

This Week's Citation Classic

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Mantel N & Haenszel W. Statistical aspects of the analysis of data from retrospective studies of disease. *J. Nat. Cancer Inst.* **22**:719-48, 1959.
[Biometry Branch, Natl. Cancer Inst., NTH, Public Health Serv., US Dept. Health, Education, and Welfare, Bethesda, MD]

The relationship of the retrospective study to the forward-type study and other practical issues are discussed. Methods of statistical analysis controlling on confounding factors are provided. A chisquare test for significance of any observed association is given. One of several summary measures of relative risk is recommended. [The *SCI*[®] indicates that this paper has been cited over 815 times since 1961.]

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"This paper was the conception of its junior author, William Haenszel, who had the practical familiarity with the problems of retrospective studies. My experience had been largely in the application of statistics and statistical thinking to laboratory investigations and Haenszel suggested that I augment his own work by any statistical concepts I thought appropriate. Those concepts were, in a way, simple and I was not satisfied to give them only as mathematical formulas. In the end, there was a blending of Haenszel's practical ideas with my own – Haenszel, in his generosity, suggested that the order of authorship be reversed.

"In a way, our work was an extension of still earlier work by Jerome Cornfield who had suggested the effective utilization of retrospective studies.^{1,2} He illustrated his

concepts with the homogeneous case, a single-stratum population, but was aware of and had published on the heterogeneous case. Haenszel and I went into the heterogeneous case more thoroughly and more formally.

"The high frequency of citation of our paper comes about from a number of reasons. It may be cited because of its generally useful ideas, though most likely in relation to retrospective or other observational studies. It may be cited for the chisquare test it provides and/or for its summary measure of relative risk. It may be cited for the emphasis that it puts on stratified analysis, or it may be cited for no good reason that I can see.

"Since the publication of the paper, both observational studies and clinical trials have been on the increase, with a consequent rising frequency of citation to our paper. Also contributing has been the growing awareness of the statistical community of the relevance of the paper. The statistical methods of the paper have become subjects of statistical investigation in their own right. For my own part, I have written several papers extending the concepts of the initial Mantel-Haenszel paper in interesting ways.^{3,4} To the extent that these derivative papers are increasingly cited, there may be reducing citation of the original paper. Citations by statistical writers frequently emphasize advantageous properties of some aspect of the Mantel-Haenszel package (stratification + significance test + summary relative risk or relative odds measure), but citations of a critical nature are by no means uncommon. I have recently published several articles in this field.⁵⁻⁷

1. **Corfield J.** A method of estimating comparative rates from clinical data. Applications to cancer of the lung, breast, and cervix. *J. Nat. Cancer Inst.* **11**:1269-75, 1951.
2. A statistical problem arising from retrospective studies. *Proc. Third Berkeley Symp. Math. Statist. Probab.* **4**:135-48, 1956.
3. **Mantel N.** Chi-square tests with one degree of freedom; extensions of the Mantel-Haenszel procedure. *J. Amer. Statist. Assn.* **58**:690-700, 1963.
[The *SCI*[®] indicates that this paper has been cited over 285 times since 1963.]
4. Evaluation of survival data and two new rank order statistics arising in its consideration. *Cancer Chemother. Rep.* **50**:163-70, 1966.
[The *SCI*[®] indicates that this paper has been cited over 300 times since 1966.]
5. **Mantel N, Bohidar N R & Ciminera J L.** Mantel-Haenszel analyses of litter-matched time-to-response data, with modifications for recovery of interlitter information. *Cancer Res.* **37**:3863-8, 1977.
6. **Mantel N.** Tests and limits for the common odds ratio of several 2x2 contingency tables: methods in analogy with the Mantel-Haenszel procedure. *J. Statist. Plan. Infer.* **1**:179-89, 1977.
7. **Mantel N & Fleiss J L.** Minimum expected cell size requirements for the Mantel-Haenszel one-degree-of-freedom chi-square test and a related rapid procedure. *Amer. J. Epidemiol.* **112**:129-34, 1980.