Bibliometric Analysis

for the U.S. Environmental Protection Agency/Office of Research and Development's Human Health Risk Assessment Research Program

This is a bibliometric analysis of the papers prepared by researchers of the U.S. Environmental Protection Agency (EPA) for the Human Health Risk Assessment (HHRA) Research Program. For this analysis, a total of 420 publications published from 2001 to 2007 were reviewed. The 420 publications included 292 journal articles and 128 non-journal publications (e.g., technical reports, handbooks, books/book chapters). These publications were cited 2,152 times in the journals covered by Thomson's *Web of Science*[1] and Scopus[2]. The 292 journal publications were cited 1,897 times in the journals and the 128 non-journal publications were cited 255 times in the journals. Of the 292 journal publications, 226 (77%) have been cited at least once in a journal. Of the 128 non-journal publications, 39 (30.5%) were cited at least once in a journal.

Searches of Thomson Scientific's *Web of Science* and Scopus were conducted to obtain times cited data for the HHRA journal publications. Searches of *Web of Science* were used to obtain times cited data for the HHRA non-journal publications. The process for searching non-journal publications differed from that used for the journal publications in that the Cited Reference Search feature was used to identify the number of times the non-journal publications were cited in the journals covered by *Web of Science*. Such searching involves an iterative process to identify the citing references; for example, searches for EPA, Environmental Protection Agency, USEPA, the document number, the publisher, and so on, are conducted. The results of these different searches then are combined to eliminate duplicate citations and determine total times cited data. The times cited data for the non-journal publications in this report do not include the citations of these documents in other non-journal publications. The analysis was completed using Thomson's *Essential Science Indicators (ESI)* and *Journal Citation Reports (JCR)* as benchmarks. *ESI* provides access to a unique and comprehensive compilation of essential science performance statistics and science trends data derived from Thomson's databases. For this analysis, the *ESI* highly cited papers thresholds as well as the hot papers thresholds were used to assess the influence and impact of the HHRA publications. *JCR* is a recognized authority for evaluating journals. It presents quantifiable statistical data that provide a systematic, objective way to evaluate the world's leading journals and their impact and influence in the global research community. The two key measures used in this analysis to assess the journals in which the EPA HHRA papers were published are the Impact Factor and Immediacy Index. The Impact Factor is a measure of the frequency with which the "average article" in a journal has been cited in a particular year. The Impact Factor helps evaluate a journal's relative importance, especially when compared to other journals in the same field. The Immediacy Index is a measure of how quickly the "average article" in a journal is cited. This index indicates how often articles published in a journal are cited within the same year and it is useful in comparing how quickly journals are cited.

[1] Thomson Scientific's *Web of Science* provides access to current and retrospective multidisciplinary information from approximately 8,830 of the most prestigious, high impact research journals in the world. *Web of Science* also provides cited reference searching.

[2] Scopus is a large abstract and citation database of research literature and quality Web sources designed to support the literature research process. Scopus offers access to 15,000 titles from 4,000 different publishers, more than 12,850 academic journals (including coverage of 535 Open Access journals, 750 conference proceedings, and 600 trade publications), 27 million abstracts, 245 million references, 200 million scientific Web pages, and 13 million patent records.

The report includes a summary of the results of the bibliometric analysis, an assessment of the 292 HHRA journal articles analyzed by *ESI* field (e.g., Clinical Medicine, Environment/Ecology), an analysis of the journals in which the HHRA papers were published, an assessment of the non-journal publications, a table of the highly cited researchers in the HHRA Research Program, and information on the patents/patent applications (if any) that have resulted from the program.

SUMMARY OF RESULTS

1. **About one-sixth of the 292 HHRA journal publications are highly cited papers.** 48 (16.4%) of the 292 HHRA journal publications qualify as highly cited when using the *ESI* criteria for the top 10% of highly cited publications. This is 1.6 times the number expected. 3 (1.0%) of the HHRA journal papers qualify as highly cited when using the *ESI* criteria for the top 1%, which is about the number expected. No journal publications qualified as very highly cited when using the criteria for the top 0.1% or top 0.01% thresholds for the most highly cited papers.

