Library Use of Public Health Materials: Description and Analysis*

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ABSTRACT

A method is described for optimizing the efficiency of a journal collection. The method is employed to determine an optimal journal collection in public health. A citation analysis of 3,456 citations from the bibliographies of forty-four master's and doctoral dissertations from five different universities is performed. It is verified that the distribution of references to journal titles is approximately logarithmic (Bradford's Law) and that the distribution of references by year is exponential. These two parameters are combined to formulate an equation which may be used to specify a journal collection satisfying the greatest possible percent of demand. In public health, for example, a 1,500-volume library containing sixty titles could satisfy 73% of the demand for references in health related areas and 48% of the total demand for references for this particular, diverse research group. Other desirable aspects of a public health collection are also described as determined from the data.

BECAUSE of the diverse interests of public health personnel (e.g., administration, mental health, maternal health, epidemiology, community health, health education, environmental health, occupational health) the discipline poses a challenge to the medical library. What material should be on hand for these users? What material is central to their needs and what peripheral? How do they use the library?

This paper will present the findings of a study conducted to identify the nature of materials used by master's and doctoral candidates in public health. It is an attempt to identify the library needs of this segment of the public health professional population. A total of 3,456 citations from the bibliographies of forty-four theses from Yale, Harvard, University of California, Los Angeles, University of California, Berkeley, and California State University, Northridge, are analyzed. The citation analysis method is employed to identify a core of public health journals useful to this population and to answer the questions: What is the point at which the usefulness of journals of a certain age falls off rapidly enough to make purchase or retention questionable? Is the use of journals an exponential function of age? How many journals constitute a core public health collection? How closely does the distribution of citations to journals follow "Bradford's Law of Scattering"? Can these answers lead to the determination of an optimally efficient public health journal collection? Secondary questions are: What is the most used form of bibliographic materials? Who produces the most used publications? Are there any significant differences between the bibliographies of master's theses and of doctoral dissertations?

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REVIEW

Citation analysis (reference counting) has generally been used to study the obsolescence of materials, the existence of a core of heavily used sources, and the form of the most used materials. The factor most often studied this way is the obsolescence rate of the literature in different subject areas. Jenkins, in 1931, found that 82% of the citations in a sample of medical journals were to items published within the previous ten years (1). A study done a year later showed that 55% of the citations in the medical journals under consideration were to papers published within the former five years and that 75% referred to papers published in the former ten years (2). Still another study of the biomedical literature, published in 1937, showed that 52% of the citations were to materials

published within the previous five years (3). A 1938 study revealed a 46% figure for biochemistry journals published within the previous five years and 59% within the previous ten years (4). More recently, Cole studied the petroleum literature and presented a theory, based on the exponential growth of use, to be used for the prediction of future journal demand by age. He defines a "median age" similar to the half life of radioactive substances:

> The significance of this median age is not merely that 50 percent of the usage relates to journals older than the median age, $x(½)$; there is the further relationship that 25 percent of the usage relates to journals older than twice the median age and 12½ percent to journals older than three times the median age. In fact, as each successive increment of $x(½)$ is added to journal age x, the usage of journals older than x is halved (5).

He found a median age of three years for the petroleum literature and calculated from published data that the median age for general technical material was 5.9 years and for aviation, 4.9 years (6).

Cole's formula for arriving at the median age was later applied by Meadows to the astronomy literature. The decay half life for that subject material was found to be 5.4 years, indicating that the astronomy literature ages at about the same rate as medical literature, assuming exponentiality, but more slowly than petroleum literature (7). Most recently, Garfield's study using the *Science Citation Index* data base covering all of science, indicated that 21 to 25% of the references were to publications three or fewer years old (8). Again assuming exponentiality, the median age for science would then be 8.5 years.

Completed studies of the literature of the social sciences using the citation analysis method have indicated that citations in these areas tend to refer to older materials than do those in the natural sciences (9, 10).

