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Review

A bibliometric analysis of scientific production in mesothelioma research

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ABSTRACT

This study aims at comparing scientific production in malignant mesothelioma (MM) among countries and evaluating publication trends and impact factor (IF).

The PubMed database was searched with a strategy combining keywords listed in the Medical Subject Headings and free-text search. Publications numbers and IF were evaluated both as absolute values and after standardization by population and gross domestic product (GDP).

5240 citations were retrieved from the biennium 1951–1952 ($n = 22$) to 2005–2006 ($n = 535$). The 177% increase of MM publications from 1987 to 2006 exceeded by large the corresponding value of total cancer literature (123.5%). In these two decades, 2559 articles with IF were published: 46.4% came from the European Union (EU) (the UK, Italy and France ranking at the top), and 36.2% from the US. The highest mean IF was reported for the US (3.346), followed by Australia (3.318), and EU (2.415, with the UK, Belgium and the Netherlands first). Finland, Sweden and Australia had the best ratio between IF (sum) and resident population or GDP. The number of publications correlated with GDP ($p = 0.001$) and national MM mortality rates ($p = 0.002$). An association was found between a country commitment to MM research and the burden of disease ($p = 0.04$). Asbestos, survival, prognosis, occupational exposure, differential diagnosis, and immunohistochemistry were the most commonly used keywords.

This report represents the first effort to explore the geographical and temporal distribution of MM research and its determinants. This is an essential step in understanding science priorities and developing disease control policies.

1. Introduction

Malignant mesothelioma (MM) is a highly aggressive tumor mostly arising in the pleura and peritoneum. MM has a poor prognosis and conventional therapies fail to improve life expectancy substantially [1]. The inhalation of asbestos fibers is universally considered as the main etiological factor, explaining more than 80% of MM cases. In industrialized countries where asbestos was widely used, incidence rates of MM are about 1–2/1,000,000/year among women and up to 10–30/1,000,000/year among men [2]. These figures are generally increasing in Western countries, even if a deceleration has likely started in some countries [3–6].

As a direct effect of the extensive epidemiological research linking MM to asbestos exposure [7], asbestos use has been banned in many countries all over the world, although this exposure continues to be a public health problem, not only for developing countries.

Publication of scientific findings represents a central part of the research process and bibliometric studies are systematically conducted to evaluate the relative importance of scientific production in a specific field. This approach provides a pivotal tool to interpret the temporal evolution and the geographical distribution of research on a specific topic [8–15]. The most commonly used endpoints for evaluating scientific production are the absolute number of papers published, and impact factor (IF), i.e., the average number of times an article published in a given journal is cited as a reference in other articles. This latter measure is based on the assumption

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that the number of time a paper is cited in the literature reflects its influence and visibility.

The main purpose of the present article was to examine the geographical distribution and temporal trends of biomedical publications in the field of MM research. To this aim, articles on MM published between 1951 and 2006 have been retrieved and analyzed. A special attention has been paid to articles with IF published in the most recent decades (years 1987–2006), with *ad hoc* geographical analyses evaluating IF as absolute value and weighted according to major socioeconomic variables, i.e. population size and gross domestic product (GDP). To evaluate if the burden of the disease is able to prioritize research, MM mortality rates were calculated in individual countries and associated with publication performance. In addition, a list of journals most commonly chosen by researchers in the field to publish their results, and the most frequently used keywords are reported, as they may provide useful hints about research trends and may help to interpret new perspectives of the field.

2. Methods

2.1. Bibliographic search

The search for papers to be included in the analysis was performed on February 2008. The PubMed database (National Library of Medicine, National Institutes of Health, Bethesda, MD, USA – http://www.ncbi.nlm.nih.gov/PubMed) was used as the only source of data, and all papers published in the period 1951–2006 were evaluated.

The search strategy was built by [1] inputting the keyword *mesothelioma* in the MeSH field [mesh]; and [2] searching for *mesothelioma* as a free-text word present in title or abstract [tiab]; for completeness. A group of special keywords was added to exclude non-research publications; as identified in publication type field [pt]. The final search strategy was the following: (mesothelioma[mesh] OR mesothelioma[tiab]) AND 1951:2006[dp] NOT (congresses[pt] OR letter[pt] OR editorial[pt] OR news[pt] OR case reports[pt]).

