



BMJ Open Identifying globally relevant learnings from Africa's challenges and solutions to climate change and air pollution-related health impacts: a data science scoping review protocol

Caradee Yael Wright ¹, Anelisa Jaca,² Thandi Kapwata,³ Natasha Naidoo,¹ Babatunde Awokola,⁴ Engineer Bainomugisha,⁵ Kiros T Berhane,⁶ Suzana Blesic,⁷ Anderson Kehbila,⁸ Rajen Naidoo,⁹ Bono Nemukula,¹⁰ Benjamin Kofi Nyarko,¹¹ Akinkunmi Paul Okekunle ¹², Tolu Oni,¹³ Reginald Quansah,¹⁴ Sokhna Thiam,¹⁵ Ibrahim Sidi Zakari,¹⁶ Negussie Beyene¹⁷

To cite: Wright CY, Jaca A, Kapwata T, *et al.* Identifying globally relevant learnings from Africa's challenges and solutions to climate change and air pollution-related health impacts: a data science scoping review protocol. *BMJ Open* 2024;**14**:e076941. doi:10.1136/bmjopen-2023-076941

► Prepublication history for this paper is available online. To view these files, please visit the journal online (<https://doi.org/10.1136/bmjopen-2023-076941>).

Received 21 June 2023
Accepted 09 April 2024



© Author(s) (or their employer(s)) 2024. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

For numbered affiliations see end of article.

Correspondence to

Dr Caradee Yael Wright;
Caradee.Wright@mrc.ac.za

ABSTRACT

Introduction Leveraging data science could significantly advance the understanding of the health impacts of climate change and air pollution to meet health systems' needs and improve public health in Africa. This scoping review will aim to identify and synthesise evidence on the use of data science as an intervention to address climate change and air pollution-related health challenges in Africa.

Methods and analysis The search strategy will be developed, and the search will be conducted in the Web of Science, Scopus, CAB Abstracts, MEDLINE and EMBASE electronic databases. We will also search the reference lists of eligible articles for additional records. We will screen titles, technical reports, abstracts and full texts and select studies reporting the use of data science in relation to the health effects and interventions associated with climate change and air pollution in Africa.

Ethics and dissemination There are no formal ethics requirements as we are not collecting primary data. Results, once published, will be disseminated via conferences and shared with policy-makers and public health, air pollution and climate change key stakeholders in Africa.

BACKGROUND

Exposure to climate change and air pollution impacts, including changes in the environment, are currently the most prominent environmental hazards that threaten the health and well-being of populations in Africa.¹ These public health problems require advanced research and evidence to inform interventions and systemic change. Understanding how to source, manage, model, and analyse health, air quality and climate data and interpret findings is rapidly becoming highly valued, yet somewhat a rare skill set.²

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This scoping review is the first to focus on the use of data science in addressing the interplay between climate change, air pollution and related human health outcomes and interventions in Africa.
- ⇒ We will focus on studies that use data science methods and techniques.
- ⇒ The search strategy will be conducted in four databases (Web of Science, Scopus, MEDLINE and EMBASE) as well as grey literature.
- ⇒ As terminology for climate change and air pollution is evolving and integrated into the larger field of planetary health, newly emerging terms may not be incorporated into our search.

This is especially true considering the vast amount of non-standardised and homogenised records that need to be organised, analysed and modelled in an easily accessible way so that preferably all interested stakeholders understand the technical language.³

Conventional biostatistical analysis and modelling techniques, which still play an important role, have always been the foundation for environmental epidemiology.⁴ However, as data sets grow in diversity, size and complexity, the need for data science techniques such as machine learning, related advanced scalable statistical learning tools and astute data management (including data integration and harmonisation) has increased in numbers. Aspects such as computer programming, that is, computer science, artificial intelligence algorithms (eg, machine learning, deep learning, natural language processing, support vector



machine and the artificial neural network),⁵ predictive analysis, working with imperfect, real-world datasets and rigorously critiquing data science-based research in environmental health are now critical skills essential for conducting environmental epidemiological studies. Moreover, infusing fundamental statistical principles into data science practices is paramount when applying data science approaches to hypothesis-driven environments and health-related investigations.⁶

Of particular relevance to Africa, the issues of algorithmic fairness and sparsity of data, when data science tools are used for prediction and projection at a global scale need to be considered carefully. In many countries across Africa, existing morbidity/mortality data from statistical systems, databases and registries may be outdated⁷ and have low coverage. Many populations are not adequately enumerated, leading to gaps in the data, such as disaggregation up to the lower level, where in some areas, populations such as people living with disabilities are not taken into consideration.⁸ Thus, the lack of accurate, timely and comprehensive data requires sophisticated techniques to optimise analyses despite data quality challenges.⁹

