Factors Influencing Publication of Research Results

Follow-up of Applications Submitted to Two Institutional Review Boards

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Objective.—To investigate factors associated with the publication of research findings, in particular, the association between "significant" results and publication.

Design.—Follow-up study.

Setting.—Studies approved in 1980 or prior to 1980 by the two institutional review boards that serve The Johns Hopkins Health Institutions—one that serves the School of Medicine and Hospital and the other that serves the School of Hygiene and Public Health.

Population.—A total of 737 studies were followed up.

Results.—Of the studies for which analyses had been reported as having been performed at the time of interview, 81% from the School of Medicine and Hospital and 66% from the School of Hygiene and Public Health had been published. Publication was not associated with sample size, presence of a comparison group, or type of study (eg, observational study vs clinical trial). External funding and multiple data collection sites were positively associated with publication. There was evidence of publication bias in that for both institutional review boards there was an association between results reported to be significant and publication (adjusted odds ratio, 2.54; 95% confidence interval, 1.63 to 3.94). Contrary to popular opinion, publication bias originates primarily with investigators, not journal editors: only six of the 124 studies not published were reported to have been rejected for publication.

Conclusion.—There is a statistically significant association between significant results and publication.

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FACTORS influencing publication of research findings have been a source of continuing interest in various disciplines, including medicine. Of particular interest have been characteristics of the investigators, such as sex and academic rank, and various characteristics associated with the study, such as sample size, source of funding, and the nature or direction of results.[1-6]

The latter characteristics have received the most attention, particularly in regard to publication bias, ie, the tendency of investigators to submit, and of reviewers and editors to accept, manuscripts for publication based on the direction or strength of study findings. Though publication bias has been cited with increasing frequency as a potential problem in drawing conclusions from the published literature,[7-10] evidence demonstrating its existence has been scanty.[8,11] Some of the earliest evidence suggesting its existence in medicine was provided by Simes[12] in a meta-analysis of chemotherapy trials and by Dickersin and coworkers[13] in a survey of authors of published trials.

The aim of this research was to assess the association of factors, such as those just listed, with publication as observed within a defined cohort of investigators and studies at The Johns Hopkins University Health Institutions, Baltimore, Md. The project was carried out from 1986 to 1990.

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METHODS

An application to perform this study was submitted to and approved by the Committee on Human Volunteers and the Joint Committee on Clinical Investigation.

The studies that formed the basis for our research were those that appeared on the logs of the two institutional review boards (IRBs) that serve The Johns Hopkins Health Institutions and were approved in 1980 or prior to 1980 and were still ongoing in that year. The two IRBs included those that serve (1) the School of Medicine, Hospital, Kennedy Institute, School of Nursing, and the Francis Scott Key Medical Center (hereafter referred to as MED) and (2) the School of Hygiene and Public Health (hereafter referred to as PH).

For editorial comment see p 411.

The logs of the two institutions together enumerated 1048 applications (MED, 766; PH, 282) (Table 1). The two logs differed in that MED included all applications received by the IRB, whereas PH did not include applications subsequently withdrawn by the submitting investigator or those judged to be exempt from review. Trained project staff were responsible for locating logged applications in the archives of the two IRBs, for abstracting and recording information contained in the applications, and for classifying the studies described as to study design. Each application was read, abstracted, and clas-

Table 1.—Applications and Interview Counts*

	MED		PH		MED and PH	
	PIs	Studies	PIs	Studies	PIs	Studies
Applications						
Interview eligible	258	537	88	200	337	737
Excluded	156	229	57	82	209	311
Total†	337	**766**	112	**282**	433	**1048**
Interview status						
Full	225	392	84	182	303	574
Partial	48	96	8	13	55	109
Total Interviewed†	251	**488**	85	**195**	329	**683**
Refused	25	49	2	2	27	51
Deceased or not located	0	0	2	3	2	3
Total Not Interviewed	**25**	**49**	**4**	**5**	**29**	**54**
Total Interview Eligible†	258	**537**	88	**200**	337	**737**
Full interviews that provided data on study results and publication	207	342	80	172	281	514

*See "Methods" section of text for explanation of MED and PH. PI indicates principal investigator.
†The totals for PIs correspond to unduplicated counts and are not the sum of the individual counts appearing above a given total.