Another point often studied by citation analysis is the existence of a core of particularly heavily used journals in various subject areas. The importance of journals, measured by the number of citations to a title, diminishes rapidly beyond a defined core. This fact was first recognized in 1927, when Gross and Gross indicated in their study of chemistry literature that five journals received 50% of the references included (11). In the field of biochemistry, Henkle found that 50% of the references were to ten journals (12). In the general biomedical area, studied by Hunt in 1937, 50% of the references referred to six journals (13). In 1969, Fenner's study of the geology literature produced a list of ninety-four serials that accounted for 49% of the world-wide published geological literature cited in the *Bibliography and Index of Geology* (14). Recently, Garfield found that 152 titles from all science areas accounted for 50% of all journal citations (15).

A formula for the determination of the size of a core collection in terms of the most productive journals was developed by S.C. Bradford in 1948 (16). His "law" states that the distribution of the number of citations to journals is logarithmic and can be divided into three zones—the nuclear (most productive) zone, the moderately productive zone, and the least productive zone. Since then, the Bradford (also called the Zipf or Mandelbrot) Law has been much discussed. In 1968 Brookes reformulated it into more simple terms and illustrated its use in terms of the "completeness" of a search (17).

Another trend in the scientific literature studied by researchers using the citation analysis method is the type or form of the most heavily used materials. In 1949, Fussler found that in his sample of literature in chemistry and physics, 90% of the citations were to journals, 6% to monographs, and 4% to other forms of literature (18). Very different results were produced by a study of literature in communications research. Journal citations accounted for 43% of all citations, book citations for 31%, and other forms for 26% (19). The latter 26% was largely made up of citations to informal communications.

Very few studies using citation analysis have been concerned with citations from theses or dissertations. William Emerson did a study of engineering theses at Columbia, hypothesizing that "recent material of a serial nature in the English language" (20) is most often used by scientific personnel. His results indicated that 70% of the citations were to serials and 30% to monographs. As to type of publisher, trade publications turned out to be the most used of the monographs and societal publications the most used of the serials. He found that fewer than

half of the citations were to sources published within the previous five years. This may be attributed to the fact that theses were used as the sources.

Another study of theses categorized them as to method used (historical or experimental) and concluded that a greater number and greater proportion of rarely used titles were cited in the historical than in the experimental research results (21).

METHOD

The advantages of the citation analysis method are several. The most important characteristic of this method is that it is an unobtrusive measure.

> There is little danger that the responses are distorted to fit the predispositions of the questioner or the ideals of the respondent (as may happen in questionnaires or interview studies); and no danger that the natural behavior is distorted by the presence of an observer (as in some observation techniques) (22).

Although circulation statistics afford another unobtrusive measure, many libraries no longer circulate journals. Even when they do, many uses may not be recorded, because users have simply photocopied articles in the library.

Another advantage is that a value judgment has already been placed on the material cited. A third is that the user population can be easily and precisely selected. Finally, access to the bibliographies is usually a simple matter.

It was decided to collect theses from Yale University, the University of California, Los Angeles, the University of California, Berkeley, Harvard University, and California State University, Northridge, because of their varied geographical situations, the high reputations of their Schools of Public Health, Departments of Public Health, or Departments of Community Health Education, the need for a broad data base, the different emphases in instruction in specialty areas, the different types of libraries serving them, and because the coverage of public health in the combined library collections could be considered nearly infinite. Twenty-two master's and twenty-two doctoral theses done after 1966 were chosen.

A journal list was compiled by categorizing all of the citations by form. A book list was not generated because a list, published in the *Bulletin of the Medical Library Association* by La Rocco and Jones, already exists (23). When a title was mentioned three or more times, it qualified for inclusion in the journal list. All titles of journals were checked for proper entry and spelling. The list was arranged in priority order according to the number of times titles were cited.