Specific analyses were conducted in the subgroup of the most recent citations (1987:2006[dp]).

2.2. Keywords

Keywords are MeSH (Medical Subject Headings) terms (generally 5–15) assigned to PubMed documents by trained indexers choosing in the MeSH thesaurus [16]. All keywords used for indexing the articles were identified and their frequency was calculated using Excel software. To produce a list of the most often used terms, keywords with similar meaning were assembled, i.e., risk and risk factors, pulmonary diseases and lung diseases, etc.

2.3. Countries

The first author's country identified the country of origin of the article. Occasionally, it was necessary to manually identify the country after consulting various bibliographic sources, but finally 99.8% of the articles were geographically classified.

The European Union (EU) was defined as the 15 official member states plus Norway, given its inclusion in the European economic area (EEA) and in all the EU statistics issued by the Statistical Office of the European Communities (Eurostat). For the non-EU countries, only data from 7 countries with more than 20 entries during 1987–2006 were evaluated. The remaining countries accounted for a total of 60 articles.

2.4. Impact factor

The number of publications and mean IF (sum of each paper IF of the total number of publications) for biennium was reported for each country. To attribute IF to each paper we used the Journal Citation Reports (JCR, Thomson Reuters) edition issued 2 years after publication of the article, i.e. 1989 edition for articles published in 1987. For articles published in 2005 and 2006, the 2006 edition has been used.

2.5. Demographic and economic data

To increase the comparability between countries, we considered the effects of country size and of the heterogeneous availability of resources. Demographic and economic data for each country were retrieved from Eurostat for the EU and/or from International Monetary Fund and US Census Bureau [17–19] for other countries.

The ratio between the scientific production of each country (expressed as the sum of IF of all published papers) and population size (expressed in millions of inhabitants), or national GDP (expressed in current billion US dollars) was calculated using average figures of the period under analysis.

2.6. Disease occurrence and relative commitment to MM research

The relative commitment to MM research was defined as the ratio between the proportional contribution of each country to the world literature on MM and its proportional contribution to the world literature on cancer ("cancer subset" [20]), i.e. the ratio between values of column 2 (%) and column 4 (%) of Table 4. Country specific death rates for MM were calculated from World Health Organisation—WHO national mortality tables and demographic data [17–19,21]. The number of MM deaths for all countries, but Belgium, Denmark, Switzerland and Turkey, was available for the year 2003 and was used in the analysis.

2.7. Statistical analysis

A negative binomial regression model [22] was applied to data to investigate the relationship between the total number of MM publications and some potential predictors. This model allowed taking into account the count nature of variables. The multivariate analysis concerning the relative MM commitment was carried out by means of a multiple linear regression model. Standard diagnostic procedures to inspect the validity of the models such as residual analysis, delta-beta, cook distance and leverage analysis, have been applied.

3. Results

3.1. Historical overview

Publication search retrieved a total of 5240 citations from the PubMed database in the period 1951–2006. Articles published worldwide on MM grew from 22 in the biennium 1951–1952 up to 535 in the biennium 2005–2006. Publication trend of MM papers was compared with the so called "*cancer subset*" (a set of papers specifically referring to cancer research built by PubMed experts [20]). The two curves show similar trends, indicating that MM research has grown with the same speed of total cancer research (Fig. 1). The quality and completeness of early data available in the PubMed was not stable enough to allow a more specific evaluation of published reports, therefore the following analyses were focused on the period 1987–2006, with a total of 3273 citations retrieved.

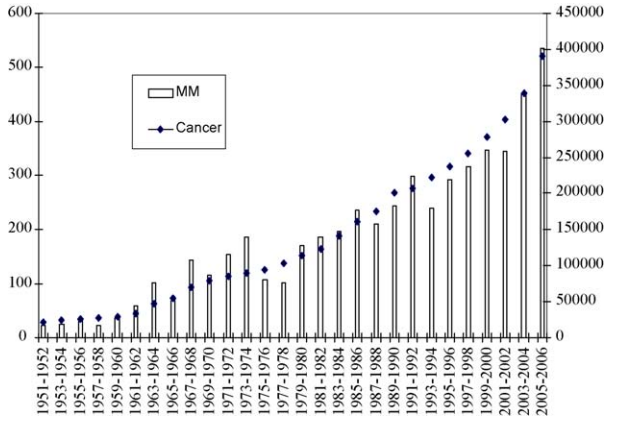

Fig. 1. Comparative trend of publications reporting research on malignant mesothelioma (MM) and in the "cancer subset" from 1951 to 2006.

