

## Other Reviews

# A bibliometric study of scientific literature on obesity research in PubMed (1988–2007)

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## Summary

This article describes a bibliometric review of the publications on obesity research in PubMed over the last 20 years. We used Medline via the PubMed online service of the US National Library of Medicine from 1988 to 2007. The search strategy was: ([obesity] in MesH).

A total of 58 325 references were retrieved, 25.5% in 1988–1997, and 74.5% in 1998–2007. The growth in the number of publications showed an exponential increase. The references were published in 3613 different journals, with 20 journals contributing 25% of obesity literature. The two journals contributing most were the *International Journal of Obesity* (5.1%), *Obesity-Obesity Research* (2.9%). North America and Europe were the most productive world areas with 44.1% and 37.9% of the literature, respectively. The US was the predominant country in number of publications, followed by the United Kingdom, Japan and Italy. The ranking of production changed when the number of publications was normalized by population, gross domestic product and obesity prevalence by countries. The great increase of publications on obesity during the period 1988–2007 was particularly evident in the second decade of the period which is concordant with the worldwide obesity epidemic. USA and Europe were leaders in the production of scientific articles on obesity.

**Keywords:** Bibliometry, literature review, obesity, research.

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## Introduction

Obesity is considered a major risk factor for diabetes, cardiovascular disease, cancer and premature death (1,2). The prevalence of overweight and obesity has been rapidly increasing worldwide although the growth is faster in the less developed world (3). Overall, 23.2% of the world's adult population in 2005 were overweight, and 9.8% were obese (4). To what extent this alarming increase in obesity prevalence goes together with a literature production in the field is a question that remains open.

There are international bibliometric studies in other fields of medicine such as gastroenterology (5), infectious diseases (6), microbiology (7), otolaryngology (8), oncology (9), public health (10), respiratory medicine (11), surgery (12), and so on. Regarding obesity, there is indirect

evidence of an increase in the number of worldwide books and journal articles dealing with obesity in the seventies of the last century (13,14); there is also recent publications on obesity production in developing countries (15) and a mapping of the literature of dietetics (16) although we are not aware of recently published bibliometric analysis on obesity.

The aim of this study was to give an overview of obesity research using PubMed over a period of 20 years (1988 to 2007), and to explore to what extent scientific production parallels the so-called obesity epidemic.

## Methods

The Medline database via the PubMed was selected as the most suitable for references to obesity publications,

because of its ease of accessibility and wide use. PubMed was accessed online on 15 November 2008 (17), which allowed us to capture all publications of 2007. The search strategy was: ([obesity] in MeSH). The period of study was from 1988 to 2007 to match world development indicators. The subject content analysis of records was conducted according to the structure of the US national Library of Medicine's Medical Subject Headings (MeSH) thesaurus; thus, check tags, main headings and subheadings were also considered. The 'document type' was used to refer to the format of the publications and type of article. The impact factor of a journal was copied from *Journal Citation Report* (JCR) (18) in 2007. The accuracy of the address (and country) of first participating author of all publications was verified by two authors. Based on geographic, scientific and economic criteria, the world was divided into the seven regions of the World Bank (19): East Asia & Pacific, Europe & Central Asia, Latin America & Caribbean, Middle East & North Africa, North America, South Asia, and Sub-Saharan Africa.

In order to calculate the population index (publication per million inhabitants) and the gross domestic product (GDP) index (publication per 1 billion GDP \$) for both periods, 1988–1997 and 1998–2007, we used the national population data from the 'World Development Indicators 1997 and 2007' from the online data bases of the World Bank (19). We estimated the population index and GDP index for the whole study period from 1988 to 2007 as the mean of inhabitants and GDP for the two periods 1988–