Each of the theses was coded as to name of the school, degree objective of the author, number of citations in the bibliography, field of study, and method of study. Each citation in the bibliography was categorized according to form (journal, book, thesis, document, serial, unpublished), date, country of origin (U.S., Great Britain, other), and type of publisher (trade, society, government, unpublished). When the type of publisher was not evident, as often happened in the case of journal titles, this information was obtained from a standard reference work. The coded information was transferred to key-sort cards, which were then manipulated manually.

RESULTS

Tables 1 and 2 contain background data. The number of bibliographies from each of the five schools which contributed theses and the degrees for which the theses were written are indicated in Table 1.

An analysis of the number of theses in each field of study, the method of investigation used, and the degree for which the theses were written is given in Table 2.

Counts of citations according to form, date,

TABLE 1

SCHOOLS AND DEGREES FOR WHICH THESES WERE DONE

School	Master's	Doctoral	Total
California State University, Northridge	10	0	10
U.C.L.A.	7	5	12
Harvard	0	6	6
Berkeley	0	6	6
Yale	5	5	10
Total	22	22	44

TABLE 2

BREAKDOWN OF THESES BY DEGREE AIM, FIELD OF STUDY, AND METHOD OF INVESTIGATION

	Degree		Total
	Master's	Doctoral	
Field of Study			
School Health	6	1	7
Environmental Health	1	3	4
Epidemiology	2	7	9
Community Health Education	5	7	12
Occupational Health	4	2	6
International Health	4	2	6
Total	22	22	44
Method of Investigation			
Bibliographic	0	3	3
Field Study	12	14	26
Curriculum Development	1	1	2
Questionnaire	2	1	3
Other	2	1	3
Total	22	22	44

and type of publisher are shown in Table 3. Most used were journals, post-1960 materials, and societal publications. The total number of journal citations was 1,785. One hundred and fifteen titles received three or more citations. Unpublished materials alone received 7% of the total number of citations.

Figure 1 shows the distribution of usage by age of the cited journals. The age of the journal citations when they were included in the thesis bibliography (i.e., a 1960 journal cited in a 1966 thesis would be considered six years old) is plotted on the y axis against the log cumulative percentage of references on the x axis. The distribution is exponential in type, since it is a straight line when plotted on semi-log paper. The slope of the line, k, is .043. According to Cole's formula, the median age for public health journals is seven years (24).*

Figure 2 shows the Bradford-type distribution of the journal titles cited. Plotted on the y axis are the cumulative totals of the references. On the logarithmic scale along the x axis are plotted, in decreasing order of productivity, the numbers of journals. The curve shows a logarithmic relationship between cumulative citations and the number of titles. The curve is divided into three sections, which are not the three sections Bradford describes. The first section, corresponding to 0–12 titles, deviates from the logarithmic relationship. This type of deviation has often been found (25). This is the region of a heavier-than-expected concentration of citations to the most cited core journals. The second portion of the curve, corresponding to the predicted usage, covers the 13th to the 117th journal. The last portion of the curve, beginning with an inflection, is an unusual tail, not seen in other studies of the science literature (26). It would seem to be the result of the large number of unique citations—474. These titles were exremely varied in nature—ranging from obscure foreign titles to *Good Housekeeping*. The tail is most likely due to the widespread interests of public health personnel and to the interdisciplinary nature of public health. There-

* The formula defining median age given by Cole is: $x(\frac{1}{2}) = 2 - \log_{10}50/k$. x is the journal age and k is the plot of $\log_{10}(Rx/RT \times 100)$ against x where Rx is the number of references older than x years and RT is the total number of references.