3.2. Research topics

The keywords (MeSH terms) used by PubMed experts to classify these 3273 articles included as many as 2487 different terms. Only 1537 (61.8%) of these were used more than twice. We further restricted the analysis to the keywords used more than 15 times, i.e., 351 (14.1%). Resulting keywords were arbitrarily assembled in 6 groups using higher order keywords in the MeSH tree structure used by indexers, i.e., Neoplasms/Diseases by site (including 41% of all keywords), Chemicals and drugs (21%), Diagnostic, therapeutic and investigative techniques (13%), Epidemiologic methods (11%), Environmental and public health (9%), and Laboratory techniques (5%). Table 1 shows the top 10 terms for each homogeneous groups of keywords (MeSH terms). The most frequently used keywords were from the group of Neoplasms/Diseases by site, with mesothelioma (3252 times) and pleural neoplasms (1702 times) ranking first, and from the group of Chemicals and drugs (asbestos 1330 times). Other commonly used keywords were survival (523), risk/risk factor (435), prognosis (435), occupational exposure and differential diagnosis (421 each) and immunohistochemistry (420).

Table 2
List of 50 journals with impact factor, publishing more than 14 articles on malignant mesothelioma from 1987 to 2006.

Journals	% of articles	Journals	% of articles
Lung Cancer	4.50	Am J Surg Pathol	1.40
Am J Ind Med	3.50	Diagn Cytopathol	1.40
Cancer	3.30	J Clin Oncol	1.40
Chest	2.50	Clin Cancer Res	1.40
Cancer Res	2.30	Ann Occup Hyg	1.20
Br J Cancer	2.10	Rev Mal Respir	1.20
Hum Pathol	1.80	J Thorac Cardiovasc Surg	1.20
Int J Cancer	1.70	Ann Oncol	1.10
Histopathology	1.70	Eur Respir J	1.10
Anticancer Res	1.60	Am J Respir Cell Mol Biol	1.00
J Pathol	1.60	Mod Pathol	1.00
Occup Environ Med	1.60		

Other journals (publishing <1% of the papers): Br J Ind Med; Ann N Y Acad Sci; Ann Thorac Surg; Oncogene; Thorax; Arch Pathol Lab Med; Eur J Cardiothorac Surg; Int J Occup Environ Health; Scand J Work Environ Health; Semin Oncol; Semin Diagn Pathol; Acta Cytol; Am J Clin Pathol; Eur J Cancer; Pathol Res Pract; Tumori; Ultrastruct Pathol; Cancer Genet Cytogenet; J Clin Pathol; J Surg Oncol; Respir Med; Ann Surg Oncol; Environ Health Perspect; Virchows Arch; Ind Health; Int J Radiat Oncol Biol Phys; Oncol Rep.

3.3. Journals

Out of the 3273 papers published in the period 1987–2006, 713 (21.8%) were not indexed in the JCR. Most of these articles were from Italy (155 articles), the US (148), Japan (50), France (47) and Germany (40). The properly indexed papers (2559; 78.2%) were published in 420 journals, but only 98 of them published more than 6 articles during the period considered. The first 50 journals in the list published 80% of the articles. Table 2 reports this list and gives more detail on the first 23 journals, publishing more than 1% of articles. A wide range of journals hosts scientific literature on MM, including some of the most important journals in the following ISI category: Oncology (8 journals), Pathology (6), Respiratory Medicine (6), Public, Environmental & Occupational Health (3).

3.4. Papers number

The number of indexed papers in the field of MM research in the selected countries increased from 156 in the biennium 1987–1988 to a maximum of 432 papers in the biennium 2005–2006 (Table 3).

Table 1
Keywords [MeSH terms] most frequently assigned by PubMed indexers to papers in the field of malignant mesothelioma research.