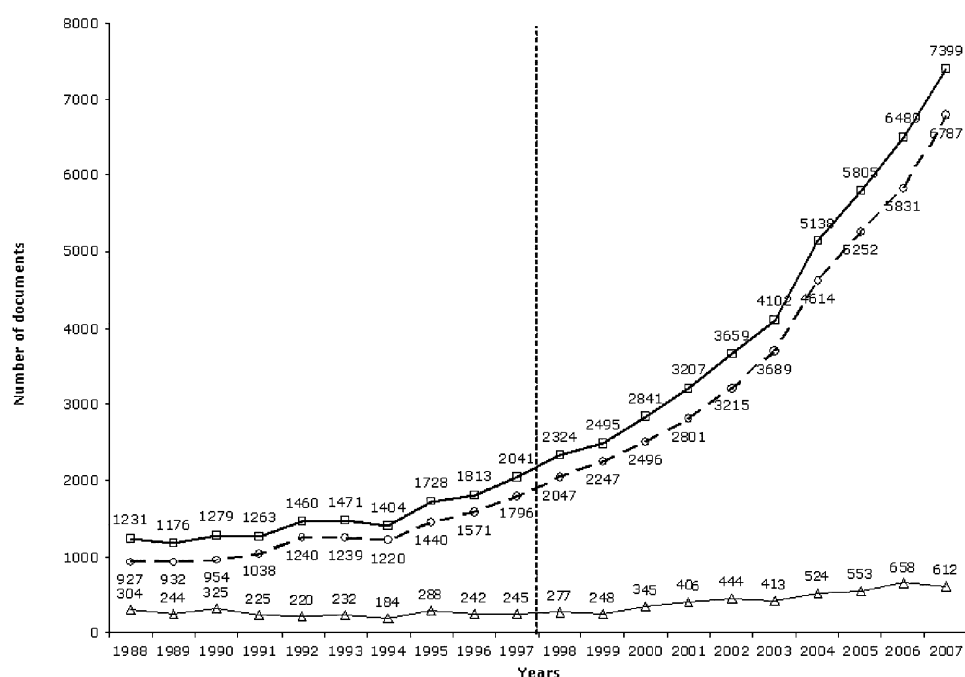
1997 and 1998–2007. In order to calculate the obesity index (publications per 100 000 obese people estimated in the country with a body mass index  $\geq 30$  kg m<sup>-2</sup>), we used the most recent data on prevalence of obesity from the WHO Global Body Mass Index Estimates (20).

## Statistical analysis

For the scientific literature search and the creation of the bibliographic database, we used Reference Manager (Version 12). Databases including all domains of every document were converted to Excel files to manage all the information and perform statistical analysis with SPSS (v. 16) and Stata (SE Version 10; StataCorp LP, College Station, TX, USA). Results were expressed as percentages. Linear regression analysis was used to explore the trend of publications (dependent variable) over time in years (independent variable). The number of publications was treated in two ways in the regression analysis, in its natural scale to explore linear trend, and after a natural-log transformation to explore the percentage of change by year and determine whether the increase of publications followed an exponential trend. All tests are two-sided and based on a 5% level of significance.

## Results

Figure 1 shows the numbers of PubMed publications on obesity research during the 20-year study period. We



**Figure 1** Number of obesity research publications in PubMed in all languages (□), in English (○) and in non-English (△) between 1988 and 2007.

retrieved 58 325 references for the whole study period, with 14 866 (25.5%) publications from 1988 to 1997, and 43 459 (74.5%) from 1998 to 2007. The absolute number of publications increased 501% from 1988 to 2007 (1231 vs. 7399). The yearly average increase of publications was 10.0% in the study period although this percentage was much higher in the second decade (+13.5%) than in the first (+5.7%). When the number of publications was fitted over time in linear regression analysis, a better fit was observed for an exponential curve (coefficient of determination for exponential fit,  $R^2 = 0.957$ ) than for a straight line ( $R^2 = 0.839$ ).

The predominant languages of the 30 different languages identified were English (88.0%), French (2.1%), German (1.7%), Spanish (1.6%) and Japanese (1.4%). The average annual growth of English language publications (+11.1%) was higher than that observed for non-English language publications (+6.0%) (Fig. 1).

