



# STATEMENT

Synopsis of Research Report 213

HEALTH  
EFFECTS  
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## Ambient Air Pollution and All-Cause Mortality in an Analysis of Asian Cohorts

### BACKGROUND

Much of what is currently known about the adverse effects of ambient air pollution comes from studies conducted in high-income regions, especially North America and Europe, with relatively low air pollution levels. The study by Dr. George S. Downward and Dr. Roel Vermeulen from Utrecht University, the Netherlands, addresses a clear research gap by leveraging harmonized data from the *Asia Cohort Consortium*, a large multicenter collaborative research effort in Asia that began in 2008.

### APPROACH

The study by Downward and Vermeulen assessed the association between long-term exposure to outdoor air pollution and all-cause and cause-specific mortality in an analysis of six Asian cohorts, with more than 340,000 participants in six countries (Statement Figure). The cohorts were general population studies and varied widely in size, study period, recruitment method, geographical scope, exposure assignment, and outcome assessment. The cohorts in India and Japan were the largest by far. Participants were recruited from 1991 to 2008 and followed up between 5 (India) and 23 years (Taiwan). Some cohorts were conducted in a single city or district (e.g., cohorts in India and Bangladesh). Others included much larger areas in a country (e.g., Japan).

The investigators estimated exposure for fine particles and nitrogen dioxide by using existing global satellite-based models. The estimates were assigned to study participants based on geocoded residential location for the year of recruitment only.

The study included all-cause mortality and nonaccidental, all-cancer, lung cancer, cardiovascular disease, and noncancer lung disease mortality. The outcome assessment was performed for each individual cohort, typically through active follow-up or linkage to death registries.