Neoplasms/diseases by site (41%)	Citations	Chemicals and drugs (21%)	Citations	Diagnostic, therapeutic and investigative techniques (13%)	Citations
Mesothelioma	3252	Asbestos	1330	Prognosis	435
Pleural neoplasms	1702	Cisplatin	221	Diagnosis, differential	421
Lung neoplasms	815	Vimentin	77	Combined modality therapy	340
Lung diseases	790	Mineral fibers	70	Biopsy	287
Pleural diseases	554	Doxorubicin	68	Tomography	180
Pleural effusion	426	Interferons	68	Pneumonectomy	144
Peritoneal neoplasms	340	Mitomycin	68	Thoracoscopy	101
Asbestosis	316	Interleukins	63	Gene therapy	71
Neoplasms	227	Glutamates	59	Palliative care	67
Ovarian neoplasms	92	Deoxycytidine	44	Immunotherapy	59

Epidemiologic methods (11%)	Citations	Environment and public health (9%)	Citations	Laboratory techniques (5%)	Citations
Survival	523	Risk/risk factors	435	Immunohistochemistry	420
Incidence	379	Occupational exposure	421	Immunoenzyme techniques	168
Retrospective studies	195	Occupational diseases	340	Polymerase chain reaction	156
Registries	139	Environmental exposure	236	Flow cytometry	57
Follow-up studies	129	Smoking	107	In situ hybridization	45
Cohort studies	126	Risk assessment	66	Neoplasm transplantation	41
Sensitivity and specificity	121	Industry	63	Staining and labeling	32
Prospective studies	99	Occupational health	46	Histocytochemistry	27
Case–control studies	95	Population surveillance	36	Karyotyping	25
Clinical trials	62	Air pollutants	29	Enzyme-linked immunosorb assay	24

Table 3
Numbers of published papers on malignant mesothelioma (Nr) and mean Impact Factor (mIF) by country, from 1987 to 2006.

Countries	1987–1988		1989–1990		1991–1992		1993–1994		1995–1996		1997–1998		1999–2000		2001–2002		2003–2004		2005–2006		Totals		IF rank
	Nr	mIF	Nr	mIF	Nr	mIF	Nr	mIF	Nr	mIF	Nr	mIF	Nr	mIF	Nr	mIF	Nr	mIF	Nr	mIF	Nr	mIF	
UK	12	3.140	14	2.088	25	2.015	18	1.644	18	3.087	18	2.158	17	3.551	34	4.223	38	4.237	43	3.095	237	2.924	1
Italy	7	1.731	10	1.675	19	1.024	11	1.408	11	1.778	16	1.771	17	2.396	32	3.586	46	3.511	46	3.829	215	2.271	6
France	4	1.302	4	0.177	10	1.386	21	2.170	9	3.217	24	2.357	27	1.980	17	2.094	18	4.415	28	1.691	162	2.079	7
Germany	10	0.594	12	1.424	17	0.756	7	0.838	6	0.709	13	1.753	19	1.970	22	2.099	23	3.003	10	2.548	139	1.569	8
Finland	2	1.037	4	2.086	20	1.888	5	2.726	10	3.598	12	2.467	14	3.399	12	3.093	10	2.537	7	2.605	96	2.544	5
Sweden	5	1.266	6	2.247	5	1.635	9	5.151	13	2.161	8	2.289	12	3.017	9	2.376	11	3.128	12	3.024	90	2.629	4
The Netherlands	5	1.920	6	2.062	7	2.933	4	2.179	9	2.663	9	2.944	9	2.524	9	3.256	18	3.323	9	3.833	85	2.764	3
Belgium	0	0.000	0	0.000	4	2.936	6	3.651	9	2.235	8	3.716	10	4.255	6	2.886	3	3.004	7	5.660	53	2.834	2
Spain	2	0.023	1	0.550	1	0.054	2	0.882	2	1.089	6	1.542	3	1.379	5	2.861	4	2.512	4	2.355	30	1.324	10
Norway	1	1.127	3	0.769	4	1.346	0	0.000	1	0.807	0	0.000	2	3.904	1	0.996	4	3.597	9	2.481	25	1.503	9
Greece	1	0.230	0	0.000	2	1.983	1	0.317	1	1.117	2	0.760	5	1.474	2	1.128	2	3.966	5	1.271	21	1.224	11
Denmark	2	1.824	2	0.626	2	0.676	6	0.549	3	2.201	2	0.879	2	2.382	0	0.000	1	0.481	0	0.000	20	0.962	12
Austria	1	0.224	0	0.000	1	0.027	0	0.000	1	0.683	0	0.000	1	0.724	2	1.143	4	3.253	0	0.000	10	0.605	13
Ireland	1	0.030	0	0.000	0	0.000	1	0.436	0	0.000	0	0.000	0	0.000	0	0.000	1	1.777	1	1.777	4	0.402	14
Portugal	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	15
Luxembourg	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	16
EU	53	1.707	62	1.675	117	1.606	91	2.117	93	2.427	118	2.208	138	2.679	151	3.117	183	3.520	181	3.090	1,187	2.415	3
US	74	2.845	60	3.138	83	1.889	64	3.216	89	3.049	87	4.047	88	3.687	102	3.786	108	4.157	171	3.643	926	3.346	1
Australia	5	1.226	11	2.174	16	1.561	9	2.823	12	2.767	8	2.426	8	3.488	8	2.664	14	8.009	22	6.036	113	3.318	2
Japan	0	1.332	7	1.582	8	1.662	3	1.836	7	1.526	6	0.961	7	2.007	10	1.536	9	1.203	24	2.176	81	1.582	7
Canada	11	1.309	12	1.910	7	0.885	6	2.458	10	1.978	6	3.160	7	2.270	3	2.242	1	0.481	10	3.078	73	1.977	5
Turkey	2	2.081	0	0.000	2	1.458	2	0.606	6	1.301	2	1.573	10	1.814	10	1.795	3	1.602	13	3.684	50	1.591	6
Switzerland	6	1.071	2	0.783	5	2.453	6	2.814	4	3.272	3	1.843	3	1.774	1	0.674	4	4.017	10	3.174	44	2.187	4
South Africa	5	2.085	2	0.967	5	0.981	1	0.326	1	1.318	1	0.231	3	1.479	2	2.846	4	1.524	1	1.777	25	1.353	8
	156		156		243		182		222		231		264		287		326		432		2499	2.221	
Others	2	1.332	1	0.112	6	0.557	0	0	1	0.395	6	0.964	13	1.031	5	0.829	15	0.900	11	3.432	60	0.955	
All	158	1.665	157	1.371	249	1.450	182	1.799	223	2.004	237	1.935	277	2.248	292	2.165	341	2.823	443	3.343	2559	2.327	