The majority of documents retrieved in PubMed (96.2%;  $n = 56\,136$ ) were included in *Index Medicus* journals and 3.8% ( $n = 2189$ ) in journals or citation subset representing a specialized topics (non-*Index Medicus*). With respect to the object of research, 83.5% of documents referred to humans, 9.9% to animals, and 6.6% to both humans and animals. Regarding the type of documents, the most frequent type was 'journal articles' ( $n = 52\,869$ ; 90.6%); 'letters', 'editorials' and 'news' accounted for 4.6%, 2.8% and 1.2% respectively. Of the documents, 19.1% were 'reviews' and 12.1% were 'comparative studies'. Only 0.4% of the documents were 'meta-analyses' ( $n = 217$ ), 1.0% 'randomized controlled trials' ( $n = 584$ ) and 4.9% 'clinical trial' ( $n = 2835$ ). Research support was reported in 23 149 publications (39.7%). Concerning the main topics as defined by the sub-headings, we identified 83 different, not mutually exclusive topics, for indexing and cataloguing obesity manuscripts. The most frequent subheadings used, in descending order, were: 'complication', 'metabolism', 'blood', 'pathology', 'physiology', 'epidemiology', 'therapy' and 'physiopathology', all of them mentioned in between 20 and 30% of the articles.

Most of the documents were published in 3613 printed journals although a few (6.8%) were published in electronic journals. Table 1 presents a list of the 61 journals with the highest number of papers published on obesity during the years 1988–2007, as well as their impact factors for the year 2007, language and subject category according to the JCR classification. Four of these journals were not included in the JCR, three were published in languages other than English and one English journal had only recently been set up. The first 20 journals of the list published approximately 25% of the literature on obesity, and 137 journals accounted for about half of the literature. There were 950 journals with only one document published on obesity. The principal subject categories of the top 61

journals were 'Endocrinology & metabolism' ( $n = 18$ ), 'Nutrition & dietetics' ( $n = 13$ ), 'Medicine general & internal' ( $n = 6$ ), 'Peripheral vascular diseases' ( $n = 5$ ) and 'Public environmental & occupational health' ( $n = 4$ ).

The institutional address of the first author of the publication was reported in 85.9% of documents ( $n = 50\,120$ ), all of them 'journal articles' and 'reviews'. Thus, we were able to classify the production of obesity publications by World region for the whole of the study period, 1988–2007 (Table 2). The three most productive areas in absolute terms were North America (44.1%), Europe & Central Asia (37.9%), and East Asia & Pacific (11.8%). However, the relative contribution of the two most productive areas felt slightly from the first (46.1% and 39.3%, respectively) to the second period (43.4% and 37.4%). When production was normalized by population, GDP and obesity index, the same ranking was observed except for East Asia & Pacific which was ranked fourth after Latin America and Caribbean countries when publications were normalized by population. Figure 2 shows the trends on obesity research production by World regions over the 20-year study period. The largest mean yearly growth rates were observed for South Asia (+57.7), Latin America (+31.1), Sub-Saharan Africa (+23.6), Middle East (+19.9) and East Asia (+19.5), while North America and Europe showed the lowest mean yearly growth rates (+11.1 and +11.7, respectively). North America published more articles than Europe, particularly from 2002.

Concerning the country of publication, 128 countries were identified. Table 3 shows the top 30 countries in terms of absolute production, and relative production to the number of inhabitants, GDP and estimated obesity cases. The USA was the most productive country with more than 40% of publications on obesity. Other leading countries in total number of publications were United Kingdom, Japan, Italy and France which accounted for an additional 20% of publications. Overall, 30 countries contributed 96.0% of production.

When normalized by population, the most productive countries were Sweden, Denmark, Finland and Switzerland with more than 100 publications per million inhabitants. Normalized by GDP, we found that the Gambia was the most productive country, followed by Sweden, Finland and Israel. Considering the magnitude of prevalence of obesity, Denmark, Sweden, Japan and Singapore were the four most productive countries.

