Health effects of black carbon - an overview

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Fifth Joint session of the Working Group on Effects and the Steering Body to EMEP
Geneva, Switzerland, 9-13 September, 2019

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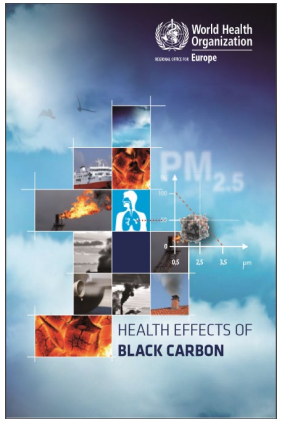
Health Effects of Black Carbon

(WHO, 2012)



A systematic review of evidence of the health effects of BC

- What **metrics** are used to estimate the health effects of exposure to BC?
- What are the effects of BC exposure observed in **epidemiological** studies?
- What are the effects of BC in the human **controlled exposure experiments**? Do they differ qualitatively and/or quantitatively from the effects of PM2.5 mass concentration, or other measured components of PM2.5?
- What are the mechanisms of the effects of BC indicated by **toxicological** studies?

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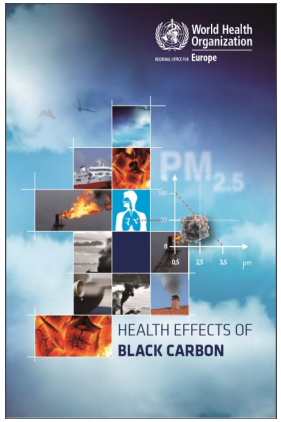

- BC is an operationally defined term, which describes carbon as measured by light absorption. As such, it is not the same as elemental carbon (EC), which is usually monitored with thermal optical methods.

- Current measurement methods for BC and EC need to be standardized so as to facilitate comparison between the results of various studies.

- BC is a universal indicator of a variable mixture of particulate material from a large variety of combustion sources and, when measured in the atmosphere, is always associated with other substances from combustion sources, such as organic compounds

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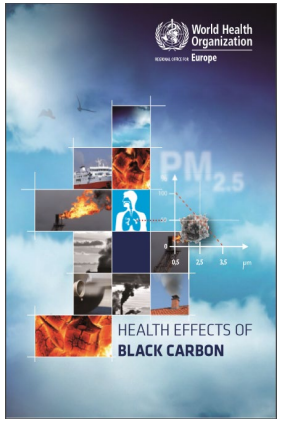

- Sufficient evidence: an association of short-term/daily variations in BC concentrations with short-term changes in health (all-cause and CV mortality, and cardiopulmonary hospital admissions)

- Sufficient evidence: associations of all-cause and cardiopulmonary mortality with long-term average BC exposure, based on cohort studies

- Short-term studies suggest that BC is a better indicator of harmful particulates from combustion sources (especially traffic) than undifferentiated particulate matter (PM) mass, but the evidence for the relative strength of association from long-term studies is inconclusive

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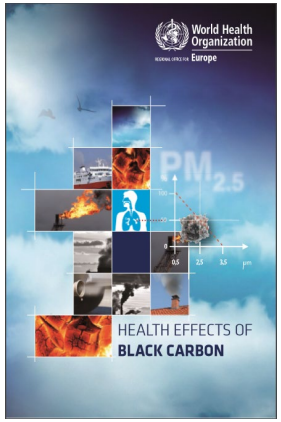

- Toxicological studies suggest that BC may not be a major directly toxic component of fine PM, but may act as a universal carrier of a variety of chemicals of varying toxicity to the lungs, the body's major defence cells and possibly the systemic blood circulation

- Not enough clinical or toxicological studies to evaluate: the qualitative differences between the health effects of exposure to BC or to PM mass (for example, different health outcomes); quantitative comparison of the strength of the associations or identification of any distinctive mechanism of BC effects

Health Effects of Black Carbon

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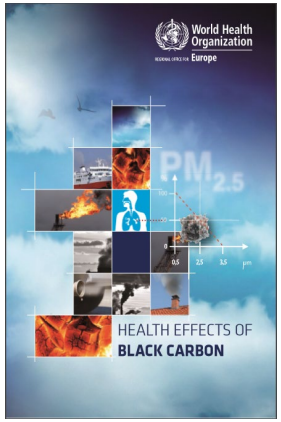
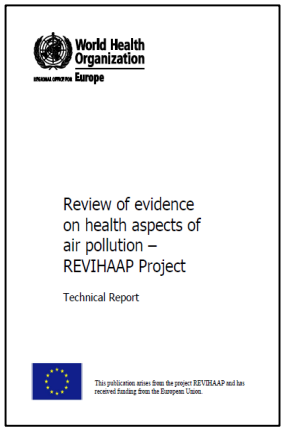


- The Task Force on Health recommended to continue using PM2.5 as the primary metric in quantifying human exposure to PM and its health effects, and for predicting the benefits of exposure reduction measures

- BC may be useful as an additional indicator in evaluating local action aimed at reducing the population's exposure to combustion PM (for example, from motorized traffic)

- The Task Force on Health agreed that reducing exposure to PM2.5 containing BC and other combustion-related PM (for which BC is an indirect indicator) should lead to a reduction in the health effects associated with PM

REVIHAAP - review of evidence on health aspects of air pollution (WHO, 2013)


World Health Organization
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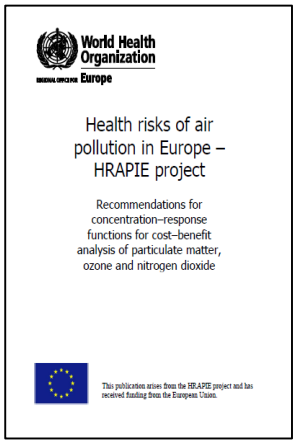
Review of evidence on health aspects of air pollution – REVIHAAP Project

Technical Report

This publication arises from the project REVIHAAP and has received funding from the European Union.