Data science, big data and computational science have been used in public health science,¹⁰ including environmental health science.² Research Data Platforms, such as the European COVID-19 Data Portal,¹¹ have been built to provide an open, trusted and scalable environment where researchers can store and share datasets and epidemiological data. Data science has helped to solve the methodological challenges in environmental health research, for example, high-dimensional outcomes and exposure and the creation of prediction models (essential in the face of climate change).¹² However, most of this research has been done in countries outside of Africa.¹³ Africa would benefit greatly from such research emanating from collaborations between epidemiologists, biostatisticians, data, environmental and climate scientists, and modelling scientists, among others. These efforts would contribute to reducing synergistic human health impacts from environmental factors, such as air pollution and climate change.

The Data Science for Health Discovery and Innovation in Africa (DS-I Africa) programme (<https://dsi-africa.org/>) is leveraging data science technologies and previous National Institute of Health (NIH), USA (<https://www.nih.gov/>) investments to develop solutions for Africa's most pressing public health problems through a robust ecosystem of academic, government and private sector partnerships.¹⁴ DS-I Africa projects are helping to harness the enabling factors in Africa for catalytic change and developing data science applications. Their focus is on centres of excellence in data science and innovation; advancing policy for ethical, legal and social implications of data science research in Africa; increased capacity to advance data science tools and applications; and interdisciplinary collaborations to advance scientific knowledge to improve clinical practice and human health.¹⁴

In light of DS-I Africa, the need is apparent for a scoping review of the possibilities for data science applications in transforming knowledge generation and evidence-building in Africa for some of its most pressing environmental health challenges. This scoping review aims to map out and synthesise the existing evidence on the use of data science to address adverse health outcomes associated with climate change and air pollution. This review will also synthesise evidence on data science-related solutions to address these problems among all populations in the African context. We will provide a review that ignites ideas for multidisciplinary teams to apply data science and big data methodologies and techniques in settings that are potentially plagued with data challenges such as accessibility, quality and scarcity, which are some of our main data limitations in Africa. The findings from peer-reviewed literature are expected to provide valuable solutions for climate change adaptation and air pollution mitigation to improve human health and well-being on the African continent, which we propose to discuss. The review of existing literature will assist in identifying not only solutions for these two pressing health threats, but also research priorities within the human health impacts of focus. As part of the outcomes of this organised scoping review, we plan to use the data for an evidence-based discussion exploring the application, feasibility and acceptability, among others, of using data science approaches in climate change and air pollution studies in Africa.

METHODS AND ANALYSIS

Our scoping review will map and synthesise current information on the use of data science to explore the links between climate change and air pollution, particularly focusing on adverse health impacts in Africa, as well as identifying solutions. This review will use the Johanna Briggs Institute framework¹⁵ adapted from Arksey and O'Malley¹⁶ for conducting scoping reviews. This framework includes the following steps: (1) developing the objectives and questions; (2) search strategy; (3) inclusion criteria; (4) extraction and charting of results; (5) consultation; (6) presentation of the results and (7) discussion, conclusion and implications for research and practice. This scoping review will be reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analysis extension for Scoping Reviews.¹⁷

Defining data science

The NIH Strategic Plan for Data Science defines data science as 'the interdisciplinary field of inquiry in which quantitative and analytical approaches, processes and systems are developed and used to extract knowledge and insights from increasingly large and/or complex sets of data'.¹⁸ Data science is broadly interpreted to include topics such as data, big data, blockchain, data analytics, artificial intelligence algorithms, digital technology, mobile technology, geospatial analysis, remote

sensing, image processing, informatics, computational analysis and modelling, regression analysis and modelling (including multilevel modelling, time to event analysis, etc), time series analysis, complex systems approaches and complex networks algorithms, hazards, extremes and compound extremes analyses.

Defining climate change and air pollution

Long-term significant changes in temperature and weather patterns are referred to as climate change.¹⁹ Natural processes, such as fluctuations in the solar cycle, sea spray and volcanic eruptions, occur; however, since the 1800s, human activities, primarily the combustion of fossil fuels such as coal, oil and gas, have been the primary cause of climate change.²⁰

Air pollution is defined as any substance that alters the natural properties of the atmosphere, and whether it be chemical, physical or biological, is considered an air pollutant.²¹ Air pollution can occur indoors or outdoors; some common air pollutants are carbon monoxide, nitrogen dioxide, ozone, particulate matter, sulfur dioxide and lead.