## Discussion

This study has shown an exponential increase in the number of publications on obesity research over the period 1988–2007. The increase in obesity publications seems to be more pronounced than that observed in other fields (6,21) probably related to the health consequences and the

**Table 1** Ranking of the journals ( $n = 61$ ) with the highest number of obesity documents published during the period 1988–2007, their impact factors for the year 2007, language, journal category from the *Journal Citation Report* and period of publication

| Journals                                                            | No. articles | %   | Impact factor 2007 | Lan* | Journal category                                                        | Period of publication           |
|---------------------------------------------------------------------|--------------|-----|--------------------|------|-------------------------------------------------------------------------|---------------------------------|
| <i>International Journal of Obesity</i>                             | 3020         | 5.1 | 3.560              | Eng  | Endocrinology & metabolism/nutrition & dietetics                        | 1977–1991<br>1992–2003<br>2004– |
| <i>Obesity (Previously Obesity research)</i>                        | 1662         | 2.9 | 1.520 (4.953)      | Eng  | Endocrinology & metabolism<br>Nutrition & dietetics                     | 1993–2005<br>2006–              |
| <i>Obesity Surgery</i>                                              | 1392         | 2.4 | 2.852              | Eng  | Surgery                                                                 | 1991–                           |
| <i>American Journal of Clinical Nutrition</i>                       | 1018         | 1.7 | 6.603              | Eng  | Nutrition & dietetics                                                   | 1954–                           |
| <i>Journal of Clinical Endocrinology &amp; Metabolism</i>           | 929          | 1.6 | 5.493              | Eng  | Endocrinology & metabolism                                              | 1952–                           |
| <i>Diabetes</i>                                                     | 689          | 1.2 | 8.261              | Eng  | Endocrinology & metabolism                                              | 1952                            |
| <i>Metabolism: Clinical and Experimental</i>                        | 656          | 1.1 | 2.647              | Eng  | Endocrinology & metabolism                                              | 1952–                           |
| <i>Diabetes Care</i>                                                | 640          | 1.1 | 7.851              | Eng  | Endocrinology & metabolism                                              | 1978–                           |
| <i>American Journal of Physiology. Endocrinology and Metabolism</i> | 632          | 1.1 | 4.138              | Eng  | Endocrinology & metabolism/physiology                                   | 1980–1999<br>2000–              |
| <i>Journal of the American Dietetic Association</i>                 | 565          | 1.0 | 3.011              | Eng  | Nutrition & dietetics                                                   | 1925–                           |
| <i>Diabetologia</i>                                                 | 392          | 0.7 | 5.822              | Eng  | Endocrinology & metabolism                                              | 1965–                           |
| <i>Nippon rinsho. Japanese Journal of Clinical Medicine</i>         | 375          | 0.6 | NI                 | Jap  |                                                                         | 1943–                           |
| <i>Lancet</i>                                                       | 333          | 0.6 | 28.638             | Eng  | Medicine, general & internal                                            | 1823–                           |
