THE GROWTH OF HEALTH-RELATED META-ANALYSES PUBLISHED FROM 1980 TO 2000

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A MEDLINE search was conducted to estimate trends in the growth of health-related meta-analyses published during the past two decades. Employing a more specific than sensitive search strategy, and not supplementing these results with known sources of published meta-analyses or manual search strategies, 3,025 probable meta-analyses were selected from the 5,128 citations identified. The data showed a definitive upward (and generally linear) trend across time with no evidence for this genre of research either leveling off or decreasing.

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Many of the articles in this special issue have discussed the potential impact, role, and importance of meta-analyses in medicine and related fields. Few methodological advances have been implemented as quickly and extensively as this family of techniques and procedures designed to provide quantitative syntheses of entire areas of research endeavor.

As Cooper and Hedges (1994) discussed in their introductory chapter in *The Handbook of Research Synthesis* (which remains the most comprehensive methodological treatment of the topic and to which the majority of the authors of this special issue contributed), probability combining methods have existed for at least a century for pooling the results of independent but related studies (e.g., Fisher, 1932; Tippett, 1931). (Arguably, Pearson [1904] conducted the first meta-analysis almost a century ago in attempting to assess the effectiveness of typhoid fever inoculations in reducing mortality.)

It was Glass (1976), however, who gave the methodology its name and very soon thereafter opened the floodgates for the actual conduct of meta-analyses by conducting (with his wife) two seminal meta-analytic studies (Glass & Smith, 1978; Smith & Glass, 1977) and writing the first comprehensive text (Glass, McGaw, & Smith, 1981) on the topic, laying the foundation of the methodology in clear, unambiguous, nontechnical terms.

Methodologically and scientifically, the field has made great strides in the past two decades. Although no one knows exactly how many meta-analyses have been conducted during this period, there is no question that they now literally number in the thousands. (Chalmers, Enkin, and Keirse [1989], for example, presented more than 700 in their 2-volume *Effective Care in Pregnancy and Childbirth* alone.)

There have been a few attempts at assessing the actual numbers of meta-analyses conducted in the health sciences (e.g., Bausell, Li, Gau, & Soeken, 1995; Dickersin, Higgins, & Meinert, 1990), but this is an extremely difficult task given (a) variations in indexing terms, (b) the fact that meta-analysis was added as a MEDLINE MeSH heading in 1989 and as a publication type only in 1993, and (c) inaccuracies in assigning MeSH subject headings even when they exist (Boynton, Glanville, McDaid, & Lefebvre, 1998).

In many ways, however, trends in the publishing of meta-analytic studies are more interesting than absolute numbers. Bausell, Li, Gau, Yu-Fang, and Soeken (1995), for example, in an attempt to place a previous special methodological issue on meta-analysis in this journal in perspective, surveyed the literature from 1980 to 1993 in order to ascertain the extent to which quantitative syntheses were increasing over time. Bausell and his team found a remarkably linear trend in health related meta-analyses from 1980 (in which less than 10 were found) to 1991, at which point an extreme upward spike was observed for which they provided no definitive explanation, but which was probably due to changes in MEDLINE indexing practices and implementation.

As part of this follow-up special issue, we have attempted to perform a similar trend analysis from 1980 to 2000 by employing more standardized and less labor-intensive techniques than were used in the earlier attempt. (The majority of the meta-analytic reviews located in the previous effort, for example, were physically retrieved and archived.)

The purpose of the present study, therefore, was to ascertain if the number of published meta-analyses has continued its upwardly escalating trend over the past decade as it did during the previous one. We felt that this would be an interesting question to answer because a positive finding could be interpreted as indicative of the continued acceptance of this innovative methodology and the production of sufficient new research in new topic areas to provide the requisite raw material for the continued growth in the application of this methodology (because each new meta-analysis requires that multiple research studies be conducted that basically address the same empirical question).

METHOD

Before presenting the search procedures employed, both a caveat and a definition are in order. First, the caveat: any literature retrieval endeavor employing only computerized searching strategies will be, by necessity, woefully incomplete. In the previously mentioned effort by Dickersin et al. (1990), for example, only 48% of the meta-analyses located were found via MEDLINE. Although indexing practices have improved over the past decade, especially with respect to meta-analysis, this basic principle still holds. As will be discussed later, we have become aware of many meta-analyses published during our time frame that were not located by our search strategies. By employing a common, unsupplemented strategy across time, however, we felt that we had a reasonable chance at answering the basic question of whether the conduct of meta-analysis remains on an upward trend.

As for the promised definition, it should be noted that we are only interested in meta-analytic reviews. Over the past few years, studies that classify themselves as systematic reviews have become increasingly prevalent, and although, strictly speaking, a meta-analytic study is a type of systematic review (which is defined in Last's *Dictionary of Epidemiology* as an assembly, critical appraisal, and synthesis of all relevant studies on a specific topic), we are interested only in those reviews that statistically pool results from separate empirical studies. We have therefore attempted to electronically separate meta-analyses from those systematic reviews that do not pool results, which is admittedly a tenuous procedure.

