



STATEMENT

Synopsis of Research Report 176

HEALTH
EFFECTS
INSTITUTE

Effect of Coal Bans on Air Quality and Health in Ireland

BACKGROUND

Dr. Douglas W. Dockery and colleagues studied the effects on air quality and human health of regulatory actions to ban the use of coal in 12 cities in Ireland. This study is an important addition to the small number of empirical studies of the effects of regulatory actions and other interventions on air quality and health. The investigators extended their earlier examination of the effects of a coal ban in Dublin in 1990 (published by Clancy et al. in *The Lancet* in 2002) to 11 smaller Irish cities where coal bans were implemented in 1995, 1998, and 2000.

APPROACH

The investigators characterized changes in air pollution levels using measurements of black smoke (BS) and of sulfur dioxide measured as total gaseous acidity (TGA). Measurements of BS and TGA were collected from 1981 to 2004 from a small number of fixed-site monitors in the 12 cities. No monitoring data were available in the areas of Ireland where the bans were not instituted. To evaluate the effects of the bans on air pollution levels, the investigators compared the average daily BS and TGA concentrations for the 5 years before and after each ban.

To evaluate the effects of the bans on health, the authors collected data on mortality, as in the previous study, as well as data on hospital admissions. Data on total nonaccidental and cause-specific mortality were obtained from death certificates from 1981 to 2004 to assess the effects on mortality of the 1990, 1995, and 1998 bans (but not the 2000 ban). Hospital admissions data suitable for analysis were available only for the 1995 and 1998 bans.

The study populations for each ban consisted of the residents of the city as well as the surrounding

county (except for Dublin, whose study population consisted of city residents only). In their analyses of mortality, the investigators also included a “comparison” population, residents of the Midlands counties in Ireland in which coal bans were not implemented. Evaluation of this comparison population made it possible to assess whether the mortality effects could be attributed to the coal bans or might have resulted from other factors including

What This Study Adds

- Dockery and colleagues’ study of a series of Irish bans on the use of coal is an important addition to air quality and health outcomes research. In this study, the investigators extend their earlier examination of the effects of a coal ban in Dublin in 1990 to 11 smaller Irish cities where coal bans were implemented in 1995, 1998, and 2000.
- The investigators found clear decreases in black smoke concentrations, particularly during the heating season, after each ban. Respiratory mortality decreased significantly, by 17%, after the 1990 ban (confirming the earlier study) and, to a lesser extent, after the 1995 and 1998 bans. However, unlike the earlier study, the current study did not find a reduction in total or cardiovascular mortality after either the 1990 ban or the later bans.
- The study demonstrates the importance — and challenges — of disentangling the effects of an intervention from those of other social and economic factors that might also influence long-term trends in air quality and health.

the societal changes occurring over the same time period in Ireland. The investigators used an interrupted-time-series analysis to evaluate the effects of the coal bans on mortality and hospitalization rates. They estimated the percent change in total and cause-specific mortality, while adjusting for seasonal and long-term background trends, weather, and influenza epidemics. The adjustment for long-term background trends in mortality in both study and comparison populations was done with a smooth function of mortality rates from an Irish “reference” population living in western coastal counties presumably not affected by the bans. Extensive analyses were conducted to evaluate the sensitivity of the results to model choices.

RESULTS AND INTERPRETATION

The investigators confirmed the existence of clear decreases in BS concentrations ranging from 4 to 35 $\mu\text{g}/\text{m}^3$ (–45% to –70%), particularly during the heating season, after the coal bans were implemented in each of the 12 cities over the years from 1990 to 2000. The largest absolute reductions were seen after the earliest ban, in Dublin. No general decrease was seen in TGA concentrations after the bans, probably because of the nonspecificity of the measurement method and the low concentrations that were present during the study period.

The study found that respiratory mortality decreased significantly, by 17%, after the 1990 ban in Dublin (confirming the earlier study) and, to a lesser extent, after the 1995 and 1998 bans, in a pattern largely consistent with the magnitude of BS reductions across the successive bans. Such decreases were not observed in the comparison population (see Figure). However, in a notable difference from the earlier study of the 1990 ban in Dublin, the current study did not find a reduction in total or cardiovascular mortality after either the 1990 or later bans. Analyses of the hospital admissions data were hampered by substantial underreporting issues and the absence of data from a reference population to account for long-term background trends.

In its independent review of the study, the HEI Health Review Committee agreed with the investigators that the previous study had likely overestimated the effects of the Dublin ban on total and cardiovascular mortality but not on respiratory mortality. The Committee thought that the investigators’ detailed sensitivity analyses and thorough discussions demonstrated how these major differences in findings could be explained by differences in the studies’ approaches to correcting for long-term background trends in mortality rates that were unrelated to the bans.

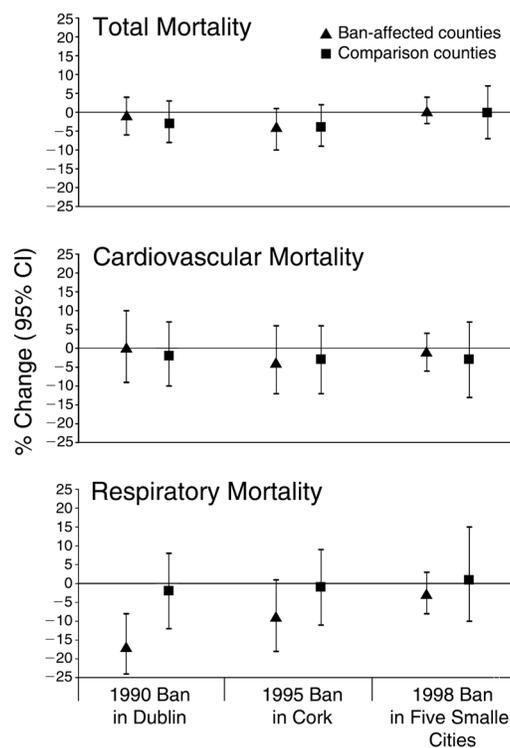


Figure 3. Percent change in cause-specific mortality for the ban-affected and comparison counties after the 1990, 1995, and 1998 coal bans. CI denotes confidence interval.

CONCLUSIONS

Overall, the current study provides evidence that the Irish coal bans improved air quality and respiratory health, confirming earlier observations by Clancy and colleagues in their study of the 1990 ban in Dublin. The study holds important lessons for future intervention studies that plan to use interrupted-time-series designs in the presence of long-term background trends in health. In this case, the study was conducted during a time when the Irish economy was the fastest growing in Europe and Ireland was experiencing a number of social and economic changes, unrelated to the intervention under investigation, that could also have influenced trends in air quality and health. The study demonstrates the importance of using multiple approaches to evaluate and control for the effects of such changes, including the use of comparison populations unaffected by the intervention and the use of simulation and sensitivity analyses to evaluate choices of reference populations and of statistical models adjusting for background trends. At the same time, the study illustrates the considerable challenges faced by this type of analysis in eliminating biases that can lead to either overestimation or underestimation of the effects of an intervention on public health.