2. **The HHRA journal publications are more highly cited than the average paper.** Using the *ESI* average citation rates for papers published by field as the benchmark, in 9 of the 14 fields in which the 292 HHRA journal papers were published, the ratio of actual to expected cites is greater than 1, indicating that the HHRA journal publications are more highly cited than the average papers in those fields. For all 14 fields combined, the ratio of total number of cites to the total number of expected cites (1,897 to 1,592) is 1.2, indicating that the HHRA journal papers are more highly cited than the average paper.

3. **Nearly one-half of the HHRA journal papers are published in high impact journals.** 120 of the 292 journal papers were published in the top 10% of journals ranked by *JCR* Impact Factor, representing 41.1% of the HHRA journal publications. This number is 4.1 times higher than expected. 131 of the 292 papers appear in the top 10% of journals ranked by *JCR* Immediacy Index, representing 44.9% of EPA's HHRA journal publications. This number is 4.5 times higher than expected.

4. **There were no hot papers.** Using the hot paper thresholds established by *ESI* as a benchmark, no hot papers were identified in the analysis. Hot papers are papers that are highly cited shortly after they are published.

5. **The authors of the HHRA journal publications cite themselves much less than the average author.** 111 of the 1,897 cites are author self-cites. This 5.8% author self-citation rate is well below the accepted range of 10-30% author self-citation rate.

6. **About 5% of the non-journal publications are highly cited and the non-journal publications are cited less than the average journal publication.** 6 (4.7%) of the 128 non-journal publications qualify as highly cited when using the *ESI* criteria for the top 10% of highly cited publications. This is about one-half the number expected. 2 (1.6%) of the HHRA papers qualify as highly cited when using the *ESI* criteria for the top 1%, which is 1.6 times the number expected. None of the non-journal publications qualified as very highly cited when using the criteria for the top 0.1% or top 0.01% thresholds for the most highly cited publications. The ratio of total number of cites to the total number of expected cites (255 to 664) is 0.4, indicating that the HHRA non-journal publications are cited less than the average journal article.

7. **Sixteen of the 402 authors of the HHRA journal publications are included in *ISIHighlyCited.com***, which is a database of the world's most influential researchers who have made key contributions to science and technology during the period from 1981 to 1999.

8. **No patents were issued and no patent applications were filed** by investigators from 2001 to 2007 for research that was conducted under EPA's HHRA Research Program.

Highly Cited HHRA Journal Publications

All of the journals covered by ESI are assigned a field, and to compensate for varying citation rates across scientific fields, different thresholds are applied to each field. Thresholds are set to select highly cited papers to be listed in *ESI*. Different thresholds are set for both field and year of publication. Setting different thresholds for each year allows comparable representation for older and younger papers for each field.

The 292 HHRA journal publications reviewed for this analysis were published in journals that were assigned to 17 of the 22 *ESI* fields. The distribution of the papers among these 17 fields and the number of citations by field are presented in Table 1.

Table 1. HHRA Journal Publications by *ESI* Fields

***ESI* Field**	**No. of Citations**	**No. of EPA HHRA Papers**	**Average Cites/Paper**
Clinical Medicine	592	79	7.5
Environment/Ecology	472	92	5.1
Neuroscience & Behavior	281	17	16.5
Pharmacology & Toxicology	237	54	4.4
Biology & Biochemistry	62	8	7.8
Social Science, General	59	14	4.2
Immunology	56	3	18.7
Agricultural Sciences	40	3	13.3
Geosciences	40	5	8.0
Molecular Biology & Genetics	29	4	7.2
Engineering	13	4	3.2
Chemistry	9	3	3.0
Mathematics	6	2	3.0
Microbiology	1	1	1.0
Computer Science	0	1	0.0
Multidisciplinary	0	1	0.0
Materials Science	0	1	0.0
Total = 17	**Total = 1,897**	**Total = 292**	**6.5**

There are 48 (16.4% of the 292 journal papers analyzed) highly cited HHRA journal publications in 9 of the 17 fields—Clinical Medicine, Environment/Ecology, Neuroscience & Behavior, Pharmacology

& Toxicology, Immunology, Social Sciences, Agricultural Sciences, Geosciences, and Engineering—when using the *ESI* criteria for the **top 10% of papers**. Table 2 shows the number of HHRA journal publications in those 9 fields that meet the **top 10% threshold in *ESI***.

