationist (K.M.S.) from inception to 9/20/21 in PubMed, Embase (Elsevier), Environmental Science Index- Pollution Abstracts (Proquest) , CINAHL Complete (EBSCO), Scopus (Elsevier), and Web of Science (SCI-EXPANDED, SSCI, ESCI, CPCI-S). The team supplemented the comprehensive literature searches with searches in the Environmental Protection Agency, Mednar, and clinicaltrials.gov to identify relevant grey literature. In order to minimize the possibility of missed studies, references for all included studies were reviewed, and cited references of the included studies were also reviewed. The resulting citations were moved to the citation manager Endnote 20 (Clarivate Analytics) for multipass duplicate detection and removal.

The searches were built around two main concepts: particulate air pollution and chronic kidney disease. Each search consisted of a combination of controlled terms appropriate for the selected databases and keywords. A human limit was added as a third concept in the databases where this function was possible. A source type limit was also used in Scopus. See **Appendix I** for PubMed search strategy. The final reproducible search strategies and exported search files will be deposited in University of Michigan's institutional data repository, Deep Blue Data.

The studies will be included in this review, such as observational studies (such as cross-sectional, cohort, case-control, and nested case-control studies), surveys, quasi-experiments, and true experiments (randomized controlled trials). In addition, it could expand to include qualitative studies.

Within the query, the online evidence from observational studies, non-randomized comparison studies, and randomized controlled trials (if available) by matching study terms or keywords will be included as shown in **Table 1**.

For organizing citing quality, these citations will then link to the complete reference if detailed information is not applicable, which will be excluded.

TABLE 1: Study sources of evidence

Inclusion	Exclusion
Big data analysis	Scoping reviews
Observational studies	Systematic review and meta-analysis
Randomized controlled trials	
Grey literature (conference proceedings, reports, dissertations)	

iii. Selection of Eligible Studies

To properly select the evidence synthesis with coverage of CKD progression and its mortality risk profiles related to either $PM_{2.5}$, $PM_{10,}$ and PM_1 particles, thus it should be eligible based on inclusion/exclusion criteria.

As stated in the Joanna Briggs Institute (JBI) scoping review methodology, once again, PCC mnemonic will be used as crucial recommendations for setting up each eligible criteria. Therefore the key element of this section including;

Population: This review will contribute no specific population on account of consideration more broadly to chronic diseases on the population burden of chronic kidney disease.

Concept: CKD

As the study objective requires determining the relevant literature describing the relationship between specific pollutants exposure and the subsequent risk of developing CKD, features of chronic kidney diseases will be focused as a concept of this review. According to the definition and classification of CKD in which recommended by the Kidney Disease Quality Outcome Initiative (K/DOQI)(10) that can be briefly defined as follows: 1) there is clinical apparent of either kidney damage or declined kidney function, 2) decreased glomerular filtration rate (GFR) as lower as 60 mL/min/1.73 m^2 and

both of criteria must have existed over the cut-off point of 3 months last. As eligibility concept criteria, the eligible study must be meet the following criteria:

Inclusion:

- Populations with CKD or ESRD, or renal dysfunction with its progression (Staging 1-5)
- The estimated glomerular filtration rate (eGFR) is reported.
- Specific age as an adult because adults are most likely to have chronic adverse effects with exposure to $PM_{2.5}$, $PM_{10,}$ and PM_{1} rather than children.

Exclusion:

- Populations with acute kidney injury (AKI)
- CKD patients who have undergone renal replacement therapy (dialysis or transplantation)

Context: Particle air pollution

The term particles air pollutants, $PM_{2.5}$, $PM_{10,}$ and PM_{1}, are defined as particle size which is less than or equal to 2.5 micrometers in diameter, 10 micrometers in diameter, and diameter less than one-millionth of a meter, respectively. As eligibility context criteria, the eligible study must be meet the following requirements:

Inclusion:

- Particulate ($PM_{2.5}$, $PM_{10,}$ and PM_{1}), primarily the fine particulate matter ($PM_{2.5}$ and PM_{1}) as well as coarse PM (i.e., PM_{10}) in terms of affecting to health with its levels as major air pollutants,
- Outdoor air pollutants exposure

Exclusion:

- Returning to the study's aim, specific kinds of air pollutants will be initiated only. Other exposome such as chemical, water or soil pollution and even indoor air pollution will not be included.

iv. Data Extraction

Data were extracted manually from included papers included in the scoping review by two or more independent screeners and then proceeded to the next step, which is the data extraction stage by using the data extract utility. Data elements (features) collected and used in each study will be identified. First, identify common data elements (CDE) across the majority of the reviewed studies. Then, try to extract the data (values for each of these variables from each study). Moreover, extracting qualitative data will be performed for the information that some studies will share their data. And then, we can try to "harmonize & aggregate" the data across studies. Additionally, we can also try to look for de novo associations between CKD and air pollution (PM). A draft extraction form is initially

provided (see **Appendix II**). This form is able to further customize in accompaniment with the process of extracting data from each included evidence source.

Chartering the data

The data extracted will include the table layout with the necessary information as in the following fields (**Table 2**). In addition, this form can further be customized in accompaniment with the process of extracting data from each included evidence source.