Defining human health and well-being

The WHO defines human health and well-being as ‘a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity’.²²

Eligibility criteria

We have followed the PECOS framework (Population, Exposure, Concept/Context, Outcome and Study)²³ in identifying our eligibility criteria. Studies eligible for inclusion will have to meet the following criteria:

- ▶ Population: Studies conducted in Africa, although special attention will be given to groups vulnerable to the impacts of climate change and air pollution, for example, infants and children, older persons and people with pre-existing/chronic diseases, outdoor workers (in the context of global warming).
- ▶ Exposure: Studies that assess environmental factors or agents or exposures related to climate change and air pollution such as heat, heatwaves, particulate matter, temperature, floods, droughts and black carbon, among others.
- ▶ Concept/context: We will look at literature on climate change and/or air pollution in the African context.
- ▶ Outcome: Outcomes related to climate change and/or air pollution including climate change or air pollution-related morbidities or mortalities. In addition, studies report on solutions for adaptation, mitigation or interventions.
- ▶ Study designs: Primary studies (qualitative and quantitative) that have investigated the use of data science to address health outcomes caused due to climate change and air pollution.

Exclusion criteria

Articles will be excluded for the following reasons using the PECOS framework:

- ▶ Population: Studies conducted in populations outside Africa, individuals not exposed to and affected including African descendants or Africans living outside the African continent affected by climate change and air pollution.
- ▶ Exposure: Studies that do not assess environmental-related climate change and/or air pollution such as studies on pesticides and heavy metals, among others.
- ▶ Context: All countries/continents excluding Africa and African countries.
- ▶ Outcomes: Any study not reporting on the impacts on human health or adaptations/interventions related to human health and air pollution/climate change.
- ▶ Study designs: Studies that do not apply data science. We will not include conference abstracts, books, book chapters and book reviews, protocols, animal studies and studies without full text.

Search strategy

Working with an information specialist, we will first conduct a pilot search strategy to enhance our search precision. A comprehensive literature search will be conducted after the pilot search in five relevant electronic databases:

- ▶ Web of Science Core Collection (accessed via Web of Science).
- ▶ Scopus (accessed via Elsevier).
- ▶ CAB Abstracts (accessed via Web of Science / OVID).
- ▶ MEDLINE.
- ▶ EMBASE.

In addition, reference lists of eligible peer-reviewed articles will be manually searched for additional articles relevant to the scoping review. The databases will be searched for relevant articles using text words and Medical Subject Headings (MeSH) as part of the search strategy for data science, climate change and air pollution, and solutions to prevent adverse associated health outcomes, as defined above, concerning human health, from the inception of the database to 31 July 2023. The text words and MeSH terms will include terms related to:

- ▶ Methods: Data science, crowdsourcing, artificial neural networks, database systems, classification techniques, etc.
- ▶ Exposures: Climate change, extreme weather events, natural disasters (ie, drought, floods, landslides, fires, dust storms or windblown dust, heatwaves, hurricanes, tropical cyclones, storm surges), air pollution, air quality, actions on clean air quality, air quality standards, indoor air quality, household air pollution, indoor air pollution, etc.
- ▶ Outcomes: health impacts, mortality, morbidity, diet, nutrition, mobility, injury and mental health.
- ▶ Solutions: interventions, implementation, climate adaptation, air pollution mitigation, adaptive capacity and resilience.

The full set of search terms is included in [table 1](#). Results of the searches, that is, records and deduplication, will be managed in EndNote and Rayyan. Following

