

COMMITTEE ON THE MEDICAL EFFECTS OF AIR POLLUTANTS

MILLER *ET AL* (2007) LONG-TERM EXPOSURE TO AIR POLLUTION AND INCIDENCE OF CARDIOVASCULAR EVENTS IN WOMEN – SIMULATED LIFE-TABLE ASSESSMENT

1. The Miller paper (Miller *et al*, 2007) reported a coefficient of a 76% increase in the risk of death from cardiovascular disease for a $10 \mu\text{g}/\text{m}^3$ increase in $\text{PM}_{2.5}$ in women aged 50-79 years without cardiovascular disease at baseline. The coefficient usually used for quantification is a 6% increase in the risk of death from all causes for a $10 \mu\text{g}/\text{m}^3$ increase in $\text{PM}_{2.5}$ in adults over 30 (from the ACS study). These coefficients are clearly very different in size but the ACS study also applies to a less specific cause of death and a more general population group.
2. It is possible for a higher coefficient for a specific cause of death and a specific susceptible group to be compatible with a lower coefficient for all causes of death and a general population group as the latter could be 'diluted out' with irrelevant causes of death and groups that are not susceptible. Is this a sufficient explanation for the differences in the size of the coefficient in this case?
3. A rather extreme hypothesis was proposed in order to provide a clear cut test of this argument. This was that cardiovascular mortality was the only relevant cause of death and that women aged 50-79 years without cardiovascular disease at baseline were the only relevant susceptible group. Of course, this is known not to be true but, if, even with these extreme assumptions, the calculated impact from the Miller study was substantially larger than that from the ACS study, then it would be clear that the identification of the relevant cause of death and the relevant susceptible group was not a sufficient explanation on its own for the differences in the size of the coefficient.
4. The Secretariat asked the Institute of Occupational Medicine to test this hypothesis using their usual life-table methodology. The details of the defined scenarios are appended. The results are given in Table 1 on the next page. The calculated impact from the Miller study (assuming women aged 50-79 years without cardiovascular disease at baseline were the only relevant susceptible group) was not greater than the calculated impact from the ACS study applied to all adults over 30 (11.5 million life years vs 28.4 million life years). On the other hand, the calculated impact from the Miller study (which only applies to women) was over 80% of the calculated impact of the ACS study in women (11.5 million life years vs 14.1 million life years). Similarly, the calculated gain in life expectancy in women using

Table 1 Comparison of the standard calculation using the ACS study coefficient with using the 76% coefficient and an extreme scenario assuming that women aged 50-79 without heart disease were the only susceptible group (for an illustrative reduction of 10 µg/m³ PM_{2.5})

Scenario	Life years gained in population			Gain in life-expectancy from birth	
	Men	Women	Total	Men	Women
6% reduction in all cause mortality adults 30+	14,317,996	14,110,957	28,428,953	221	211
76% reduction in cardiovascular mortality women without heart disease aged 50-79	Not done	11,468,798	11,468,798	Not done	175

Table 2 Comparison of the standard calculation using the ACS study coefficient with using the 76% coefficient and an extreme scenario assuming that women aged 50+ without heart disease were the only susceptible group (for an illustrative reduction of 10 µg/m³ PM_{2.5})

Scenario	Life years gained in population			Gain in life-expectancy from birth	
	Men	Women	Total	Men	Women
6% reduction in all cause mortality adults 30+	14,317,996	14,110,957	28,428,953	221	211
76% reduction in cardiovascular mortality women without heart disease aged 50+	Not done	22,388,510	22,388,510	Not done	315

the Miller study coefficient (175 days) was over 80% of that in women using the ACS study coefficient (211 days).

5. The subjects in the Miller study were aged 50-79 at baseline but will, of course, have become older during follow-up. A further lifetable run was therefore done applying the 76% coefficient to women aged 50+ without heart disease. The results are shown in Table 2. This substantially increased the impact as baseline mortality rates in women over 79 are high. The calculated impact from the Miller study (assuming women aged 50+ without cardiovascular disease at baseline were the only relevant susceptible group) was much closer to the calculated impact from the ACS study applied to all adults over 30 (22.4 million life years vs 28.4 million life years). The calculated impact from the Miller study (applied to women without heart disease aged 50+) exceeded the calculated impact of the ACS study in women (22.4 million life years vs 14.1 million life years). Similarly, the calculated gain in life expectancy in women without heart disease aged 50+ using the Miller study coefficient (315 days) exceeded that in women using the ACS study coefficient (211 days).