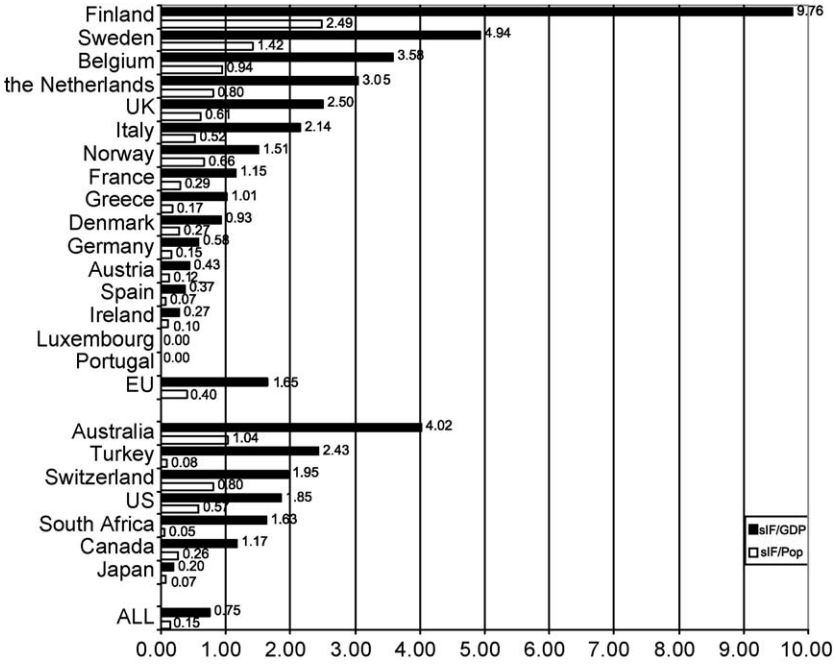

Fig. 2. Scientific production on malignant mesothelioma in the most productive countries, standardized by population (Pop) and economic parameters (GDP) from 1987 to 2006.