Table 1 Detailed search terms

Geography	Methods	Exposures	Outcomes	Solutions
“Africa” OR “Algeria” OR “Angola” OR “Benin” OR “Botswana” OR “Burkina Faso” OR “Burundi” OR “Cameroon” OR “Cape Verde” OR “Central African Republic” OR “Chad” OR “Democratic Republic of Congo” OR “Republic of Congo” OR “Cote d'Ivoire” OR “Djibouti” OR “Egypt” OR “Equatorial Guinea” OR “Eritrea” OR “Ethiopia” OR “Gabon” OR “Gambia” OR “Ghana” OR “Guinea” OR “Guinea Bissau” OR “Kenya” OR “Lesotho” OR “Liberia” OR “Libya” OR “Madagascar” OR “Malawi” OR “Mali” OR “Mauritania: OR “Mauritius” OR “Morocco” OR “Mozambique” OR “Namibia” OR “Niger” OR “Nigeria” OR “Reunion” OR “Rwanda” OR “Sao Tome and Principe” OR “Senegal” OR “Seychelles” OR “Sierra Leone” OR “Somalia” OR “South Africa” OR “South Sudan” OR “Sudan” OR “Swaziland” OR “Tanzania” OR “Togo” OR “Tunisia” OR “Uganda” OR “Zambia” OR “Zimbabwe” OR “Southern Africa” OR “East Africa” OR “Central Africa” OR “Northern Africa” OR “West Africa”	“Data Science” OR “Artificial intelligence” [MeSH] OR “AI” OR “Machine learning” OR “Machine Learning” [MESH] OR “Machine intelligence” OR “Deep learning” OR “Deep learning” [MeSH] OR “Modelling” OR OR “Satellite imag*” OR “remote sens*” OR “Computer aided vision” OR “Big data”	“Global warming” OR “global warming” [MeSH] OR “Global heating” OR “Heat” OR “Heatwaves” OR “Temperature” OR “climate change” [MeSH] AND “air pollution” OR “atmospheric pollution” OR “traffic pollution” OR “industrial pollution” OR “household pollution” OR “air pollution” OR “ambient pollution” OR “air pollution” OR “PM _{2.5} ” OR “Sulphur dioxide” OR “carbon monoxide” OR “Nitrogen dioxide” OR “Ozone” OR “Air quality”	“Health” OR “Impact” OR “Mortal*” OR “Death” OR “morbid*” OR “Food-related” OR “Agric*” OR “Diet” OR “Mobility-related” OR “Injury” OR “Respiratory” OR “Cardiovascular” OR “psychological health” OR “mental health”	“Intervention” OR “Adaptation” OR “Climate adaptation”: OR “Implementation” OR “Action” OR “Modification” OR “Alteration” OR “Solution”

a search guide developed by the information specialist, we will supplement our database search with materials in the grey literature. The websites of the following authorities will be searched for grey literature: African Development Bank, International Development Research Centre, UK Department for International Development, United Nations Environment Programme, WHO, World Meteorological Organization, World Bank, United Nations, United Nations Educational, Scientific and Cultural Organization, Intergovernmental Panel on Climate Change, United Nations Framework for the Convention on Climate Change, websites of funding bodies, and Africa Theses and Dissertations, among others that we identify during this process. No content will be excluded from the grey literature category, regardless of publication date, language or author’s country of origin (so long as the content pertains to Africa).

Study selection

Three review authors (CYW, AJ and TK) will independently screen the titles and abstracts of articles identified in the literature search for relevance against the inclusion and exclusion criteria listed in this protocol. Subsequently, the authors will independently screen full texts of potentially eligible articles for inclusion and exclusion, as per the stated criteria above. However, the

articles will not be assessed for methodological quality or risk of bias as is done for systematic reviews since our aim is to identify and map the available literature on the use of data science for addressing climate change-related and air pollution-related health impacts in Africa. The authors will provide reasons for excluded studies. During the study selection phase, disagreements between two authors will be resolved through discussion with the third author, and a fourth author (NN) will arbitrate if a consensus is not reached.

Data charting and synthesis

Three authors (CYW, AJ and TK) will independently extract data using a piloted data extraction form in Microsoft Excel. Data extracted from eligible studies will include the first author’s last name, year of publication, the country where the study was conducted, study design, study duration, participant characteristics (age, gender), data source, type of air pollution, type of climatic change, type of data science and key findings (ie, relations between climate change/air pollution and human health (specific health outcomes/impacts/pathways), as well as adaptation with respect to climate change and mitigation in relation to air pollution as well as solutions and interventions to protect human health. Differences in

data extraction will be resolved through discussion and reaching a consensus.

Data synthesis will involve analysing findings from the identified studies using thematic analysis approaches and relevant studies will be grouped into two high-level domains: climate change and human health, and air pollution and human health. We will consider gender-based differences and other sociodemographics characteristics (ie, socioeconomic status, age, refugee status) mentioned in the studies. Themes will be aggregated to synthesise overall findings.