Table 2. Number of Highly Cited HHRA Journal Publications by Field (top 10%)

***ESI* Field**	**No. of Citations**	**No. of Papers**	**Average Cites/Paper**	**% of HHRA Papers in Field**
Clinical Medicine	217	10	21.7	12.7%
Environment/Ecology	175	18	9.7	19.6%
Neuroscience & Behavior	141	3	47.0	17.6%
Pharmacology & Toxicology	83	8	10.4	14.8%
Immunology	47	1	47.0	33.3%
Social Sciences, General	47	4	11.8	28.6%
Agricultural Sciences	40	2	20.0	66.7%
Geosciences	22	1	22.0	20.0%
Engineering	11	1	11.0	25.0%
Total = 9	**Total = 783**	**Total = 48**	**16.3**	**16.4%**

Three (1.0%) of the journal publications analyzed qualify as highly cited when using the *ESI* criteria for the **top 1% of papers**. These publications cover two fields—Environment/Ecology and Clinical Medicine. Table 3 shows the 3 papers by field that meet the **top 1% threshold in *ESI***. The citations for these 3 papers are provided in Tables 4 and 5. None of the HHRA journal publications meet the **top 0.1%** or **top 0.01%** *ESI* thresholds for highly cited papers.

Table 3. Number of Highly Cited HHRA Journal Publications by Field (top 1%)

***ESI* Field**	**No. of Citations**	**No. of Papers**	**Average Cites/Paper**	**% of HHRA Papers in Field**
Environment/Ecology	26	2	13.0	2.2%
Clinical Medicine	33	1	33.0	1.3%
Total = 2	**Total = 59**	**Total = 3**	**19.7**	**1.0%**

Table 4. Highly Cited HHRA Journal Publications in the Field of Environment/Ecology (top 1%)

No. of Cites	First Author	Paper
20	Meng QY	Influence of ambient (outdoor) sources on residential indoor and personal $PM_{2.5}$ concentrations: analyses of RIOPA data. *Journal of Exposure Analysis and Environmental Epidemiology* 2005;15(1):17-28.
6	Selgrade MK	Induction of asthma and the environment: what we know and need to know. *Environmental Health Perspectives* 2006;114(4):615-619

Table 5. Highly Cited HHRA Journal Publications in the Field of Clinical Medicine (top 1%)

No. of Cites	First Author	Paper
33	Kelloff G	Progress and promise of FDG-PET imaging for cancer patient management and oncologic drug development. *Clinical Cancer Research* 2005;11(8):2785-2808.

Ratio of Actual Cites to Expected Citation Rates

The expected citation rate is the average number of cites that a paper published in the same journal in the same year and of the same document type (article, review, editorial, etc.) has received from the year of publication to the present. Using the *ESI* average citation rates for papers published by field as the benchmark, in 9 of the 17 fields in which the EPA HHRA journal papers were published, the ratio of actual to expected cites is greater than 1, indicating that the HHRA journal publications are more highly cited than the average papers in those fields (see Table 6). For all 17 fields combined, the ratio of total number of cites to the total number of expected cites (1,897 to 1,594) is 1.2, indicating that the HHRA journal publications are more highly cited than the average paper.

Table 6. Ratio of Actual Cites to Expected Cites for HHRA Journal Publications by Field

ESI Field	Total Cites	Expected Cite Rate	Ratio
Agricultural Sciences	40	8.1	4.9
Biology & Biochemistry	62	99.7	0.6
Chemistry	9	16.2	0.6
Clinical Medicine	592	446.9	1.3
Computer Science	0	0.2	0.0

ESI Field	Total Cites	Expected Cite Rate	Ratio
Engineering	13	5.4	2.4
Environment/Ecology	472	406.5	1.2
Geosciences	40	15.8	2.5
Immunology	56	43.6	1.3
Materials Science	0	0.0	*1.0
Mathematics	6	3.7	1.6
Microbiology	1	11.4	0.1
Molecular Biology & Genetics	29	42.1	0.7
Multidisciplinary	0	1.8	0.0
Neuroscience & Behavior	281	191.9	1.5
Pharmacology & Toxicology	237	274.8	0.9
Social Sciences, General	59	26.0	2.3
TOTAL	**1,897**	**1,594.1**	**1.2**

* The actual number of cites is equal to the expected number of cites, making the ratio 1.0.