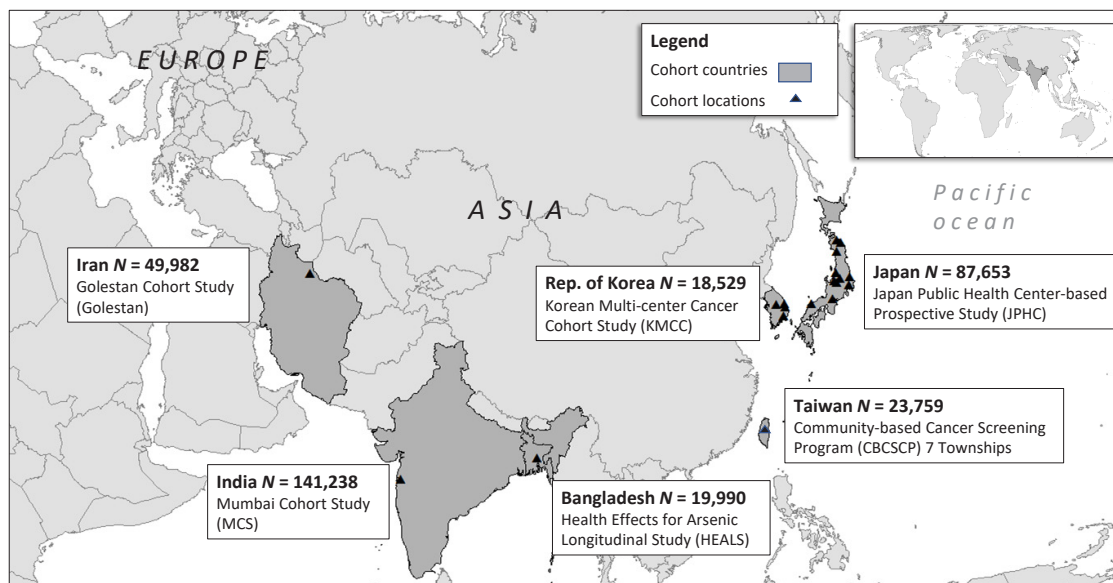
### What This Study Adds

- The study assessed the association between long-term exposure to ambient air pollution and mortality in six Asian cohorts, addressing a clear research gap.
- Combined results across the cohorts documented no association between long-term exposure to ambient PM<sub>2.5</sub> and mortality, except for a borderline significant positive association with cardiovascular mortality. Several individual cohorts (i.e., in India, Japan, and Taiwan), however, did display positive significant associations between ambient PM<sub>2.5</sub> and cardiovascular mortality.
- For ambient NO<sub>2</sub>, combined results showed positive associations for all mortality outcomes, in particular the cancer outcomes.
- Large heterogeneity of the findings was reported across the individual cohorts, with sometimes no apparent pattern. Furthermore, the combined NO<sub>2</sub> estimates were heavily driven by positive associations from a single cohort in Japan.
- Although uncertainty remains regarding the true size of the ambient air pollution and mortality associations in Asia, these populations are experiencing very high levels of air pollution, meriting attention and action to reduce ambient air pollution.

The investigators applied single-pollutant Cox proportional hazard models to assess the association between air pollution exposure and mortality with adjustment for important confounders, such as age, sex, recruitment year, smoking, body mass index, diet, and a measure of socioeconomic status (education or employment). The investigators calculated hazard ratios for each cohort separately and then combined the results using random effects meta-analysis. They conducted various sensitivity analyses in each cohort, including an adjustment for urbanicity. No meta-analyses were conducted on any of the sensitivity analysis results.

### MAIN RESULTS AND INTERPRETATION

The study by Downward and Vermeulen documented no associations between long-term exposure to ambient



**Statement Figure.** Geographical location of the six Asian cohorts.

fine particles and all-cause mortality and cause-specific mortality in meta-analyses, except for a borderline significant positive association with cardiovascular mortality (i.e., an adverse health effect of air pollution). Several individual cohorts (i.e., in India, Japan, and Taiwan), however, did display positive significant associations between ambient fine particles and cardiovascular mortality. For ambient nitrogen dioxide, the combined estimates showed positive associations for all mortality outcomes, in particular the cancer outcomes, although estimates were heavily driven by positive associations from a single cohort in Japan. The cohorts were very diverse, and large heterogeneity of the findings was reported across the individual cohorts, with null, negative, or positive findings, with sometimes no apparent pattern.

In its independent review of the study, the HEI Review Committee thought the research was well motivated and addressed a clear research gap. The large sample size and leverage of harmonized data from the Asia Cohort Consortium were considered to be strengths of the study. Furthermore, data were available for several individual-level lifestyle factors, such as smoking status and intensity, body mass index, and diet, and the analyses were adjusted accordingly. Application of existing global satellite-based models allowed for a uniform estimation of exposure at a reasonably high spatial resolution for large urban and rural populations in six Asian countries. Such a study would otherwise not have been possible given the paucity of ground-based monitors, particularly in low- and middle-income countries. Although the Review Committee broadly agreed with the investigators' conclusions, it identified limitations that should be considered when interpreting the results.

Importantly, the Committee was concerned that residual confounding was likely in the main analyses due to inadequate adjustment for characteristics that correlate with air pollution and mortality, most notably socioeconomic status and urbanicity. Findings sometimes differed for models that adjusted for urbanicity as compared to those that did not. The Committee would have been interested in better understanding potential sources of heterogeneity in the findings. There were also concerns about the exposure assessment approach because of the substantial temporal and spatial misalignment of the data, which might have influenced the analysis of mortality outcomes in unpredictable ways. For example, residential mobility was not taken into account and, for a few cohorts (in India and Iran), only aggregated residential address data were available (e.g., postal code). Also, the global models typically perform more poorly in Asia compared to North America and Europe.

## CONCLUSIONS

Overall, there remains uncertainty about the true size of the ambient air pollution and mortality associations in Asia, where the levels of air pollution are often high and the types and sources of air pollution, including household air pollution, markedly differ from those in high-income settings. The study by Downward and Vermeulen highlights the urgent need for future studies that could prove to be useful in reducing this uncertainty. At the same time, these populations are experiencing very high levels of air pollution, meriting attention and action to reduce ambient air pollution regardless of the uncertainties.