Table 2.—Characteristics of Principal Investigators (PIs) Who Provided Full Interviews*

	MED		PH	
	By PI	By Study	By PI	By Study
Total no. of PIs and studies	225	392	84	182
Median no. of studies per PI	1	...	2	...
Sex, %				
M	90.2	90.8	70.2	66.5
F	9.8	9.2	29.8	33.5
Degree, %				
MD, MD and PhD	96.4	96.2	22.6	31.3
PhD, ScD, DrPH	1.8	2.3	71.4	64.8
Other	1.8	1.5	6.0	3.8
1980 rank, %†				
Professor	19.0	22.9	39.3	42.9
Associate professor	29.9	33.0	29.8	29.7
Assistant professor	38.9	35.3	25.0	23.6
Other	12.2	8.8	6.0	3.8

*See "Methods" section of text for explanation of MED and PH.
†Information was not available for rank of four MED PIs and seven studies.

sified independently by two readers. Disagreements in classification or in other abstracted information were adjudicated by a master reader.

A total of 311 applications (MED, 229; PH, 82) (Table 1) were excluded from further study because they were either applications that were withdrawn or were not approved (MED, 28), were approved but were not implemented (MED, 133; PH, 51), were classified as exempt from review (MED, 23), did not describe a research study (eg, applications for training) (MED, 26; PH, 6), or did not involve humans (MED, 19; PH, 25). The remaining 737 applications correspond to the studies referred to in Table 1 and elsewhere in this article as "interview eligible."

The principal investigators (PIs) associated with interview-eligible studies were contacted for interviews in 1988. Arrangements for the interviews, as well as the interviews themselves, were carried out by trained interviewers. Usually, several telephone contacts were needed to arrange for and complete an interview (median, eight; interquartile range, four to 14). The order in which investigators were scheduled for the initial call was randomized to reduce the risk of an association between secular trends in the interview process and a logical ordering of the studies. When PIs had two or more studies, the sequence of the interviews (ie, which study was covered first in the interview) was also randomized. Investigators with two studies were interviewed regarding both studies in a single session. Investigators who served as PIs on three or more studies had the option of being interviewed for all studies in a single session or in multiple sessions. Investigators also had the option of designating a surrogate respondent for interviews. Investigators who were contacted but who were unwilling to provide a full interview (usually because of the time required, approximately 20 minutes per study) were queried only to the extent needed to determine whether the study described in the application had been implemented and, if so, whether the findings of the study had been published (hereafter referred to as a "partial interview").

Sample sizes reported during the interview correspond, in most cases, to total study sample size. The only exception was for multicenter clinical trials where Johns Hopkins was a recruiting site. In those cases, the sample size reported was for the Johns Hopkins site alone. Investigators associated with multicenter observational studies and with nonrecruiting sites in multicenter clinical trials, such as coordinating centers or reading centers, reported total sample size for all recruiting sites combined. The reason for the difference was that PIs associated with multicenter trials often did not know the combined sample size of the trial.

The interview involved questions on the nature of the study findings, which were stated either in statistical terms (statistically significant, suggestive trend but not statistically significant, or no trend or difference) or in terms of perceived importance (great, moderate, or little) when statistical tests for significance were not performed. Studies reported to have statistically significant findings were combined with those reported to have findings of great importance. Together they are referred to as "significant" and are contrasted with the remainder, which are referred to as "not significant."

Publication status of a study was determined from responses provided to specific questions asked during the interview. Findings from a study were classified as having been published if they were reported in one or more journal articles, monographs, books, or chapters in books, were available from medical libraries, or were in documents available from a public archive, eg, the National Technical Information Service. Journals included in the National Library of Medicine's *List of Journals Indexed in Index Medicus*[14] were classified as "indexed journals."

The association between publication and selected PI and study characteristics was evaluated using odds ratios (ORs).[15] An OR of 1.0 indicates the absence of association between publication and the indicated variable, a ratio of greater than 1.0 indicates a positive association, and a ratio of less than 1.0 indicates a negative (inverse) association between the variable of interest and publication. The greater the departure from 1.0, the more pronounced the association. Ninety-five percent confidence intervals (CIs) for the ORs that do not include 1.0 correspond to ORs with associated P values of less than .05 (statistically significant). In this article, we chose to use the term *statistically significant* to refer to P values of less than .05; we realize that this is a liberal,

rather than conservative, approach, given our use of multiple tests.