JCR Benchmarks

Impact Factor. The *JCR* Impact Factor is a well known metric in citation analysis. It is a measure of the frequency with which the "average article" in a journal has been cited in a particular year. The Impact Factor helps evaluate a journal's relative importance, especially when compared to others in the same field. The Impact Factor is calculated by dividing the number of citations in the current year to articles published in the 2 previous years by the total number of articles published in the 2 previous years.

Table 7 indicates the number of HHRA journal publications published in the top 10% of journals, based on the *JCR* Impact Factor. One hundred twenty (120) of 292 journal papers were published in the top 10% of journals, representing 41.1% of EPA's HHRA journal publications. This indicates that nearly one-half of the HHRA journal publications are published in the highest quality journals as determined by the *JCR* Impact Factor, which is 4.1 times higher than the expected percentage.

Table 7. HHRA Journal Publications in Top 10% of Journals by *JCR* Impact Factor

EPA HHRA Papers in that Journal	Journal	Impact Factor (IF)	*JCR* IF Rank
1	New England Journal of Medicine	51.296	2

EPA HHRA Papers in that Journal	Journal	Impact Factor (IF)	*JCR* IF Rank
2	Journal of the National Cancer Institute	15.27	44
1	Journal of Allergy and Clinical Immunology	8.829	136
2	Annals of Neurology	8.051	154
1	Development	7.764	165
2	Arthritis and Rheumatism	7.751	166
2	Cancer Research	7.656	172
1	Mutation Research – Reviews in Mutation Research	7.579	175
1	FASEB Journal	6.721	206
4	Clinical Cancer Research	6.177	228
31	Environmental Health Perspectives	5.861	255
1	Journal of Biological Chemistry	5.808	260
2	Neurology	5.690	270
5	American Journal of Epidemiology	5.241	308
1	Molecular Cancer Therapeutics	5.137	326
1	Emerging Infectious Diseases	5.094	332
2	Pediatrics	5.012	345
8	Toxicology and Applied Pharmacology	4.722	397
1	Breast Cancer Research and Treatment	4.671	401
1	Cancer	4.582	413
1	International Journal of Epidemiology	4.517	424
7	Epidemiology	4.339	452
1	Global Change Biology	4.339	452
2	Cancer Epidemiology Biomarkers & Prevention	4.289	463
1	Mutation Research – Fundamental and Molecular Mechanisms of Mutagenesis	4.111	505
1	Rheumatology	4.052	516
7	Environmental Science & Technology	4.040	518
1	Autoimmunity Reviews	3.760	603
2	Critical Reviews in Toxicology	3.707	623

EPA HHRA Papers in that Journal	Journal	Impact Factor (IF)	*JCR* IF Rank
2	Journal of Neurophysiology	3.652	645
1	BMC Bioinformatics	3.617	656
17	Toxicological Sciences	3.598	662
2	Biology of Reproduction	3.498	694
1	Neuroscience	3.427	721
3	Cancer Letters	3.277	777
1	Journal of Endocrinology	3.072	853
Total = 120			

Immediacy Index. The *JCR* Immediacy Index is a measure of how quickly the *average article* in a journal is cited. It indicates how often articles published in a journal are cited within the year they are published. The Immediacy Index is calculated by dividing the number of citations to articles published in a given year by the number of articles published in that year.

Table 8 indicates the number of HHRA journal publications published in the top 10% of journals, based on the *JCR* Immediacy Index. One hundred thirty-one (131) of the 292 papers appear in the top 10% of journals, representing 44.9% of the HHRA journal papers. This indicates that nearly half of the HHRA journal papers are published in the highest quality journals as determined by the *JCR* Immediacy Index, which is 4.5 times higher than the expected percentage.

