

## DEFINITION OF AVERAGE EXPOSURE

The inclusion of large numbers of cohort members who contribute no informative follow up may also bias the average exposure. An appropriately weighted average exposure will give zero weight to individual exposures in this group. If only a simple mean is used, and if this late entrant group is large and has—as is likely—systematically lower exposures, the apparent cohort exposure will be too low in relation to the observed mortality, and the estimated risk per unit exposure will be exaggerated.

## REVIEW OF COHORTS WITH POTENTIAL EFFECT DILUTION OR BIASED EXPOSURE AVERAGES

The potential biases discussed in the preceding paragraphs will not apply where the reported mortality excludes observations before the tenth year of follow up (or a later year), and where the average exposure has been weighted by expected lung cancer mortality. This leaves the following cohorts as potentially affected: Wittenoom, Ontario, Vocklabruck, US/Canada insulators, Balangero, Paterson, SA mines, Massachusetts, Albin and Ferodo. Table 16 summarises the relevant data.

The possibility of dilution due to uninformative follow-up needs to be considered for the SA mines and for the Massachusetts and Paterson cohorts. This can certainly be ignored for Massachusetts and Paterson cohorts, because of their combination of limited recruitment period with long follow up. It cannot be dismissed for the SA mines, and an adjustment will be developed below (Appendix C).

The possibility that a simple mean of individual exposures (the available figure) will be a poor proxy for the desired average weighted by expected lung cancer mortality needs to be considered for all the cohorts listed in Table 16. For all but one there are reasons (summarised individually below) for believing that the available figure is an acceptable proxy.

- For Wittenoom, the measure of excess mortality used has been truncated at subjects' 65th birthdays. The effect of this is broadly to equalise the follow up durations (and therefore the expected mortality weights) of different first exposure groups.
- The recruitment period of the Ontario cohort is relatively short, and no mention is made of major variations in exposure conditions.
- Only 18% of the Vocklabruck cohort started their exposure after 1969: described as 'the decisive year in improving the dust situation'.
- The basis for the 'mean' exposure in the US/Canadian insulators cohort (drawn from previous reviews) is very uncertain. It is not based on averaging known or estimated individual exposures. It is plausible that conditions may not have changed greatly over the relevant period (up to 1966).
- The narrow range of first exposure dates for the Massachusetts cohort implies limited scope for changes in average levels, and the long minimum follow up also means that even if there were such changes, the weighting applied to early and late entrants would be similar.
- Comparison of the most recent follow up report on the Balangero mine cohort with a previous report (recruitment to 1965, follow up to 1975), suggests that only a relatively small proportion of the latest cohort were first exposed after 1965; though it is not entirely clear how the two cohorts relate to each other, and the minimum employment qualification time was more restrictive (1 yr for the later report than for the earlier (1 month), so the comparison is not straightforward. There was reportedly little change in exposure conditions between 1946 and 1960. Some downward bias in the derived exposure average is possible, but the extent of this is difficult to quantify. Even on an unadjusted basis, the derived risk per unit exposure for this cohort is one of the lowest seen.

Table 16. Recruitment and follow up configurations for cohorts with potential effect dilution or biased exposure averages

| Cohort               | Numbers of years latency | Recruitment |      | follow up |      | Maximum follow up (yr) | Follow up on latest entrants (yr) |
|----------------------|--------------------------|-------------|------|-----------|------|------------------------|-----------------------------------|
|                      |                          | From        | To   | From      | To   |                        |                                   |
| Wittenoom            | 10                       | 1943        | 1966 | 1943      | 1986 | 44                     | 20                                |
| Ontario              | 20                       | 1948        | 1959 | 1948      | 1977 | 30                     | 18                                |
| Vocklabruck          | 20                       | 1907        | 1979 | 1950      | 1990 | 84                     | 11                                |
| US/Canada insulators | 20                       | 1907        | 1966 | 1967      | 1986 | 80                     | 20                                |
| Balangero            | 20                       | 1930        | 1986 | 1946      | 1987 | 58                     | 1                                 |
| Paterson             | 5                        | 1941        | 1945 | 1941      | 1982 | 42                     | 37                                |
| SA mines             | 0                        | 1925        | 1980 | 1946      | 1980 | 56                     | 0                                 |
| Massachusetts        | 0                        | 1951        | 1953 | 1953      | 1988 | 38                     | 35                                |
| Albin                | 20                       | 1907        | 1977 | 1927      | 1986 | 80                     | 9                                 |
| Ferodo               | 10                       | 1920        | 1977 | 1942      | 1979 | 60                     | 2                                 |