Initially, unadjusted ORs for the association between variables listed in Table 4 and publication were calculated for each IRB separately, using *SAS Release 5.18*.[16] Subsequently, adjusted ORs for each IRB alone and for the two IRBs combined (by including a term in the model for the effect of IRB) were calculated using multiple logistic regression.[17] The combined model included two-way interaction terms between IRB and each of the other factors. Backward, stepwise procedures, used for variable selection, involved elimination of variables from the regression model in descending order of P values. The elimination process was stopped once all remaining associations between variables and publication yielded P values of less than .05. The final models for MED and PH, along with the combined model, are listed in the legend of the Figure.

RESULTS

Table 1 provides the number of applications reviewed and interviews performed. Of the 1048 applications, 737 were considered to describe studies eligible for follow-up. The 737 studies involved a total of 337 different PIs and led to 683 interviews, 109 of which were partial. The majority of the interviews (444 of 683) were conducted with the PI, as specified on the application. The remainder were conducted with surrogates designated by the PI or selected in lieu of the PI.

The characteristics of the PIs represented in full interviews are presented in Table 2. There are differences in investigator sex, academic rank, and, not surprisingly, terminal degree, by institution. The MED studies compared with the PH studies had a higher proportion of male investigators and a lower proportion of senior investigators, as represented by academic rank.

Table 3 provides information on the characteristics of studies involving a full interview and information on study results and publication. As might be expected, the mix of study design types differed for the two IRBs. The most common type in PH was observational (85%), while the most common type in MED was clinical trial (46%). Differences were also seen in sources of funding (more National Institutes of Health and industry support for MED) and in the size of the studies (larger sample sizes for PH).

Table 4 provides publication rates for all studies for which there was a full interview and for which information on the nature of results and publication was provided. Eighty-one percent of the 342 MED studies and 66% of the 172 PH studies had been published at the time of interview. For MED, 89% of the studies classified as significant were published, compared with 69% of those classified as not significant. The corresponding values for PH were 71% and 58%, respectively. The strength of the association between significant results and publication was greater for MED (OR = 3.38; 95% CI, 1.96 to 5.83) than for PH (OR = 1.78; 95% CI, 0.94 to 3.39). The differential publication rate by the nature of the results is indicative of a publication bias.

Other differences in publication rate noted in Table 4 are for type of study (PH) and funding source (external vs none for both MED and PH and industry vs other forms of external funding for MED). The association between external funding and publication was statistically significant for MED (OR = 2.75; 95% CI, 1.57 to 4.83) and for PH (OR = 7.25; 95% CI, 3.19 to 16.49). A statistically significant association was also found between the

Table 3.—Characteristics of Studies as Reported by PIs or Their Surrogates Who Provided Full Interviews*†

	MED	PH
Type of study, %		
Observational	37.1	84.9
Clinical trial	46.2	5.8
Other experimental	16.7	9.3
Total	342	172
Median sample size		
Trials		
Single center	29.5	264.5
Multicenter (JHU site only)	30.0	136.0
Multicenter (all sites)	67.5	267.5
Total trials	154	7
Nontrials		
Single center	55.0	452.0
Multicenter (all sites)	152.5	336.0
Total nontrials	184	162
All studies	40	400
Primary funding source, %		
External Total	**75.1**	**83.1**
NIH	49.6	36.3
Other government	5.3	25.7
Drug industry	11.7	1.2
Other	8.5	19.9
Internal	4.4	3.5
None	20.5	13.4
Total	341	171
Data collection sites, %		
Single center	75.9	72.9
Multicenter	24.1	27.1
Total	340	171
Study groups, %		
One	43.3	33.7
Two or more	56.7	66.3
Total	342	172
Exclusions, %		
Males	8.2	15.1
Females	8.5	9.3
Pregnant women	81.0	48.8
Children	64.0	57.0
Publications, %		
None	19.1	34.3
One	28.5	21.5
Two	15.0	11.0
Three	7.4	8.7
Four or more	30.0	24.4
Total	340	172
Median no. of publications	2	1
Interquartile range	1-5	0-3
Place of primary publication, %		
Indexed journal	92.1	86.6
Book	2.5	2.7
Other	5.4	10.7
Total	277	112

*Totals are based on studies for which investigators provided information on results and publication.

†PI indicates principal investigator; JHU, The Johns Hopkins University; and NIH, National Institutes of Health. See "Methods" section of text for explanation of MED and PH.

