II–6.

Olli S. Miettinen: Components of the Crude Risk Ratio. American Journal of Epidemiology 1972; 96:168–172.

Miettinen's "Components of the Crude Risk Ratio" could have equally as well appeared in Part I, as I think the most important contribution of this paper was in the realm of causal (as distinct from statistical) inference: the recognition of the standardized morbidity ratio (SMR) (and not some other adjusted risk ratio, such as Mantel-Haenszel) as the fundamental causal component of the crude risk ratio.

The idea of factorizing the crude risk ratio into two components, one due to confounding and one due to exposure effect, had been earlier employed by Bross [1966]. It was Miettinen, however, who recognized a general principle underlying such factorization. This principle is implicit in the paragraph following equation 1 of the paper. Miettinen stated that confounding could be estimated by "simulating the removal of the effect of exposure," that is, by estimating how many exposed cases would remain out of the total number of exposed cases, e, if the excess caseload attributable to exposure was removed from the case series. Estimation of the number of these "residual" cases, e^*, led immediately to the recognition of the "standardized morbidity ratio" e/e^* as the component of the crude ratio due to exposure effect. In the absence of other assumptions, this estimate of exposure effect was properly estimated by treating all quantities except e, the total number of exposed cases, as fixed.

Miettinen's arguments were widely misunderstood, and despite Miettinen's warnings in his discussion (p. 171), e^* was often confused with the chi-square null expectation. The latter is computed by treating the total number of cases ($e + f$), rather than the number of unexposed cases (f), as fixed. At other times the component of the crude risk ratio due to confounding (equation 2 of the paper) was confused with the risk ratio for the confounder's effect on risk. Miettinen [1977] attempted to address the latter confusion, and elsewhere I have attempted to address the former [Greenland, 1986], but I suspect these distinctions are still not as widely appreciated as they should be.

A technical error occurs in the paper on page 169: here Miettinen states that for person-year denominators his SMR estimate, e/e^*, is the maximum-likelihood estimate (MLE) of a common relative risk, and that this is approximately so when the denominators are counts and the rates are low. This is in fact false in either case; the MLE has no closed form [Breslow 1984], and e/e^* approximates the MLE only if, in each stratum, the number of unexposed cases (f_i) is very large relative to the number of exposed cases (e_i) (with low rates needed as well if the denominators are counts). In general, e/e^* will have a larger variance than the MLE.

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Miettinen OS. The author replies. Am J Epidemiol 1977; 106:191–193.