Data will be qualitatively synthesised on completion of thematic analysis. The nature of data to be considered will cover the topic under investigation, the data science method, if they verified the findings with a more traditional approach compared with a data science approach, and lessons learnt in applying the data science approach. Where possible, we will collate information by the six regions across Africa based on economic and political groupings: North Africa, West Africa, Central Africa, East Africa, Southern Africa and the Indian Ocean Island countries (also known as Small Island States).²⁴

Patient and public involvement

There will be no patient or public involvement in this research.

ETHICS AND DISSEMINATION

This review involves a synthesis and presentation of available resources, and therefore, does not require ethical approval. On publication, results will be published and developed into easily disseminated infographics and shared at international conferences and will be shared with policy-makers across Africa and beyond.

DISCUSSION

This scoping review will be the first to gather information to map and synthesise evidence on the use of data science to identify solutions to two of the greatest threats to public health, namely, climate change and air pollution, in the African continent. Given the synergistic effects of these two environmental risk factors, the framing of this review will emphasise the need for integrated solutions that maximise cobenefits for health and well-being. In Africa and globally, there is a lack of climate change and air pollution awareness, with a pertinent disconnect between science, policy and behaviour practice. We will address this by showing how data science in all its forms is applied to better understand the health impacts of climate change and air pollution and to inform solutions based on locally generated data.

By providing a synthesis of the literature, we will show the potential for data science to contribute to addressing adverse health impacts and to improve public health. We will emphasise the need for greater investment to scale up the use of these approaches (and the necessary capacity

strengthening) across the continent. This review will share African learnings that have relevance globally, in both high-income countries and low-income and middle-income countries, thereby making this review a milestone reference piece to guide climate change-health adaptation plans and air pollution mitigation for researchers and key stakeholders.

Limitations

Several limitations are likely with this review. Terminology related to climate change, air pollution and human health, and key concepts in this review, is evolving, and new terms may not have been encompassed in our search strategy, which may result in some literature being missed. Certainly, within the context of data science, a new and evolving field, there are bound to be new terms associated with these broader topics. While we will search five databases, we may miss some peer-reviewed literature. In anticipation of this challenge, we will search the reference lists of all included articles to identify any additional literature that may be relevant to the review. We will make a significant effort to find all relevant grey literature. However, grey literature searches are imperfect, and we may miss relevant documents.

Current study status

The search strategy is being translated for each of the five databases in collaboration with an information specialist in preparation for the search to begin on 1 April 2024.

Author affiliations

¹Environment and Health Research Unit, South African Medical Research Council, Pretoria, South Africa

²South African Medical Research Council, Tygerberg, South Africa

³Environment and Health Research Unit, South African Medical Research Council, Johannesburg, Gauteng, South Africa

⁴Medical Research Council Unit The Gambia at the London School of Hygiene and Tropical Medicine, Banjul, Gambia

⁵Makerere University, Kampala, Uganda

⁶Columbia University, New York, New York, USA

⁷University of Belgrade, Beograd, Serbia

⁸Stockholm Environment Institute, Nairobi, Kenya

⁹University of KwaZulu-Natal, Durban, South Africa

¹⁰Environment and Health Directorate, National Department Of Health, Pretoria, Gauteng, South Africa

¹¹University of Cape Coast, Cape Coast, Central, Ghana

¹²University of Ibadan, Ibadan, Nigeria

¹³University of Cambridge, Cambridge, UK

¹⁴University of Ghana, Legon, Greater Accra, Ghana

¹⁵African Population and Health Research Center, Dakar, Senegal

¹⁶Abdou Moumouni University, Niamey, Niger

¹⁷Armauer Hansen Research Institute, Addis Ababa, Ethiopia

X Caradee Yael Wright @caradeeyael and Babatunde Awokola @BAwokola

Acknowledgements We thank the National Institute for Health, Global Institute for Health Studies, Fogarty Division of International Science Policy, Planning and Evaluation and its partner organizations for initiating this project.

Contributors CYW conceptualised the study and was responsible for drafting the protocol. AJ provided methodological input. All other authors (TK, NN, BA, EB, KB, SB, AK, RN, BN, BKN, APO, TO, RQ, ST, ISZ and NB) contributed to the writing and editing of the manuscript.

Funding CYW receives research funding from the South African Medical Research Council and National Research Foundation.



Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Provenance and peer review Not commissioned; externally peer reviewed.