TABLE 3

FORM, DATE, AND TYPE OF PUBLISHER CITED

	Number of Citations	Percent
Form of Publications		
Books	961	28
Journals	1785	52
Theses	44	1
Documents	293	8
Serials	131	4
Unpublished	242	7
Total	3456	100
Date of Publications		
Pre-1960	1340	39
Post-1960	2020	61
Total	3360	100
Type of Publisher		
Trade	1219	37
Society	1508	46
Other	577	17
Total	3304	100

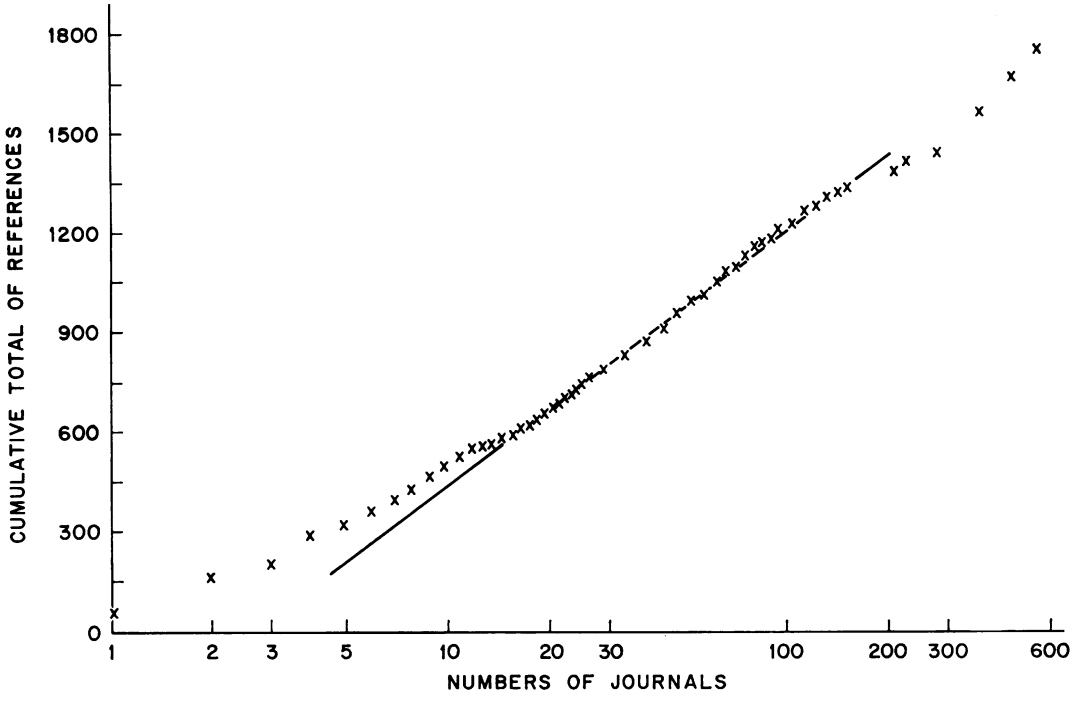

FIG. 1.—Distribution of usage by age of cited journals.

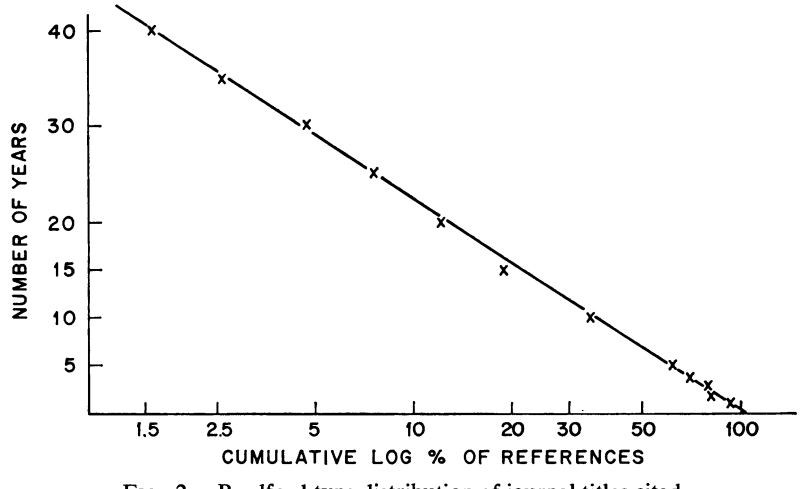

FIG. 2.—Bradford-type distribution of journal titles cited.

fore, it is probably spurious with respect to Bradford's Law.