During these two decades, the EU published 1187 papers (46.4% of the total). In the same time frame, authors from the US produced 926 articles (36.2% of the literature), Australia 113 (4.4%), Japan 81 (3.2%), Canada 73 (2.9%), Turkey 50 (2%), Switzerland 44 (1.7%) and South Africa 25 (1%). In the EU all countries except Luxembourg and Portugal were represented. The most productive countries were the UK with 237 articles (20% of total EU papers), Italy with 215 (18.1%), and France with 162 (13.6%), followed by Germany (139 papers; 11.7%), Finland (96; 8.1%), and Sweden (90; 7.6%).

3.5. Papers quality

Overall mean IF of selected countries was 2.221 (Table 3). The highest mean was reached by papers published in the US (3.346), Australia (3.318) and the EU (2.415), with the UK ranking first (2.924), followed by Belgium (2.834), the Netherlands (2.764), Sweden (2.629), and Finland (2.544).

It is worth noting the good performances of Australia (mean IF up to 8.009 in recent years), and Belgium, that scored the highest mean IF in the EU in four biennia, despite the relatively small number of papers.

Table 4
Relative commitment to malignant mesothelioma (MM) research within cancer research (1987–2006), death rates from MM (2003) and mean gross domestic product (GDP) from 1987 to 2006, by country.

Countries	MM literature		Cancer subset literature		Relative MM commitment[b]	MM deaths 2003	Population 2003	Deaths/Pop (per million)	Mean GDP 1987–2006 (billions)
	Papers[a] 1987–2006	%	Papers[a] 1987–2006	%					
Finland-FI	100	3.06	16,948	0.62	4.95	74	5,204,405	14.22	133.43
South Africa-ZA	26	0.79	5377	0.20	4.06	193	44,481,901	4.34	142.87
Italy-IT	370	11.31	105,161	3.83	2.95	1160	57,998,353	20.00	1226.24
Australia-AU	121	3.70	40,258	1.47	2.52	510	19,731,984	25.85	408.58
Sweden-SE	101	3.09	36,954	1.35	2.29	111	8,970,306	12.37	256.54
Norway	28	0.86	11,403	0.42	2.06	45	4,555,400	9.88	166.79
France-FR	208	6.36	93,698	3.41	1.86	795	62,206,254	12.78	1468.30
the Netherlands-NL	94	2.87	49,579	1.81	1.59	393	16,223,248	24.22	401.71
Greece-GR	23	0.70	12,286	0.45	1.57	9	10,625,945	0.85	157.31
United Kingdom-UK	266	8.13	153,839	5.61	1.45	1817	60,094,648	30.24	1361.92
Germany-DE	176	5.38	111,756	4.07	1.32	1083	82,398,326	13.14	2067.85
USA-US	1072	32.77	775,575	28.27	1.16	2476	290,342,554	8.53	8370.90
Canada-CA	83	2.54	68,362	2.49	1.02	343	32,207,113	10.65	696.73
Spain-ES	39	1.19	39,683	1.45	0.82	260	40,217,413	6.46	649.32
Austria-AT	13	0.40	18,281	0.67	0.60	75	8,162,656	9.19	210.01
Ireland-IE	5	0.15	7230	0.26	0.58	18	3,924,023	4.59	92.95
Japan-JP	125	3.82	220,810	8.05	0.47	878	127,357,744	6.89	4028.48
Luxembourg-LU	0	0.00	193	0.01	0.00	7	456,764	15.33	20.36
Portugal-PT	0	0.00	3734	0.14	0.00	19	10,479,955	1.81	113.16
World	3273	100.00	2,743,760	100.00					

[a] Indexed + not indexed in the Journal Citation Reports—JCR (Thomson Reuters).
[b] Calculated as the ratio between the relative contribution to global MM literature (%) and the relative contribution to global cancer literature (%).

3.6. Scientific production vis-à-vis population and GDP

To take into account differences in country population, the ratio between IF sum in 1987–2006 to resident population (average of the period expressed in millions of inhabitants) was calculated. This index, representing IF standardized by population size, showed a mean value of 1.04 for Australia, 0.80 for Switzerland, 0.57 for the US, and 0.40 for the EU. Standardized IF was particularly elevated in a few relatively small European countries: Finland first (2.49), followed by Sweden (1.42), Belgium (0.94), the Netherlands (0.80), Norway (0.66) and the UK (0.61) (Fig. 2).