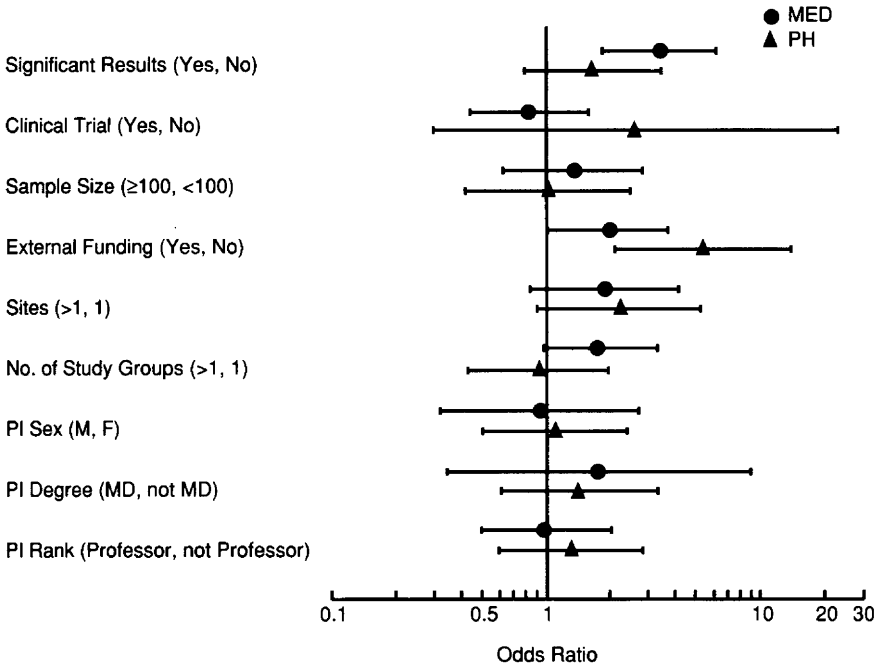
Table 4.—Publication Rates by Nature of Result and Other Selected Characteristics*†

	MED, No.	(%)	PH, No.	(%)
Overall	342	(81.0)	172	(65.7)
Nature of result				
Significant	208	(88.5)	106	(70.8)
Not significant	134	(69.4)	66	(57.6)
Total	**342**	(81.0)	**172**	(65.7)
Type of study				
Observational	127	(80.3)	146	(61.6)
Clinical trial	158	(80.4)	10	(90.0)
Other experimental	57	(84.2)	16	(87.5)
Total	**342**	(81.0)	**172**	(65.7)
Sample size				
Trials‡				
JHU (clinical center)				
Multicenter				
<100	44	(84.1)	1	(100.0)
≥100	19	(89.5)	1	(100.0)
Single center				
<100	72	(75.0)	0	. . .
≥100	9	(88.9)	1	(100.0)
JHU (nonclinical center)				
Multicenter				
<100	4	(100.0)	0	. . .
≥100	0	. . .	2	(100.0)
Single center				
<100	6	(50.0)	1	(0.0)
≥100	3	(100.0)	2	(100.0)
Total Trials	**157**	(80.3)	**8**	(87.5)
Nontrials				
Multicenter				
<100	9	(77.8)	8	(87.5)
≥100	17	(94.1)	37	(75.7)
Single center				
<100	104	(77.9)	26	(53.9)
≥100	48	(83.3)	87	(59.8)
Total Nontrials	**178**	(80.9)	**158**	(63.9)
Primary funding source				
External				
NIH	169	(90.5)	62	(74.2)
Other government	18	(88.9)	44	(75.0)
Drug industry	40	(65.0)	2	(50.0)
Other	29	(82.8)	34	(70.6)
External Total	**256**	(85.5)	**142**	(73.2)
Internal	15	(86.7)	6	(16.7)
None	70	(64.3)	23	(30.4)
Total	**341**	(81.2)	**171**	(65.5)
Data collection sites				
Single center	245	(78.4)	119	(59.7)
Multicenter	97	(87.6)	53	(79.3)
Total	**342**	(81.0)	**172**	(65.7)
Study groups				
One	148	(75.7)	58	(62.1)
Two or more	194	(85.1)	114	(67.5)
Total	**342**	(81.0)	**172**	(65.7)
PI sex				
M	311	(80.7)	117	(66.7)
F	31	(83.9)	55	(63.6)
Total	**342**	(81.0)	**172**	(65.7)
PI degree				
MD, MD and PhD	331	(81.0)	54	(74.1)
PhD, ScD, DrPH	6	(83.3)	111	(63.1)
Other	5	(80.0)	7	(42.8)
Total	**342**	(81.0)	**172**	(65.7)
PI 1980 rank				
Professor	77	(80.5)	73	(74.0)
Associate professor	110	(82.7)	50	(64.0)
Assistant professor	119	(82.4)	42	(61.9)
Other	29	(75.9)	7	(14.3)
Total	**335**	(81.5)	**172**	(65.7)

*Totals are based on studies for which investigators provided information on results and publication.