Differences between the master's and the doctoral theses were tested using the Chi-Square test. Blocks of date categories were tested and a highly significant difference was found in the 1961–1965 date category. A Chi-Square of 8.02 was found, significant at the 2% level of significance. The data indicate, then, that there were particularly large numbers of doctoral candidates citing a particularly large number of citations in this date category. No difference was found in the origin (U.S., Great Britain, other) of the publications cited in master's and

in doctoral theses. Differences in the forms of materials cited were also tested using the Chi-Square. The only significant difference was found in the journal category, with a Chi-Square of 7.90, again highly significant at the 2% level. The indication is that a particularly high number of journals were cited by a particularly high number of doctoral theses.

The number of total citations per thesis for both master's and doctoral theses was tested against the method of investigation used. No significant difference was found using the Chi-Square.

TABLE 4

PREVIOUS AND PRESENT FINDINGS IN CITATION STUDIES ABOUT DATE, CORE MATERIALS, AND FORM

DATE

Name of Researcher	Subject	Median Age (years)
Hunt	Medicine	5
Sherwood	Medicine	5
Emerson	Engineering	over 5
Garfield	Science	8.5
Cole	Petroleum	3
	General technical	5.9
	Aviation	4.9
Meadows	Astronomy	5.4
Present study	Public health	7

CORE MATERIALS

Name of Researcher	Subject	Citations (%)	Number of Journals
Gross & Gross	Chemistry	50	5
Fenner	Geology	49	94
Garfield	Science	50	152
Present study	Public health	50	40
		63	115

FORM

Name of Researcher	Subject	Journals (%)	Books (%)	Other (%)
Fussler	Science	90	6	4
Parker	Communications	43	31	26
Emerson	Engineering	70	30	—
Present study	Public health	52	28	20

Table 4 summarizes previous findings, cited earlier, and juxtaposes them with the findings of the present study. The first question asked whether use is an exponential function of age. We have seen that in this study it is. The median age has been calculated at 7 years. Compared with the median ages for other subjects, this figure is high. The reason may be that theses tend to cite older materials. Emerson's study of theses in engineering showed that fewer than 50% of references were published within the previous five years (27).

DISCUSSION AND CONCLUSIONS

By combining what has been determined about age and about core material, a journal collection of maximum efficiency can be determined. The basic formula for finding the number of journal titles and references in a complete search, given by Brookes (28), is $R(n) = TT \log_e n$, where n = the rank of the journal represented at a convenient point of reference in Figure 2, and TT = the total number of titles which would be found in a complete search. When $n = 40$, $R(40) = TT \log_e 40$, so $TT = 241$ journal titles in a complete public health search. To find the number of citations in a complete search, $R(241) = 241 \log_e 241 = 1320$ citations.

The median age ($x = 7$) has been determined, as has k (.043), the slope of the age distribution. To find the percent of satisfied demands by age, the formula 100-antilog $[2 - k(v/n)]$ can be used where v = the number of volumes being considered for a collection and n = the number of titles. To find the percent of satisfied demands by title, the equation $(100/\log TT) \log n$ can be used. To find the total percent of satisfied demands by age and by number of titles, these equations can be combined thus:

$$\left[\frac{1}{\log TT} \log n\right]\left[1 - \text{antilog}\,\frac{[2 - k(v/n)]}{100}\right] 100,$$

which equals

$$\left[\frac{1}{\log TT} \log n\right]\left[100 - \text{antilog}\,[2 - k(v/n)]\right].$$

For example, if you were considering adding forty journal titles in public health to your new library and you had decided that 1,500 back file volumes were all you could afford, with $n = 40$

and $v = 1500$,

$$\left[\frac{1}{\log 241}\log 40\right] \cdot \{100 - \text{antilog}\,[2 - .043\,(1500/40)]\}$$
$$= 66\%\ \text{demand satisfied.}$$

To find the most efficient 1,500 volume library, you can use different n's. Table 5 shows that maximum efficiency is at approximately sixty volumes, where the efficiency level is at 68.7%.