| <i>European Journal of Clinical Nutrition</i>                       | 330          | 0.6 | 2.326              | Eng  | Nutrition & dietetics                                                   | 1988–                           |
| <i>Endocrinology</i>                                                | 329          | 0.6 | 5.045              | Eng  | Endocrinology & metabolism                                              | 1917–                           |
| <i>New England Journal of Medicine</i>                              | 318          | 0.5 | 52.589             | Eng  | Medicine, general & internal                                            | 1928–                           |
| <i>Journal of the American Medical Association</i>                  | 317          | 0.5 | 25.547             | Eng  | Medicine, general & internal                                            | 1960–                           |
| <i>British medical journal</i>                                      | 301          | 0.5 | 9.723              | Eng  | Medicine, general & internal                                            | 1852–                           |
| <i>Circulation</i>                                                  | 299          | 0.5 | 12.755             | Eng  | Cardiac & cardiovascular systems/hematology/peripheral vascular disease | 1950–                           |
| <i>Obesity Reviews</i>                                              | 296          | 0.5 | 7.821              | Eng  | Endocrinology & metabolism                                              | 2000–                           |
| <i>Journal of Nutrition</i>                                         | 291          | 0.5 | 3.771              | Eng  | Nutrition & dietetics                                                   | 1928–                           |
| <i>Diabetes Research and Clinical Practice</i>                      | 269          | 0.5 | 1.823              | Eng  | Endocrinology & metabolism                                              | 1985–                           |
| <i>Hypertension</i>                                                 | 263          | 0.5 | 7.194              | Eng  | Peripheral vascular disease                                             | 1979–                           |
| <i>American Journal of Epidemiology</i>                             | 248          | 0.4 | 5.285              | Eng  | Public, environmental & occupational health                             | 1964–                           |
| <i>Pediatrics</i>                                                   | 246          | 0.4 | 4.473              | Eng  | Pediatrics                                                              | 1948–                           |
| <i>Surgery for Obesity and Related Diseases</i>                     | 234          | 0.4 | NI                 | Eng  |                                                                         | 2005                            |
| <i>American Journal of Public Health</i>                            | 218          | 0.4 | 3.612              | Eng  | Public, environmental & occupational health                             | 1971–                           |
| <i>Journal of Pediatrics</i>                                        | 215          | 0.4 | 4.017              | Eng  | Pediatrics                                                              | 1932                            |
| <i>Hormone and Metabolic Research</i>                               | 215          | 0.4 | 2.254              | Eng  | Endocrinology & metabolism                                              | 1961–                           |
| <i>Clinical Endocrinology</i>                                       | 207          | 0.4 | 3.370              | Eng  | Endocrinology & metabolism                                              | 1972–                           |
| <i>Journal of Clinical Investigation</i>                            | 202          | 0.3 | 16.915             | Eng  | Medicine, research & experimental                                       | 1924–                           |