Table 8. HHRA Journal Publications in Top 10% of Journals by *JCR* Immediacy Index

EPA HHRA Papers in that Journal	Journal	Immediacy Index (II)	*JCR* II Rank
1	New England Journal of Medicine	12.743	2
2	Journal of the National Cancer Institute	2.776	58
2	Annals of Neurology	2.716	61
1	International Journal of Epidemiology	2.200	84
1	Journal of Allergy and Clinical Immunology	1.790	118
1	Development	1.579	157
7	Epidemiology	1.437	187
1	FASEB Journal	1.241	238

EPA HHRA Papers in that Journal	Journal	Immediacy Index (II)	*JCR* II Rank
2	Emerging Infectious Diseases	1.222	243
2	Cancer Research	1.220	246
2	Arthritis and Rheumatism	1.204	251
1	Journal of Biological Chemistry	1.110	291
2	Neurology	1.110	291
5	American Journal of Epidemiology	1.091	306
1	Mutation Research – Reviews in Mutation Research	1.050	331
4	Clinical Cancer Research	1.010	354
30	Environmental Health Perspectives	0.994	373
2	Critical Reviews in Toxicology	0.880	442
2	Journal of Neurophysiology	0.821	500
2	Pediatrics	0.784	537
2	Biology of Reproduction	0.736	593
17	Toxicological Sciences	0.734	597
1	Cancer	0.713	629
1	Rheumatology	0.698	649
1	Omics – A Journal of Integrative Biology	0.694	657
1	Global Change Biology	0.660	705
3	Cancer Letters	0.658	707
7	Environmental Science & Technology	0.646	729
3	Journal of Rheumatology	0.637	746
1	Cancer Chemotherapy and Pharmacology	0.631	755
1	Bioorganic & Medicinal Chemistry Letters	0.624	769
1	Neuroscience	0.611	790
1	Thrombosis Research	0.605	801
13	Journal of Exposure Science and Environmental Epidemiology	0.596	821
1	Environmental Research	0.583	844
1	Molecular Carcinogenesis	0.580	852

EPA HHRA Papers in that Journal	Journal	Immediacy Index (II)	*JCR* II Rank
1	Molecular Cancer Therapeutics	0.568	877
2	Cancer Epidemiology Biomarkers & Prevention	0.560	889
1	Clinical Journal of the American Society of Nephrology	0.558	897
1	BMC Bioinformatics	0.557	899
Total = 131			

Hot Papers

ESI establishes citation thresholds for hot papers, which are selected from the highly cited papers in different fields, but the time frame for citing and cited papers is much shorter—papers must be cited within 2 years of publication and the citations must occur in a 2-month time period. Papers are assigned to 2-month periods and thresholds are set for each period and field to select 0.1% of papers.

Using the hot paper thresholds established by *ESI* as a benchmark, there were no hot papers identified among the 292 journal publications included in this analysis.

Author Self-Citation

Self-citations are journal article references to articles from that same author (i.e., the first author). Because higher author self-citation rates can inflate the number of citations, the author self-citation rate was calculated for the HHRA papers. Of the 1,897 total cites of the 292 journal publications, 111 are author self-cites—a 5.8% author self-citation rate. Garfield and Sher[3] found that authors working in research-based disciplines tend to cite themselves on the average of 20% of the time. MacRoberts and MacRoberts[4] claim that approximately 10-30% of all the citations listed fall into the category of author self-citation. Kovacic and Misak[5] reported a 20% author self-citation rate for medical literature. Therefore, the 5.8% self-cite rate for the HHRA papers is well below the range for author self-citation.

Non-Journal Publications

This analysis included 128 non-journal publications (e.g., technical reports, books/book chapters, handbooks). For the non-journal publications, the Cited Reference Search feature of *Web of Science* was used to determine the number of times the non-journal publications were cited in the journals

[3] Garfield E, Sher IH. New factors in the evaluation of scientific literature through citation indexing. *American Documentation* 1963;18(July):195-210.

[4] MacRoberts MH, MacRoberts BR. Problems of citation analysis: a critical review. *Journal of the American Society of Information Science* 1989;40(5):342-349.

[5] Kovacic N, Misak A. Author self-citation in medical literature. *Canadian Medical Association Journal* 2004;170(13):1929-1930.

covered by *Web of Science*. Through an iterative search process, citing references were identified, duplicates were eliminated, and times cited counts were generated. The times cited data for the non-journal publications in this report do not include the citations of these documents in other non-journal publications.