This, though, is assuming you have each of the sixty titles back twenty-five years. It would be even more efficient if the most used title went back the required number of years and the sixtieth title did not have such a complete back file. If the percent contribution of the sixty-first journal title is taken to be the number of citations it received divided by 1,320 (the total number of citations in a complete ideal search) and you find the year that gives the same percent contribution, you will know the maximum number of years back you want to collect the first title. The line drawn between these two points, as shown by the solid line in Figure 3, showing age (the maximum of which is, in this case, thirty-seven years) against the number of titles (sixty) represents the distribution of the most efficient library. The total percentage satisfied by this library can be found by cumulating

TABLE 5

PERCENT DEMAND SATISFIED BY VARIOUS NUMBERS OF JOURNALS IN A 1500 VOLUME PUBLIC HEALTH COLLECTION

Number of Journals (n)	% Demand Satisfied
25	58.6
40	66.0
50	67.6
55	68.4
60	68.7
65	68.2
100	63.5
200	50.8

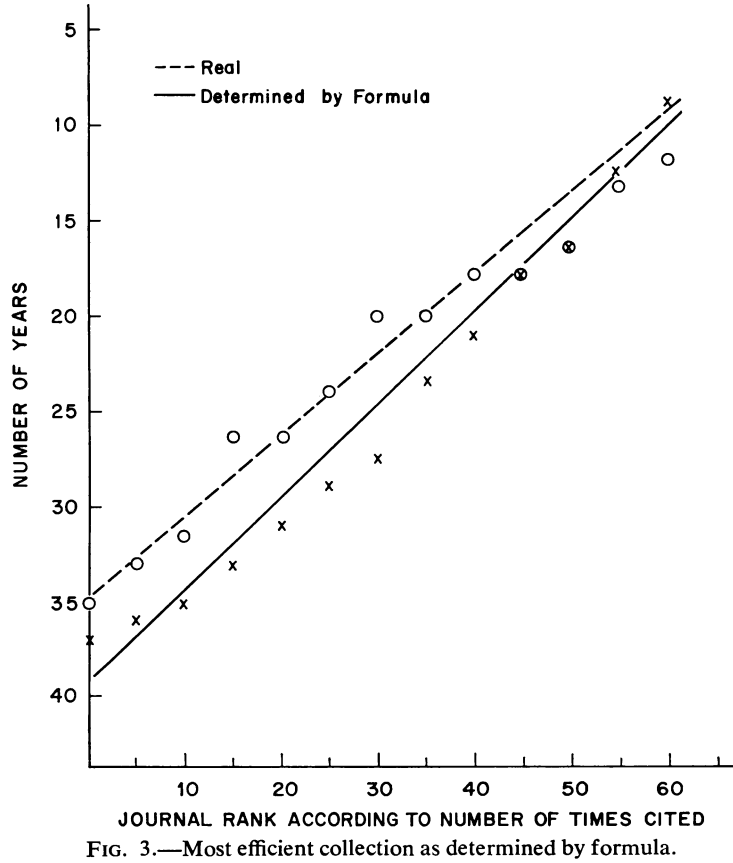

FIG. 3.—Most efficient collection as determined by formula.

