Letters to the Editor

Readers are invited to submit letters for publication in this department. Submit to Doris Flournoy, Executive Editor, Journal of Occupational Medicine, 150 N. Wacker Drive, Chicago, IL 60606. Letters should be typewritten, double spaced and should be designated "For Publication."

Dose-Response and Immortality in SMR Studies

To the Editor: Because dose-response is an important criterion in the determination of causality, industrial epidemiologists often examine their standardized mortality ratio (SMR) results by level of exposure. Classification of workers into high and low categories based upon their highest exposure job is a method commonly used (see the acrylonitrile study in the April 1980, *JOM* for a recent example). Unfortunately, investigators using this "highest exposure job" method often make the mistake of allocating all of the person-years at risk for each worker to just one exposure category, a procedure that can negate or reverse what might actually be a positive dose-response gradient. The problem has received little attention to date, and consequently misallocation of person-years is rather common. For instance, three of nine SMR studies of vinyl chloride-exposed workers have made this error.[1,2,3]

An example will help to illustrate the problem. Suppose there is a plant at which all workers start at the same time in low-exposure jobs, and 20 years later the process changes such that all jobs for those still working are considered high exposure (no workers enter or leave the work force, except for deaths). When the workers are subsequently classified into low and high categories on the basis of highest exposure job ever held, one finds in the low-exposure category that the number of observed deaths is much greater than the expected number, in fact all of the workers in the low exposure category are dead. However, in the high-exposure category the mortality is much less than expected, in fact nobody in the high-exposure category dies in the first 20 years after initial employment. One would conclude from such an analysis that low exposures are quite dangerous but that high exposures are somehow protective.

This fictitious example is extreme, but it serves to show that workers who move from low- to high-exposure jobs will bias results if they (and all their person-years) are classified by highest exposure job. The problem is that, for such workers, low-exposure person-years are included in the high-exposure category. These low-exposure person-years are immortal in the high category because if workers die while in low-exposure jobs, their deaths are put into the low category. The high category, therefore, contains too many person-years at risk and overestimates the expected number of deaths. The opposite occurs in the low category. The result for the high category is conservative mortality ratios and the result for the low category is inflated mortality ratios.

Letters continued

A solution is to allocate person-years to the low-exposure category until workers switch to high-exposure jobs. Only when they make the job change should their person-years be allocated to the high-exposure category. This principle has previously been termed "concurrent classification" by Waxweiler.[4] Workers who start in high-exposure jobs and change to low-exposure jobs do not require special handling, because with the highest exposure job method, all of their person-years are considered high exposure. (The method assumes that the highest exposure determines excess disease risk.)

The correct data processing requires selection of certain workers and control over the beginning and ending of person-years calculations for each worker. For the "low" computer run, workers who *began* work in a low-exposure job are selected. Those selected who changed to a high-exposure job have their person-years stop accumulating on the date of the job change, and the remainder (those who stayed in low-exposure jobs) are processed as usual. For the "high" computer run, all workers who were ever in a high-exposure job are selected. Those selected whose first job was a low-exposure job have their person-years start on the date of the switch to the first high-exposure job, and again the remainder (those who started in high-exposure jobs) are processed as usual. If three or more categories are desired, e.g., low, medium, and high, the analysis is more complex but is still feasible.

A final comment is that the highest exposure job method does not take into account the length of time exposed. To account for time, an alternate method of assessing dose-response is to analyze by length of exposure and to weight the time by a dose factor relating to the actual exposure level of the job (the resultant variable can be called "cumulative exposure"). But regardless of whether the "highest exposure job" or "cumulative exposure" method is used, care needs to be taken to allocate a worker's person-years at risk to appropriate exposure categories, and not to lump all of a worker's person-years into one category.

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3. Ott MG, Langner RR, and Holder BB: Vinyl chloride exposure in a controlled industrial environment. *Arch Environ Health* 30:333-339, 1975.

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Bladder Cancer and Dairy Farming

To the Editor: A recent occupational survey from Roswell Park Memorial Institute[1] reported an association between bladder cancer and dairy farming. Although this association was not evident in other mortality surveys of farmers,[2-5] the wide range of potentially hazardous exposures (i.e., pesticides, fuels and oils, solvents, paints, and fertilizers) used in farming plus the large population-at-risk underscores the need to further evaluate this new lead. Concern about pesticide exposure was also raised by the recent report of an excess risk of bladder cancer among pesticide applicators.[6] Through a quick and inexpensive case-control study, we examined the occupational statements on a large number of death certificates from Wisconsin, a state with a large dairy industry.

Between 1968 and 1976 there were 1,386 deaths from bladder cancer among white males 30 years or older. For each death certificate giving bladder cancer as the underlying cause, a control certificate, matched on race, sex, age and year of death, and county of residence was chosen from other causes of death. Occupation, as recorded on the death certificate, was coded according to the 1960 Census.[7] Odds ratios (OR), as calculated by the McNemar test,[8] significance tests, and 95% confidence