†JHU indicates The Johns Hopkins University; NIH, National Institutes of Health; and PI, principal investigator. See "Methods" section of text for explanation of MED and PH.

‡Sample size for JHU site only when JHU was a clinical center in a multicenter trial.



Adjusted odds ratios (ORs) and 95% confidence intervals (CIs) for the association between selected characteristics and publication (ORs and CIs were obtained by using multiple logistic regression separately for each institutional review board [IRB]). See "Methods" section of text for explanation of MED and PH; PI indicates principal investigator. Final models using backward stepwise regression, with P indicating publication proportion, were for MED: logit P = 0.3001 + 1.1473 (significant results) + 0.8336 (external funding); for PH: logit P = −0.9651 + 1.9815 (external funding); and for combined: logit P = −0.9889 + 1.0576 (IRB) + 0.9301 (significant results) + 0.7464 (No. of sites) + 1.0864 (external funding).

Table 5.—Stated Main Reason for Not Publishing*

	MED, No. (%)		PH, No. (%)	
Did not submit manuscript				
Results not interesting	26	(40.0)	11	(18.6)
Design or operational problems	17	(26.2)	23	(39.0)
Publication not an aim	8	(12.3)	8	(13.6)
Other reasons	12	(18.5)	13	(22.0)
Total Not Submitted	**63**	(97.0)	**55**	(93.2)
Manuscript rejected by journal	2	(3.1)	4	(6.8)
Total	**65**	**(100.0)**	**59**	**(100.0)**

*See "Methods" section of text for explanation of MED and PH.

number of data collection sites (multicenter vs single center) and publication for MED (OR = 1.96; 95% CI, 1.00 to 3.82) and for PH (OR = 2.58; 95% CI, 1.22 to 5.44). The number of study groups (>one vs one) and sample size (≥100 vs <100) were significantly associated with publication in MED but not in PH. Although the publication rate for trials and other experimental studies was higher than for observational studies in PH (90% and 88% vs 62%, respectively), the association between study type and publication was not statistically significant due to small numbers of trials and other experimental studies. There were no differences in publication rates by sex of the PI, for either institution, or by academic rank in MED. There was an indication of a positive association between PI rank and publication in PH (OR = 1.93; 95% CI, 0.99 to 3.72). Of interest, although not noted in Table 4, is that there was no association between use of randomization and publication. None of the factors noted in Table 4 was associated with publication bias. For example, there was no difference in the associations seen between significant results and publication for studies that received external vs internal funding.

All factors examined in the univariate analyses (Table 4) were evaluated simultaneously using logistic regression methods; adjusted ORs and 95% CIs for the association between publication and these factors are presented separately for each IRB (Figure). Only the nature of results (significant vs not significant) for MED and the source of funding (external vs none or internal) for both MED and PH remained significantly associated with publication after backward stepwise selection of variables.

When data from the two IRBs were combined, the following factors remained in the logistic model as having a statistically significant association with publication: nature of results (significant vs not significant: OR = 2.54; 95% CI, 1.63 to 3.94); funding (external vs none or internal: OR = 2.96; 95% CI, 1.82 to 4.84); IRB (MED vs PH: OR = 2.88; 95% CI, 1.83 to 4.54); and number of data collection sites (multicenter vs single center: OR = 2.11; 95% CI, 1.23 to 3.63). None of the interaction terms was statistically significant and, thus, were not included in the final combined model.

Table 5 lists the reasons provided by PIs for not publishing studies. Over 90% (MED, 97%; PH, 93%) of studies remained unpublished because of the actions, or inaction, of investigators, as opposed to the actions of editors.