TABLE 6

THE MAXIMALLY EFFICIENT PUBLIC HEALTH JOURNAL COLLECTION

Title	Years	Title	Years
1. American Journal of Public Health	37	32. Acta Cytologica	25
2. Archives of Environmental Health	37	33. California School Health	25
3. Journal of the American Medical Association	37	34. Demography	24
4. Journal of School Health	36	35. Journal of Educational Psychology	23
5. Pediatrics	36	36. Journal of Health, Physical Education, Recreation	23
6. American Journal of Clinical Nutrition	36	37. American Journal of Obstetrics and Gynecology	22
7. Journal of the American Dietetic Association	35	38. American Sociological Review	22
8. Lancet	35	39. Archives of Industrial Health	21
9. British Medical Bulletin	35	40. British Journal of Industrial Medicine	21
10. Journal of Occupational Medicine	35	41. Nursing Outlook	20
11. New England Journal of Medicine	35	42. Transactions of the Royal Society of Tropical Medicine and Hygiene	19
12. American Industrial Hygiene Association Journal	34	43. Educational Technology	19
13. American Journal of Diseases of Children	34	44. Journal of Health and Social Behavior	18
14. American Journal of the Medical Sciences	34	45. Journal of Hygiene	17
15. Annals of Internal Medicine	33	46. Nursing Research	17
16. Journal of Chronic Diseases	33	47. American Journal of Nursing	16
17. Journal of Nutrition	33	48. American Journal of Sociology	16
18. Journal of Pediatrics	32	49. California Medicine	16
19. Industrial Medicine and Surgery	32	50. Canadian Medical Association Journal	16
20. Health Services Reports	31	51. Gastroenterology	15
21. Science	30	52. International Journal of Health Education	15
22. American Review of Respiratory Disease	30	53. Journal of Laboratory and Clinical Medicine	14
23. Health Education Monographs	30	54. Journal of Marriage and the Family	13
24. Studies in Family Planning	29	55. Proceedings of the Royal Society of Medicine	12
25. Journal of the American College Health Association	29	56. Safety Monographs for Colleges and Universities	11
26. Annals of Human Genetics	28	57. Scientific American	11
27. Research Quarterly	28	58. World Health Organization Technical Report Series	10
28. Cancer	27	59. Journal of the American Statistical Association	9
29. Family Coordinator	27	60. Journal of Experimental Medicine	8
30. Nature	27		
31. Bulletin of the World Health Organization	26		

for journal 1 through journal number 60 the percent demand satisfied by each (i.e., % satisfied by title × % satisfied by age). This figure, for these sixty titles, is 73.38%. Even if the titles only cited once are included, 48% of the overall demand will be satisfied.

To test this method for choosing the number of back file volumes, an empiric approach was taken. A matrix was made showing the percent contribution of each volume of the most efficient 1,500 volumes of the first sixty titles in this study. The broken line in Figure 3 shows the most efficient collection as determined this way. The outlined method is a quite accurate predictor.

Table 6 shows the application of the most efficient distribution to the list of the 115 titles cited three or more times. If a library had nothing but these sixty titles, back the number of years noted, it could theoretically satisfy 73.38%

of the journal literature demand aside from that for titles receiving only one citation, or 48% of the total demand.

At a time when budgets are being squeezed, the question of which journal titles and how much back file material should be acquired or retained is becoming crucial. Space shortages are at the same time necessitating decisions on what to store or weed. A library serving an academic public health community should be aware of the high percentage of the journal material demanded by this population that can be supplied by only sixty titles and 1,500 volumes, with the 1,500 figure arbitrarily chosen. If the library decided it had the funds to purchase only 200 volumes, it could use the outlined method to choose the 200 most efficient volumes.

Tied to collecting policy is collection evaluation. In a recent survey on what guidelines are used by various professional associations and societies to evaluate libraries the Standards and Accreditation Committee of the American Library Association found that the American Public Health Association has no written guideline (29). Quantitative data on public health collections is not available, probably because such collections are normally in either the medical school library or in a general collection. From the point of view of quality, checklists seem to be one of the most convenient and valuable sources for evaluation purposes (30, 31). Several checklists for the evaluation of medical collections have been devised (32, 33, 34). In public health, La Rocco's book list and this author's list of current reference sources have been published (35, 36). For journals, the list shown here could be checked.

From the point of view of reference service to public health professionals, this study may be helpful also. Because of the diversity of interests these users have, public services personnel should be aware of other local resources to which they may be referred. Another implication for reference is the relatively great interest this user population has in nonbook, nonjournal materials. Reference tools exist which list this type of literature, and the librarians aiding these users should be aware of them.

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