SEARCH PROCEDURES

We employed computerized searches in MEDLINE for locating published meta-analyses. The title words "meta-analysis," "metaanalysis," "quantitative review," "systematic review," and "pooled" were used for retrieval purposes in the 1980 to 2000 MEDLINE databases. The following specific search strategy was used:

Meta-analysis (explode Mesh heading)
Meta-analysis (title word)
Meta-analysis (key word)
Quantitative review (title word)
Systematic review (title word)
Pooled (title word)
Metaanalysis (title word)
Combined (3) and (5)
Combined (1) or (2) or (4) or (6) or (7) or (8)
Limit to human and English

Once retrieved, the titles of each article were reviewed to ensure that it was not one of the following:

1. letter to the editor;
2. reply to a letter to the editor;
3. comment on a meta-analysis;
4. description of a meta-analysis;
5. methodological or statistical article;
6. general article explaining, defending, or attaching the technique; or
7. a secondary analysis of raw data drawn from two or more studies.[1]

In addition, each title was examined to ensure that the article involved human subjects and topics involving the health of patients and not strictly psychological, social, or educational topics.

This computerized search strategy was designed to be maximally specific, resulting in 59% of the references retrieved actually being judged as meta-analytic studies involving the above criteria. As always, of course, there is a trade-off with respect to sensitivity. If, for example, we had used only title words and the Boolean operator "or" for the terms above, we would have retrieved 857 titles for the year 2000 alone as opposed to the 658 we actually obtained (or an increase of 30%). If we requested the key words, again separated by "or" we would have retrieved 1,881 titles (or an increase of another 119%). Our preliminary analyses, however, indicated that there was a remarkably small increase in our hit rate of actual meta-analyses produced via these techniques (remembering that we were uninterested in review articles that did not involve actual pooled effect sizes).

RESULTS

The above strategy resulted in the location of 3,025 health-related meta-analytic reviews. Figure 1 represents the yearly trend from 1980 to 2000 with respect to this published literature. As a cursory examination of this figure indicates, the data represent a reasonably linear trend across the two decades with the number of studies published in 2000 being almost twice the number published in 1991 and the number published in 1990 being many times the seven studies located in 1980, which was for all practical purposes near the birth of medical meta-analyses as a study type. (It is interesting to note that Bausell, et al. [1995] found approximately three times as many meta-analyses conducted in the social sciences as compared to the health sciences

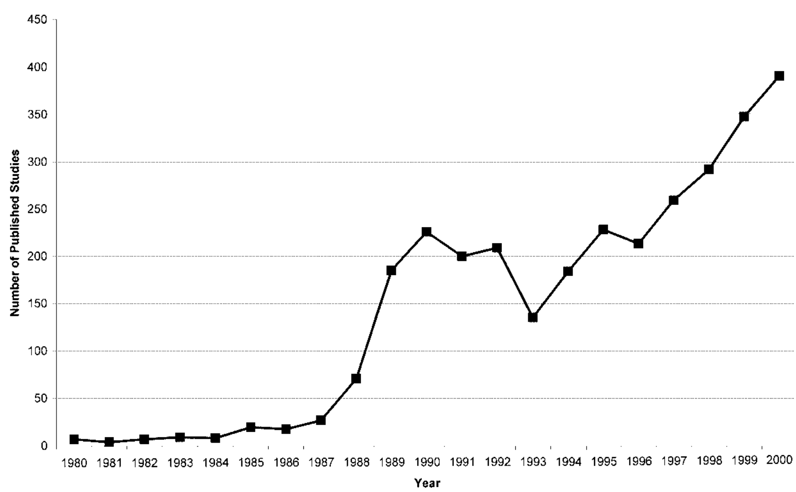

Figure 1: Health-Related Meta-Analyses Published From 1980 to 2000

from 1980 to 1986, although there are now considerably more meta-analyses being conducted in the health than the social sciences.)

There are some interesting nonlinear blips in the trend line represented in Figure 1. The large increase in yield from 1988 to 1989 (i.e., from 92 to 221) may have been due to the addition of meta-analysis as a MeSH heading. We can offer no comparable explanation for the 36% drop in output from 1992 to 1993, however, especially because meta-analysis was added as a publication type in 1993. Since that time, there has been an average yearly increase of 17% through the end of 2000 and an average 10% yearly increase for the decade (1991 to 2000), even taking the 1992-1993 dip into account.

VERSUS NON-RCT META-ANALYSES PUBLISHED STUDIES

Although RCTs are the gold standard in medical and health-related research, a large proportion of the empirical studies published in medicine are nonexperimental in nature (e.g., epidemiological, diagnostic). Consequently, we thought it would be interesting to compare the trends of non-RCT-focused meta-analyses with those presented above.