- Reassured the result of 'Health Effects of Black Carbon'
- Advised to consider developing an additional air quality guideline to cover the effects of road vehicle PM emissions, not well captured by PM2.5, building on the work on BC and/or EC
- Fewer studies and/or health outcomes available for BC and other alternative metrics as compared with PM2.5
- Risk assessments based on PM2.5 studies is the most inclusive
- Alternative metrics, such as BC, may be used in sensitivity analyses
- Not to sum up impact for different PM metrics, given that the effects and sources are not fully independent
- Emphasised the co-benefit of reducing BC

HRAPIE - health risks of air pollution in Europe (WHO, 2013)


World Health Organization
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Health risks of air pollution in Europe – HRAPIE project

Recommendations for concentration–response functions for cost–benefit analysis of particulate matter, ozone and nitrogen dioxide

This publication arises from the HRAPIE project and has received funding from the European Union.

- Estimation of impacts of BC in the EU for the cost–benefit analysis of EU air quality policies – not recommended
- BC could be used in a sensitivity analysis of the cost–benefit analysis
- BC can be an additional indicator in evaluating local action aimed at reducing the population's exposure to combustion PM
- Local assessment of the effects of BC exposure can be based on risk estimates linking long-term exposure to BC with all-cause (natural) mortality, as well as short-term exposure to BC with hospital admissions for asthma in children and for CVDs in adults (mainly > 65 years)

US EPA Integrated Science Assessment for Particulate Matter

(external review draft, 2018)

Policy-Relevant Considerations

- **PM Components and Sources**: Many $PM_{2.5}$ components and sources are associated with many health effects, and the evidence does not indicate that any one source or component is more strongly related with health effects than $PM_{2.5}$ mass
- ….

Source: https://www.epa.gov/isa/integrated-science-assessment-isa-particulate-matter

Environment International 107 (2017) 154–162

Contents lists available at ScienceDirect

Environment International

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

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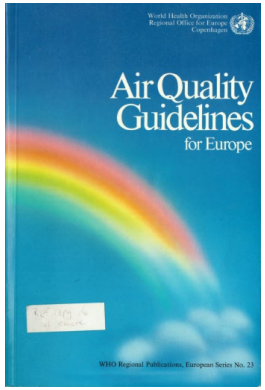
Results: The results of our systematic review demonstrate similar results for BC or EC and $PM_{2.5}$; that is, a generally modest, positive association of each pollutant measurement with cardiovascular emergency department visits, hospital admissions, and mortality. There is no clear evidence that health risks are greater for either BC or EC when compared to one another, or when either is compared to $PM_{2.5}$.

Limitations: We were unable to adequately evaluate the role of copollutant confounding or differential spatial heterogeneity for BC or EC compared to $PM_{2.5}$.

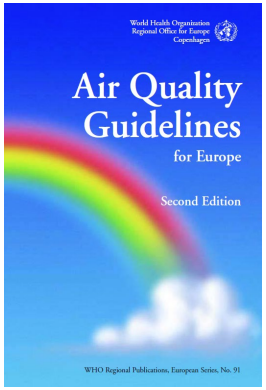
Conclusions and Implications of Key Findings: Overall, the evidence at present indicates that BC or EC is consistently associated with cardiovascular morbidity and mortality but is not sufficient to conclude that BC or EC is indep

That said, we recommend any future evaluations of PM sources and components should be conducted in the context of PM2.5 mass in order to facilitate comparisons of the components to total particle mass and incorporate the appropriate spatial resolution for estimating exposure to PM components.

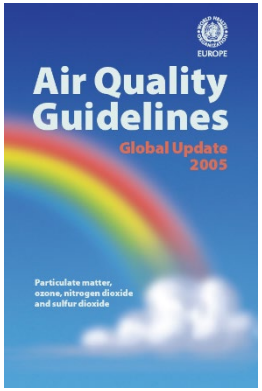
WHO Air Quality Guidelines



- The first edition
- 28 air pollutants



- 35 air pollutants
- SO_2 and PM were separated
- PM CRF



- 4 air pollutants
- PM value
- Interim targets

Updating WHO Global Air quality guidelines

- 5 air pollutants + ?
- New WHO procedure

Published 1987 *Published 2000* *Published 2006* *Since 2016 ~*

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Considering an additional AQ guideline

- Main questions asked:
  - Which PM components are the most toxic?
  - Is there a better metric than PM2.5 mass to explain the associations with adverse effects?

- Alternatively:
  - Would a guideline in addition to total PM2.5 mass be helpful in protecting public health?

- Currently, no pressure through legislation or a guideline to control primary PM where toxic components are present

- Primary PM *could be controllable* by a single country or region, while in many parts of the world, total $PM_{2.5}$ mass that cannot not controllable by a single country/region

Considering an additional AQ guideline

Good practice statements

- Stressing the imperative to monitor (BC) and thus generating data necessary for understanding the trends and impacts of the applied air pollution mitigation measures
- Providing typical levels being observed in different environments
- Outlining implications of the elevated concentrations
- Stressing the need for continuous improvement (lowering of the concentrations)
- Stressing the importance of source apportionment of PM components (as an input into policies to control pollution)

Thank you for your attention

http://www.euro.who.int/en/health-topics/environment-and-health

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