TABLE 2: The table layout for data fields

Field order	Filter criteria/ Description
Authors and year of publication	
Geography or origin/country of origin (where the source was published or conducted)	Regarding the spatial and temporal distribution of interesting events, data of country of origin, geography, and even study periods will be included.
Participants/Population and sample size within the source of evidence (if applicable)	These will also be retrieved; the reason is that there is evidence for ethnic differences that are affected by the progression of CKD.
Concept	As mentioned earlier in the background section.
Context	Including; specific levels of pollution. Data extraction will be sorted into $PM_{2.5}$, $PM_{10,}$ or PM_{1}.
A subset of context:	
• The environmental agencies	The environmental agencies where are the information sources about pollutant sources and their level (e.g.,Real-time Air Quality Index:AQI).
• Season and regional weather	Because pollution affected by these factors
• Monitoring stations	It was the location or area where the levels of PM were measured (e.g., the ground monitors, satellite assessments).
Study methods	e.g., prospective or descriptive study
Aims/purpose	
Statistical methods	What type of statistical analysis was undertaken?
Outcomes	Reviews focusing on risk effect for the disease progression, rather than its mortality; therefore, study finding is a rate of CKD progression and details of

	these (e.g., how measured or evaluated) (if applicable)

v. Collating, Summarising and Reporting the Result

Following a completed literature search, The researchers will assemble all majority data sources and remove the duplicate reference before uploading all citations into the citation management program (Endnote Version 20/2021.*(Clarivate Analytics, PA, USA)*).

Following the test out stage, multiple screening of the titles and abstracts will then be skimmed and scanned by two or more independent reviewers for assessment which one meets the inclusion criteria or against the trial exclusion criteria for the review.

The full text of potentially relevant papers will be identified and entered into an online program tool for conducting systematic review (The Joanna Briggs Institute System for the Unified Management, Assessment and Review of Information:JBI SUMARI)(11). Additionally, any reason for exclusion must be recorded. When disagreements regarding no clear consensus among reviewers arise, seeking out experts' opinions or consensus-based discussion is required.

A Preferred Reporting Items for Systematic Reviews and Meta-analyses extension for scoping review (PRISMA-ScR)(12) flow diagram will be employed for visual expression in article selection stages according to inclusion and exclusion.

REFERENCES

1. Prüss-Ustün A, van Deventer E, Mudu P, Campbell-Lendrum D, Vickers C, Ivanov I, et al. Environmental risks and non-communicable diseases. BMJ. 2019;364.
2. Ezzati M, Lopez AD, Rodgers A, Vander Hoorn S, Murray CJ, Group CRAC. Selected major risk factors and global and regional burden of disease. The Lancet. 2002;360(9343):1347-60.
3. Cockwell P, Fisher L-A. The global burden of chronic kidney disease. The Lancet. 2020;395(10225):662-4.
4. Xie Y, Bowe B, Mokdad AH, Xian H, Yan Y, Li T, et al. Analysis of the Global Burden of Disease study highlights the global, regional, and national trends of chronic kidney disease epidemiology from 1990 to 2016. Kidney Int. 2018;94(3):567-81.
5. Xu X, Nie S, Ding H, Hou FF. Environmental pollution and kidney diseases. Nat Rev Nephrol. 2018;14(5):313-24.
6. Bowe B, Xie Y, Li T, Yan Y, Xian H, Al-Aly Z. Particulate matter air pollution and the risk of incident CKD and progression to ESRD. J Am Soc Nephrol. 2018;29(1):218-30.
7. Giannadaki D, Lelieveld J, Pozzer A. Implementing the US air quality standard for PM 2.5 worldwide can prevent millions of premature deaths per year. Environmental Health. 2016;15(1):1-11.
8. Ghazi L, Drawz PE, Berman JD. The association between fine particulate matter (PM2. 5) and chronic kidney disease using electronic health record data in urban Minnesota. Journal of exposure science & environmental epidemiology. 2021:1-7.
9. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. International journal of social research methodology. 2005;8(1):19-32.
10. Levin A, Stevens PE, Bilous RW, Coresh J, De Francisco AL, De Jong PE, et al. Kidney Disease: Improving Global Outcomes (KDIGO) CKD Work Group. KDIGO 2012 clinical practice guideline for the evaluation and management of chronic kidney disease. Kidney international supplements. 2013;3(1):1-150.
11. Munn Z, Aromataris E, Tufanaru C, Stern C, Porritt K, Farrow J, et al. The development of software to support multiple systematic review types: the Joanna Briggs Institute System for the Unified Management, Assessment and Review of Information (JBI SUMARI). JBI Evidence Implementation. 2019;17(1):36-43.
12. Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. Annals of internal medicine. 2018;169(7):467-73.

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APPENDICES

Appendix I: Search strategy

PubMed was searched as the initial source of information.

1.
"Glomerular Filtration Rate"[Mesh] OR "Blood Urea Nitrogen"[Mesh] OR "Renal Insufficiency, Chronic"[Mesh] OR "Renal Insufficiency"[Mesh:NoExp] OR "Kidney Failure, Chronic"[Mesh] OR "Cardio-Renal Syndrome"[Mesh] OR Kidney[tiab] OR Renal[tiab] OR glomerular[tiab] OR eGFR[tiab] OR CKD[tiab] OR ESRD[tiab] OR "Blood Urea Nitrogen"[tiab]

2.
"Inhalation Exposure"[Mesh] OR "Air Pollution"[Mesh] OR "Particulate Matter"[Mesh:NoExp] OR "Smog"[Mesh] OR "Air Pollutants" [Pharmacological Action] OR "Air Pollutants"[Mesh] OR "Smoke"[Mesh] OR ((Air[tiab] OR airborne[tiab]) AND (quality[tiab] OR Pollution[tiab] OR Pollutants[tiab] OR pollutant[tiab])) OR "Particulate Matter"[tiab] OR "Smog"[tiab] OR "Air Pollutants" [tiab] OR "PM2.5"[tiab] OR "PM10"[tiab] OR PM1[tiab]

3.
(animals[mesh] NOT humans[mesh])

(1 AND 2) NOT 3

Appendix II: A draft extraction form

We have designed and piloted a data extraction form using Google Forms. By using the following link: https://forms.gle/iwp5WLvpLT8uzNgh7