Of the 128 non-journal publications, 39 (30.5%) had been cited at least once in a journal. Each non-journal publication was assigned an *ESI* field so that the *ESI* thresholds could be used as a baseline for identifying highly cited publications. The non-journal publications covered 9 of the 22 *ESI* fields. There are 6 (4.7% of the papers analyzed) highly cited HHRA non-journal publications in 1 of the 9 *ESI* fields—Environment/Ecology—when using the *ESI* criteria for the **top 10% of papers**. Two (1.6%) of the non-journal publications analyzed qualify as highly cited when using the *ESI* criteria for the **top 1% of publications**. These publications are in the field of Environment/Ecology. Table 9 shows the 6 non-journal publications that meet the **top 10% threshold in *ESI*** as well as the two publications that meet the **top 1% threshold in ESI**. None of the non-journal publications meet the *ESI* criteria for the **top 0.1%** or **top 0.01%**.

The 128 non-journal publications were cited 255 times. The ratio of the total number of cites to the total number of expected cites (calculated using the *ESI* average citation rates for publications by field as the benchmark) is 0.4 (255 to 664), indicating that the HHRA journal publications are cited less than the average journal article.

Table 9. Highly Cited HHRA Non-Journal Publications (top 10%)

***ESI* Field**	**No. of Cites**	**Publication**
Environment/Ecology	25	Child-Specific Exposure Factors Handbook (Interim Report). U.S. Environmental Protection Agency, EPA 600/P-00/002B, 2002.
Environment/Ecology	*70	Health Assessment Document for Diesel Engine Exhaust. U.S. Environmental Protection Agency, EPA 600/8-90/057F, 2002.
Environment/Ecology	18	An Examination of EPA Risk Assessment Principles and Practices. U.S. Environmental Protection Agency, EPA 100/B-04/001, 2004.
Environment/Ecology	24	Air Quality Criteria for Particulate Matter. Volume I and Volume II. U.S. Environmental Protection Agency, EPA 600/P-99/002aF,bF, 2004.
Environment/Ecology	*25	Guidelines for Carcinogen Risk Assessment. U.S. Environmental Protection Agency, EPA 930/P-03/001F, 2005.
Environment/Ecology	10	Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens. U.S. Environmental Protection Agency, EPA 630/R-03/003F, 2005.

* These are the two non-journal publications that qualify as highly cited when using the *ESI* criteria for the **top 1% of publications.**

Highly Cited Researchers

A search of Thomson's *ISIHighlyCited.com* revealed that 16 (4.0%) of the 402 authors of the HHRA papers are highly cited researchers. *ISIHighlyCited.com* is a database of the world's most influential researchers who have made key contributions to science and technology during the period from 1981 to 1999. The highly cited researchers identified during this analysis of the HHRA publications are presented in Table 10.

Table 10. Highly Cited Researchers Authoring HHRA Journal Publications

Highly Cited Researcher	Affiliation	*ESI* Field
Andersen, Melvin E.	Chemical Industry Institute of Toxicology (CIIT)	Pharmacology
Birnbaum, Linda S.	U.S. EPA, National Health & Environmental Effects Research Laboratory	Pharmacology
Brown, John S.	Battelle Coastal Resources and Environmental Management	Environment/Ecology
Giesy, John P.	Michigan State University	Environment/Ecology
Goldman, Lee	University of California, San Francisco	Clinical Medicine
Guillette, Louis J.	University of Florida	Environment/Ecology
Klaassen, Curtis Dean	University of Kansas Medical Center	Pharmacology
Lioy, Paul J.	University of Medicine & Dentistry of New Jersey	Environment/Ecology
Liu, Jie	National Cancer Institute	Pharmacology
Lovley, Derek R.	University of Massachusetts Amherst	Microbiology
Needham, Larry L.	Centers for Disease Control and Prevention, National Center for Environment Health	Environment/Ecology
Peterson, Richard E.	University of Wisconsin, Madison	Pharmacology
Richards, James H.	University of California, Davis	Environment/Ecology
Schwartz, Joel David	Harvard School of Public Health	Environment/Ecology
Watson, John G.	Desert Research Institute	Environment/Ecology
Winer, Arthur M.	University of California, Los Angeles	Environment/Ecology
Total = 16		

Patents

No patents have been issued or patent applications filed by investigators from 2001 to 2007 for research that was conducted under EPA's HHRA Research Program.

This bibliometric analysis was prepared by
Beverly Campbell of The Scientific Consulting Group, Inc.
in Gaithersburg, Maryland
under EPA Contract No. EP-C-05-015