COMMENT

Although we observed publication rates of 81% for MED and 66% for PH (Table 4), the true rates could be as low as 65% and 62%, respectively. The true rate depends on the final publication status of studies still under way at the time of this project and on the actual publication status of studies for which we lacked interview data. The low estimates prevail if we assume studies listed as "not yet analyzed" and studies associated with investigators who could not be interviewed are never published and if we use publication data from full and partial interviews.

Reasons for the possible disparity between the two institutions in publication behavior are not clear. Both institutions, within broad limits, operate under the same general guidelines for appointments and promotions. There are, however, clear differences in the functions they fulfill and in the nature of research they undertake—differences that are reflected in part by the sources of funding for each of the institutions and in the mix of study designs they each use. In addition, there are differences in sex, academic rank, and degree of the PIs in the two institutions (Table 2).

Interpretation of the publication rates listed in Table 4 depends on one's perception of the responsibilities of investigators engaged in clinical research. One could argue that the collective rate of publication in the field of clinical research is already too high and that the push to publish in academia has resulted in an ever-increasing proliferation of poorly designed and executed studies with manuscripts to match. On the other hand, case reports and case series of new treatments have always preceded well-designed multicenter trials. Thus, one could also argue that there is something to be learned from every research undertaking, particularly when individual IRBs have approved the

studies as sound and appropriate. Given a choice between the two positions, it may be prudent to err in favor of the latter. It can be argued further that if one undertakes research involving humans, one is taking on a public trust. This trust is violated when there is a failure to carry out a project to its logical end—dissemination of the findings by way of publication. This trust also carries with it an additional commitment to publish in any setting where there is an explicit or implicit appeal to altruism as an inducement to patients to enroll in a study.

The mix of study type was about the same for the two subsets of studies (26% of the unpublished and 35% of the published studies were clinical trials). A higher proportion of the studies that were not published were funded internally or had no funding at all, compared with those that were published (39% vs 17%). Whether the source of funding influences the publication process is of paramount importance in any field of research, but it is of special import in the health field. Research on treatment and health care procedures often has proprietary interests at its source. The highest publication rates observed in both institutions were for studies funded by the National Institutes of Health and other government agencies. The publication rate for drug industry–funded studies in MED was considerably lower than for National Institutes of Health–funded studies. There was no indication, however, that the tendency to publish significant results was any different for industry-funded than for National Institutes of Health–funded studies.

It is noteworthy that studies that corresponded to master's or doctoral thesis work in PH were no better, and perhaps were worse, than other studies in terms of publication rate. If one considers the theses themselves as unpublished documents, then the publication rate for students in PH is 47%, compared with 73% for the remaining set of investigators.

Our results belie the commonly held view that most studies fail to reach publication because of editors' preference for significant results (Table 5). Most of the reasons provided to us for failure to publish were related to the actions or inactions of the investigators, not to the actions of the editors. This observation is consistent with that reported by Dickersin et al[13] and with the observation that most manuscripts, once submitted for publication, ultimately are published.[18-20]

The association between the nature of the results and publication has been the subject of investigations because of concerns regarding the possibility of publication bias. Our results support the existence of bias and are consistent with the findings of Simes,[12] Dickersin et al,[13] and Easterbrook et al.[21] Publication bias imposes major limitations on drawing conclusions based on the published literature. These limitations are most apparent in systematic reviews of the literature, such as meta-analyses. The results of these are liable to be biased because they are likely to provide an overestimate of positive effects and an underestimate of negative ones.

The only way to avoid publication bias is to base reviews and meta-analyses on "complete" collections of studies. For example, I. Chalmers and colleagues[22] have based a series of regularly updated meta-analyses in the perinatal field on a register of randomized trials. Since 1989, they have actively pursued registration of unpublished planned and ongoing trials. A second example comes from a collaborative group[23] on the treatment of breast cancer, where an exhaustive search of the world's research was performed in order to identify all pertinent studies and their results.

The long-term solution to publication bias lies in systems providing for the registration of studies at the time they are undertaken, prior to the start of data collection. Once established and operational, such systems would provide a means of identification of studies independent of their publication status. Such systems have been proposed.[24-28] In Spain, through laws mandating review of trials by a centralized ethics committee, such a system was implemented in 1978.[29] In reality, the machinery for registration, in the form of IRBs (or their counterparts in other parts of the world), already exists.