To provide an evaluation of the research quality adjusted by different resources, we calculated the ratio between national IF and GDP (expressed in current billion US dollars). This parameter was particularly high for Australia (4.02), Turkey (2.43), Switzerland (1.95) and the US (1.85). In the EU (mean 1.65) the best performances were in Finland (9.76), Sweden (4.94), Belgium (3.58), the Netherlands (3.05) and the UK (2.50) (Fig. 2).

3.7. Comparison of scientific production with occurrence of MM and asbestos ban timing

A multivariate analysis was conducted to associate MM research output to the disease burden. As expected, the total number of publications was highly correlated with GDP ($p = 0.001$), but a statistically significant correlation was shown also with national MM mortality rates ($p = 0.002$). The specific statistics describing MM research commitment (relative to research on all cancers) is reported in Table 4.

Overall, Finland and the other Scandinavian countries, South Africa, Italy and Australia showed much stronger involvement in MM research than in other branches of cancer research. The presence of a correlation between MM research and MM mortality rates was tested through a multivariate model. A significant association between the country involvement in MM research and the burden of disease could be demonstrated after two outliers, Finland and South Africa, were removed from the model ($p = 0.04$; Fig. 3). GDP was neither a confounder nor a predictor of this association.

To evaluate whether the introduction of the asbestos ban stimulated (or depressed) the scientific interest in the field, a potential change in the scientific production trend for each country was tested comparing time periods before and after the ban. No association at all was found with this parameter (data not shown).

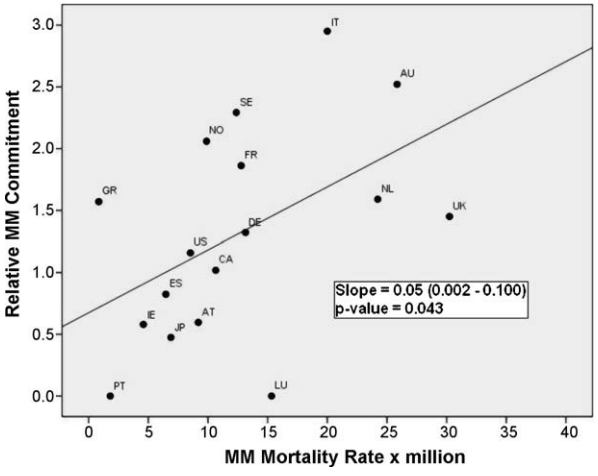

Fig. 3. Comparison of relative commitment to mesothelioma research with death rates from malignant mesothelioma (MM), by country.

4. Discussion

The number of scientific papers concerning MM increased regularly in the last 55 years, with a similar pace to that of the whole cancer literature. However, a deeper insight shows a number of up and down, which reflect changes of researchers attitude. For instance, the steeper increase in the 1960s and 1970s reflects scientific achievements of those years, when major epidemiological studies definitely assessed the causality and the specificity of the link between asbestos exposure and MM outspread. On the other hand, the lower publication rate in the 1990s could be attributable to a reduced interest of researchers, which considered the whole asbestos and MM issue of interest more for regulators than for scientists. In recent years the interest for new diagnostic tools, like serum mesothelin and other possible biomarkers [23], together with new therapeutic strategies [24] has fuelled again the interest of scientists, as shown by the high number and good quality of papers in the last few years. In addition, the role of genetic susceptibility and the possible interaction between asbestos and other causative agents have been the object of intense research [25–27].

The analytical part of the present study – focussed on indexed articles published between 1987 and 2006 – clearly identified two leading areas in mesothelioma research. In terms of number of papers, the EU has the leadership with 1187 papers, while the US has the highest mean IF (3.346 vs. 2.415). Overall, the EU and the US produced 84.6% of the total number of articles published on MM during this period. As regards the contribution of single countries, the UK, Italy, France ranked at the top three places for absolute number of papers in the EU, while among the non-EU countries (besides the US) those with the highest numbers of published papers were Australia (113), Japan (81) and Canada (73). Interestingly, the most important asbestos producers (Russia, China, Kazakhstan, Brazil, Zimbabwe, Colombia) except Canada, gave a very limited contribution to MM research, as recorded in the PubMed database (13 papers all together).