6. We know that there is an effect of $PM_{2.5}$ on lung cancer as well as on cardiovascular mortality, so a further calculation was done to estimate the impact using a coefficient from the ACS study for cardiovascular mortality (Pope *et al* 2004). This could then be used as an alternative comparison with the Miller study results. The results are shown in Table 3. It can be seen that the calculations using the coefficient from the Miller study exceed in all cases the results using the ACS coefficient for cardiovascular mortality despite the fact that this includes men as well as women.

Conclusions

7. If one takes the rather extreme hypothesis that cardiovascular mortality was the only relevant cause of death and that women aged 50-79 years without cardiovascular disease at baseline were the only relevant susceptible group, then it is possible to argue that the high coefficient of 76% in the Miller study could be accounted for solely by having identified a particularly susceptible group. Put another way, it is possible for a 76% coefficient applied to a small group and a specific cause to be compatible with a 6% coefficient for all causes and all adults over 30 if one assumes no other groups are affected.

8. It is, however, known that there are other groups affected (men; women over 79) and other causes affected (lung cancer). It then becomes more difficult to argue that identification of a particularly susceptible group is a sufficient explanation on its own. It seems likely that, if this is one of the reasons, then other reasons are also involved.

Secretariat
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Pope, C.A. III, Burnett, R.T., Thun, M.J., Calle, E.E., Krewski, D., Ito, K., and Thurston, G.D. (2002) 'Lung cancer, cardiopulmonary mortality and long-term exposure to fine particulate air pollution' *JAMA* 287(9):1132-1141.

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Table 3 Comparison of a calculation using the ACS study coefficient for cardiovascular mortality with using the 76% coefficient and an extreme scenario assuming that women aged 50-79 or aged 50+ without heart disease were the only susceptible group (for an illustrative reduction of 10 $\mu\text{g}/\text{m}^3$ $\text{PM}_{2.5}$)

Scenario	Life years gained in population			Gain in life-expectancy from birth	
	Men	Women	Total	Men	Women
12% reduction in cardiovascular mortality adults 30+	6,513,876	4,420,991	10,934,867	99	63
76% reduction in cardiovascular mortality women without heart disease aged 50-79	Not done	11,468,798	11,468,798	Not done	175
76% reduction in cardiovascular mortality women without heart disease aged 50+	Not done	22,388,510	22,388,510	Not done	315

Methodological details

Illustrative pollution reduction: $10 \mu\text{g}/\text{m}^3$ $\text{PM}_{2.5}$

Tables show total life years gained in the population (with new cohorts) followed up from 2010-2109 inclusive plus the gain in life expectancy for a birth cohort born in 2010 totalled over 106 years.

Baseline rates: England and Wales 2002 run forward to 2010

ACS study

Coefficients: 6% per $10 \mu\text{g}/\text{m}^3$ $\text{PM}_{2.5}$ all cause mortality or 12% per $10 \mu\text{g}/\text{m}^3$ $\text{PM}_{2.5}$ cardiovascular mortality

Applied to adults over 30.

Miller study

Coefficient: 76% per $10 \mu\text{g}/\text{m}^3$ $\text{PM}_{2.5}$ cardiovascular mortality.

Applied to women without heart disease aged 50-79 or aged 50+ at start.

The basic baseline rates for England and Wales 2002 do not include separate baseline rates for women with and without heart disease or give the numbers of women with and without heart disease. However, the Miller paper does explain that 22.5% of their total subjects were excluded due to having heart disease at the start of the study i.e. 77.5% of their population of women did not have heart disease at the start. The calculation here assumed that the same proportions applied in England and Wales.

In the absence of any other information it had to be assumed that the women without heart disease at the start had the same baseline rate as the general population of women. This may have slightly overestimated the result although over time some of these women will develop heart disease.

In practice, IOM implemented this by applying a 58.9% ($76\% \times 77.5\%$) reduction in the cardiovascular mortality rates to the relevant populations in the lifetable.