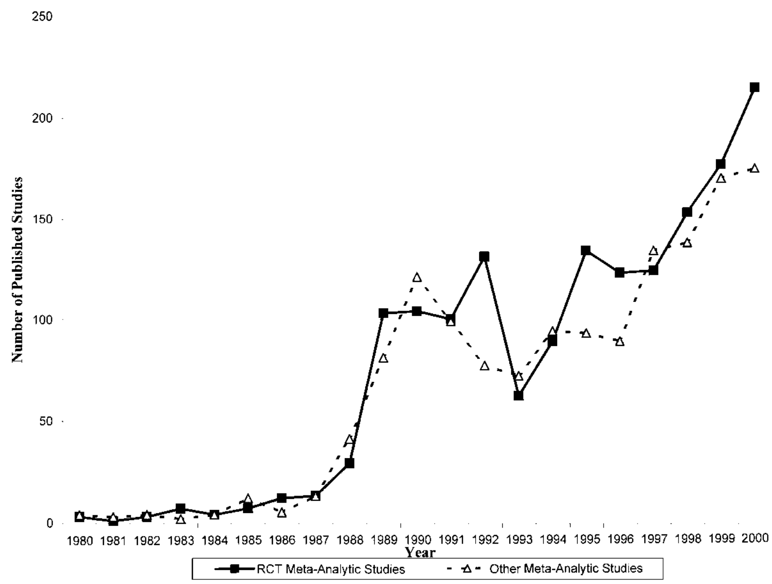

Figure 2: Health-Related Meta-Analyses Involving RCTs Versus Other Studies From 1980 to 2000

Because we did not physically examine the studies located, we cannot definitively separate meta-analyses involving RCTs from those not involving RCTs. What we were able to identify, however, were meta-analyses that almost certainly could not have been conducted using RCTs (e.g., the title explicitly indicated another type of design or the use of an independent variable that could not have been manipulated, such as smoking or cholesterol consumption).

Overall, we found 1,431 meta-analyses obviously not involving RCTs, composing 47% of the total located, which is probably an underestimate because we could predict which studies did *not* involve RCTs more accurately than those that definitely *did*. With this caveat in mind, however, an examination of Figure 2 indicates that the year-to-year trend for meta-analyses not involving RCTs was quite similar to that of their RCT counterparts.

DISCUSSION

These results, which bear some similarity to those reported by Bausell et al. (1995), also possess a number of interesting differences. These earlier investigators, for example, found more health-related meta-analyses from 1980 to 1987, undoubtedly due to their heavier emphasis on manual searching techniques and the use of known meta-analytic databases. This trend was dramatically reversed in 1989, however, with the introduction of the MeSH meta-analysis term, which is apparent in our data as well.

We certainly do not wish to understate the limitations of the present analysis, however. Although our results may provide a reasonable estimate of the trend in published meta-analyses over this time, they absolutely do not (nor were they intended to) afford an accurate point estimate of the absolute number of meta-analytic studies conducted over the past two decades. We are personally aware, for example, of many more meta-analyses that have been conducted than are represented in Figure 1. For the sake of consistency, we purposefully did not search the Cochran database of systematic reviews, for example, nor did we include other known sources of meta-analytic studies such as the previously mentioned cache found in Chalmers et al.'s (1989) Herculean effort or those located by Bausell et al. (1995).

In addition to the previously cited study conducted by Dickersin et al. (1990), in which the exclusive use of MEDLINE would have resulted in a 48% underestimate, we found—in an unrelated effort in which we located 44 complementary and alternative medical meta-analyses—that 17 (39%) were not identified via the search strategy employed for the present study. This result is probably quite comparable to Dickersin's 48% finding given the improvements in meta-analytic indexing procedures occurring over the past 10 years and therefore may serve as a *very* gross estimate of the degree of under estimation existing in the present data.

Obviously, we could have produced more accurate estimates if we had (a) physically examined the articles, (b) read the available abstracts, (c) employed multiple databases, (d) added manual search procedures, (e) not restricted our search to published literature, and/or (f) adopted a more sensitive (rather than such a specific) search strategy. Even with these limitations, however, we believe that we have accomplished our original purpose, which was simply to ascertain if the process of conducting meta-analyses in the health sciences is continuing its previously documented upward trend or if it has begun to level off. Certainly we found no evidence of either a decreasing or a leveling trend, hence we must assume that the methodology that Glass (1976) so aptly named a quarter of a century ago continues (and will continue for the foreseeable future) to be a major contributor to the scientific enterprise.

NOTE

1. This decision was admittedly idiosyncratic because the pooling of raw data from multiple studies is unquestionably a meta-analytic procedure. Such analyses are relatively rare, but to the extent that they do exist and the reader is interested in such practices, this decision would result in a slight point underestimate.

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