Most countries increased their scientific production during the years surveyed. Comparing the last biennium of the survey (2005–2006) to the first (1987–1988), a 177% increase was observed which – if compared with the corresponding value of 123.5% of total cancer literature – provides a quantitative figure of the increasing interest in this field.

The ranking among countries considerably changed when other endpoints, such as mean IF or IF sum, were considered, especially when this parameters were adjusted by the number of inhabitants or by GDP. For example, in the EU the UK, Belgium and the Netherlands ranked in the first positions for mean IF during the whole period 1987–1988 to 2005–2006.

Finland, Sweden, Australia and Belgium showed the highest scores when the sum of IF was standardized by population size or GDP. These results are attributable to the presence in these countries of single centers of excellence. In addition, these findings extend to MM research the common observation of many bibliometric studies, that small developed countries are often much more efficient in terms of scientific production [28,11,12,14,15].

The results of this study are in keeping with other analyses [8,29,30] which showed as most articles on respiratory medicine were published in the Europe.

The journal that published most papers on MM was Lung Cancer (4.50% of the articles). It is interesting to observe the interdisciplinary combination of journals. *Lung Cancer* and *Chest*, for example, are specialized for clinical or experimental research on respiratory diseases, but the list of first journals included also oncology, e.g., *Cancer*, *Cancer Res*, *Br J Cancer*; pathology, e.g., *Hum Pathol*, *Histopathology*, *J Pathol*; public health and occupational medicine, e.g., *Am J Ind Med*, *Occup Environ Med*, *Ann Occup Hyg*.

There has been increasing discussion whether research activity reflects the extent of disease occurrence in a country, and in particular if those countries where asbestos is a public health priority are more involved in MM research. Results showed that research in the field of MM is boosted mainly by the availability of experienced research facilities and economic resources, much alike of research in other biomedical sciences. However, local MM burden may have a role in driving scientific interest towards this specific research area.

A number of limitations affecting the study should be considered. First author affiliation may be misleading in attributing a study to a country. However, the present bibliometric research is based on large numbers, diluting the weight of international collaborative studies, which by the way often entail a rotation of the first author.

Another limitation is represented by the intrinsic inaccuracy of the measure used to describe the quality of scientific production. IF represents the average number of citations that a paper receives in the 2 years following publication. Clearly, this index does not give a score of the single article, but it is a journal average value, and may be severely influenced by the variation of scientific interests. This issue is currently the focus of a debate within research evaluators and funding agencies about the best methods for resources allocation [31–33]. Although citation frequency is generally considered the most reliable and suitable source of data for scientific production evaluation, ideally an exhaustive survey would combine different bibliometric indicators.

Furthermore, it should be considered that the PubMed database is biased in favour of journals published in English, therefore our survey likely penalized countries traditionally publishing in other languages, e.g., China, Japan and Russia.

Finally, in the present evaluation of the mesothelioma literature, basic science studies, epidemiological surveys, translational and clinical research, are pooled together, as well as academic and company-sponsored trials. This approach could be misleading, especially if the goal of the analysis is to understand priorities and to develop disease control policies. Unfortunately, this level of detail can be reached only reading single articles, a very expensive and time-consuming task that was out of the scope of the present paper. However, the percentage of clinical versus other research was calculated in a group of representative countries, i.e., UK, Italy, France, Finland, USA, Japan, South Africa, Turkey, Australia, using the keywords most likely associated to clinical trials. This analysis revealed that no major inter-country difference in the contribution of clinical trials to mesothelioma research existed (data not shown).

This report represents the first effort to explore the geographical distribution and temporal trends of MM research. These surveys offer a broad review of the existing data and help to gather impressions about the development of the field, including the visibility of single countries by the level of scientific production. This exercise is useful since it provides quantitative information about the knowledge growth, the geographical distribution of scientific excellence and, through the analysis of keywords, a ranking of the most successful topics. A descriptive analysis comparing nations enables a country to define its position respect to competitors and is an essential step in understanding science priorities and to develop disease control policies.

Conflict of interest statement

None declared.

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