Open access This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

ORCID iDs

Caradee Yael Wright <http://orcid.org/0000-0001-9608-818X>

Akinkunmi Paul Okekunle <http://orcid.org/0000-0003-4825-4934>

REFERENCES

- Opoku SK, Leal Filho W, Hubert F, *et al*. Climate change and health preparedness in Africa: analysing trends in six African countries. *Int J Environ Res Public Health* 2021;18:4672.
- Comess S, Akbay A, Vasiliou M, *et al*. Bringing big data to bear in environmental public health: challenges and recommendations. *Front Artif Intell* 2020;3:31.
- NASA. Fighting mosquitoes from space, Available: <https://appliedsciences.nasa.gov/our-impact/news/how-nasa-helps-fight-mosquitoes-space> [Accessed 21 Jun 2023].
- Currie DJ, Smith C, Jagals P. The application of system Dynamics Modelling to environmental health decision-making and policy – a Scoping review. *BMC Public Health* 2018;18:402.
- Tabbarah H, Abdulghafar A. Artificial Intelligence Advanced Analysis and Design: CNIT 380 Instructors. Fall 2017 Section: U1 Mariam Khaled AISedrah, 2017. Available: <https://studylib.net/doc/25548984/artificialintelligence> [Accessed 21 Jun 2023].
- Choirat C, Braun D, Kioumourtzoglou M-A. Data science in environmental health research. *Curr Epidemiol Rep* 2019;6:291–9.
- Maiğa A, Jiwani SS, Mutua MK, *et al*. Generating Statistics from health facility data: the state of routine health information systems in Eastern and Southern Africa. *BMJ Glob Health* 2019;4:e001849.
- Manda S, Haushona N, Bergquist R. A Scoping review of spatial analysis approaches using health survey data in sub-Saharan Africa. *Int J Environ Res Public Health* 2020;17:3070.
- Dash S, Shakyawar SK, Sharma M, *et al*. Big data in Healthcare: management, analysis and future prospects. *J Big Data* 2019;6:54.
- Goldsmith J, Sun Y, Fried LP, *et al*. The emergence and future of public health data science. *Public Health Rev* 2021;42:1604023.
- Europa. European COVID-19 Data Platform, Available: <https://joinup.ec.europa.eu/collection/digital-response-covid-19/news/european-covid-19-data-platform> [Accessed 21 Jun 2023].
- Sebestyén V, Czvetkó T, Abonyi J. The applicability of big data in climate change research: the importance of system of systems thinking. *Front Environ Sci* 2021;9.
- Koné B, Oulhote Y, Mustapha A, *et al*. Environmental health research challenges in Africa. *Environmental Epidemiology* 2019;3:e074.
- National Institute of Health. Harnessing Data Science for Health Discovery and Innovation in Africa (DS-I Africa), 2023. Available: <https://www.fic.nih.gov/Programs/Pages/harnessing-data-science-for-health-discovery-innovation-africa.aspx> [Accessed 21 Jun 2023].
- Jordan Z, Lockwood C, Munn Z, *et al*. The updated Joanna Briggs Institute model of evidence-based Healthcare. *International Journal of Evidence-Based Healthcare* 2019;17:58–71.
- Arksey H, O'Malley L. Scoping studies: towards a methodological framework. *International Journal of Social Research Methodology* 2005;8:19–32.
- PRISMA Scoping Reviews, Available: <http://www.prisma-statement.org/Extensions/ScopingReviews> [Accessed 21 Jun 2023].
- National Institutes of Health. National Institutes of Health (NIH) Strategic Plan For Data Science, 2018. Available: https://datascience.nih.gov/sites/default/files/NIH_Strategic_Plan_for_Data_Science_Final_508.pdf [Accessed 21 Jun 2023].
- United Nations. What Is Climate Change, Available: <https://www.un.org/en/climatechange/what-is-climate-change> [Accessed 21 Jun 2023].
- IPCC. Regional fact sheet – Africa, Available: https://www.ipcc.ch/report/ar6/wg1/downloads/factsheets/IPCC_AR6_WGI_Regional_Fact_Sheet_Africa.pdf [Accessed 21 Jun 2023].
- World Health Organization. Air pollution, Available: <https://www.who.int/health-topics/air-pollution> [Accessed 21 Jun 2023].
- World Health Organization. Health and Well-Being, Available: <https://www.who.int/data/gho/data/major-themes/health-and-well-being> [Accessed 21 Jun 2023].
- Higgins JPTGreen S, eds. Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 Updated March 2011. The Cochrane Collaboration, 2011. Available: www.handbook.cochrane.org [accessed 21 Jun 2023].
- African. Country profiles, Available: https://au.int/en/member_states/countryprofiles2 [Accessed 21 Jun 2023].