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References

1. Berlin JA, Begg CB, Louis TA. An assessment of publication bias using a sample of published clinical trials. *J Am Stat Assoc.* 1989;84:381-392.
2. Cole JR, Zuckerman H. Marriage, motherhood, and research performance in science. *Sci Am.* 1987;256:119-125.
3. Davidson RA. Source of funding and outcome of clinical trials. *J Gen Intern Med.* 1986;1:155-158.
4. Zuckerman H, Cole JR. Women in American science. *Minerva.* 1975;13:82-102.
5. Zuckerman H, Merton RK. Patterns of evaluation in science: institutionalization, structure and functions of the referee system. *Minerva.* 1971;9:66-100.
6. Chalmers I, Adams M, Dickersin K, et al. A cohort study of summary reports of controlled trials. *JAMA.* 1990;263:1401-1405.
7. Angell M. Negative studies. *N Engl J Med.* 1989;321:464-466.
8. Dickersin K. The existence of publication bias and risk factors for its occurrence. *JAMA.* 1990;263:1385-1389.
9. Chalmers I. Underreporting research is scientific misconduct. *JAMA.* 1990;263:1405-1408.
10. Chalmers TC, Frank CS, Reitman D. Minimizing the three stages of publication bias. *JAMA.* 1990;263:1392-1395.
11. Begg CB, Berlin JA. Publication bias: a problem in interpreting medical data. *J R Stat Soc A.* 1988;151:419-463.
12. Simes RJ. Publication bias: the case for an international registry of clinical trials. *J Clin Oncol.* 1986;41:1529-1541.
13. Dickersin K, Chan S, Chalmers TC, Sacks HS, Smith H Jr. Publication bias and clinical trials. *Controlled Clin Trials.* 1987;8:343-353.
14. Public Health Service. *List of Journals Indexed in Index Medicus.* Bethesda, Md: National Library of Medicine; 1988. US Dept of Health, Education, and Welfare publication 88-267.
15. Basic concepts of assessment of risk. In: Schlesselman JJ. *Case-Control Studies: Design, Conduct, Analysis.* New York, NY: Oxford University Press Inc; 1982:33-34.
16. SAS Institute. *SAS Release 5.18.* Cary, NC: SAS Institute; 1986.
17. Breslow NE, Day NE. *Statistical Methods in Cancer Research, I: The Analysis of Case-Control Studies.* Lyons, France: International Agency for Research on Cancer; 1980:192-246. Scientific publication 32.
18. Wilson JD. Peer review and publication. *J Clin Invest.* 1978;61:1697-1701.
19. Relman AS. Journals. In: Warren K, ed. *Coping With the Biomedical Literature: A Primer for the Scientist and the Clinician.* New York, NY: Praeger Publishers; 1981:67-78.
20. Research: a personal survey. In: Lock S. *A Difficult Balance: Editorial Peer Review in Medicine.* Philadelphia, Pa: ISI Press; 1985:56-71.
21. Easterbrook PJ, Berlin JA, Gopalan R, Matthews DR. Publication bias in clinical research. *Lancet.* 1991;337:867-872.
22. Chalmers I, ed. *The Oxford Database of Perinatal Trials.* New York, NY: Oxford University Press Inc; 1988.
23. Early Breast Cancer Trialists' Collaborative Group. *Treatment of Early Breast Cancer, I: Worldwide Evidence 1985-1990.* New York, NY: Oxford University Press Inc; 1990.
24. Chalmers I, Hetherington J, Newdick M, et al. The Oxford Database of Perinatal Trials: developing a register of published reports of controlled trials. *Controlled Clin Trials.* 1986;7:306-324.
25. Easterbrook P. Reducing publication bias. *BMJ.* 1987;295:1347.
26. Dickersin K. Report from the Panel on the Case for Registers of Clinical Trials at the Eighth Annual Meeting of the Society for Clinical Trials. *Controlled Clin Trials.* 1988;9:76-81.
27. Meinert CL. Toward prospective registration of clinical trials. *Controlled Clin Trials.* 1988;9:1-5.
28. Hetherington J, Dickersin K, Chalmers I, Meinert C. Retrospective and prospective identification of unpublished and published controlled trials: lessons from a survey of obstetricians and pediatricians. *Pediatrics.* 1989;84:374-380.
29. Ensayos Clínicos en España. *Serie Monografías Técnicas del Ministerio de Sanidad y Consumo.* Madrid, Spain: Ed Direccíon General de Farmacia y Productos Sanitarios; 1990. No. 17.