Table 1 Continued

| Journals                                                                                  | No. articles | %   | Impact factor 2007 | Lan* | Journal category                                                         | Period of publication |
|-------------------------------------------------------------------------------------------|--------------|-----|--------------------|------|--------------------------------------------------------------------------|-----------------------|
| <i>Nutrition</i>                                                                          | 201          | 0.3 | 2.104              | Eng  | Nutrition & dietetics                                                    | 1987–                 |
| <i>Preventive Medicine</i>                                                                | 200          | 0.3 | 2.314              | Eng  | Public, environmental & occupational health/medicine, general & internal | 1972–                 |
| <i>Journal of Endocrinological Investigation</i>                                          | 198          | 0.3 | 2.021              | Eng  | Endocrinology & metabolism                                               | 1978–                 |
| <i>Public Health Nutrition</i>                                                            | 198          | 0.3 | 1.858              | Eng  | Public, environmental & occupational health/Nutrition & dietetics        | 1998–                 |
| <i>International Journal of Eating Disorders</i>                                          | 192          | 0.3 | 2.269              | Eng  | Nutrition & dietetics/psychiatry/psychology                              | 1981–                 |
| <i>Biochemical and Biophysical Research Communications</i>                                | 190          | 0.3 | 2.749              | Eng  | Biochemistry & molecular biology/biophysics                              | 1959–                 |
| <i>Surgical Endoscopy</i>                                                                 | 190          | 0.3 | 2.242              | Eng  | Surgery                                                                  | 1987–                 |
| <i>Annals of the New York Academy of Sciences</i>                                         | 190          | 0.3 | 1.731              | Eng  | Multidisciplinary sciences                                               | 1877–                 |
| <i>Ugeskrift for Laeger</i>                                                               | 186          | 0.3 | NI                 | Dan  |                                                                          | 1839–                 |
| <i>American Journal of Cardiology</i>                                                     | 185          | 0.3 | 3.603              | Eng  | Cardiac & cardiovascular systems                                         | 1958                  |
| <i>British journal of nutrition</i>                                                       | 182          | 0.3 | 2.339              | Eng  | Nutrition & dietetics                                                    | 1947–                 |
| <i>European journal of endocrinology</i>                                                  | 181          | 0.3 | 3.239              | Eng  | Endocrinology & metabolism                                               | 1994–                 |
| <i>Archives of Internal Medicine</i>                                                      | 180          | 0.3 | 8.391              | Eng  | Medicine, general & internal                                             | 1960–                 |
| <i>Diabetes, Obesity &amp; Metabolism</i>                                                 | 179          | 0.3 | 3.441              | Eng  | Endocrinology & metabolism                                               | 1999–                 |
| <i>Diabetic Medicine</i>                                                                  | 179          | 0.3 | 2.970              | Eng  | Endocrinology & metabolism                                               | 1984–                 |
| <i>Nutrition Reviews</i>                                                                  | 175          | 0.3 | 2.860              | Eng  | Nutrition & dietetics                                                    |                       |
| <i>Atherosclerosis</i>                                                                    | 172          | 0.3 | 4.287              | Eng  | Peripheral vascular disease                                              | 1970–                 |
| <i>MMW Fortschritte der Medizin</i>                                                       | 168          | 0.3 | NI                 | Ger  |                                                                          | 1999–                 |
| <i>Appetite</i>                                                                           | 167          | 0.3 | 1.929              | Eng  | Behavioral sciences/nutrition & dietetics                                | 1980–                 |
| <i>Chest</i>                                                                              | 163          | 0.3 | 4.143              | Eng  | Respiratory system                                                       | 1970–                 |
| <i>Proceedings of the Nutrition Society</i>                                               | 163          | 0.3 | 3.931              | Eng  | Nutrition & dietetics                                                    | 1944                  |
| <i>American Journal of Physiology. Regulatory, Integrative and Comparative Physiology</i> | 161          | 0.3 | 3.661              | Eng  | Physiology                                                               | 1977–                 |
| <i>American Journal of Medical Genetics. Part A</i>                                       | 158          | 0.3 | 2.440              | Eng  | Genetics & heredity                                                      | 1977–2002             |
| <i>Medicine and Science in Sports and Exercise</i>                                        | 156          | 0.3 | 2.864              | Eng  | Sport sciences                                                           | 2003–                 |
| <i>Physiology &amp; Behavior</i>                                                          | 150          | 0.3 | 2.561              | Eng  | Behavioral sciences                                                      | 1980–                 |
| <i>Ethnicity &amp; Disease</i>                                                            | 149          | 0.3 | 0.744              | Eng  | Public, environmental & occupational health                              | 1966–                 |
| <i>Journal of Pediatric Endocrinology &amp; Metabolism</i>                                | 147          | 0.3 | 0.858              | Eng  | Endocrinology & metabolism pediatrics                                    | 1991–                 |
| <i>Proceedings of the National Academy of Sciences of the United States of America</i>    | 146          | 0.3 | 9.598              | Eng  | Multidisciplinary sciences                                               | 1995                  |
| <i>Journal of Hypertension</i>                                                            | 142          | 0.2 | 4.364              | Eng  | Peripheral vascular diseases                                             | 1915–                 |
| <i>Journal of the American College of Nutrition</i>                                       | 142          | 0.2 | 2.276              | Eng  | Nutrition & dietetics                                                    | 1983–                 |

\*Language: Eng: English; Jap: Japanese; Dan: Danish; Ger: German; NI: not included.

**Table 2** Research output of different world regions in 50 120 obesity manuscripts with institutional address of the first author published during the period 1988–2007

| World areas                | 1988–2007    |      |                   |            | 1988–1997      |              |      |                   | 1998–2007  |              |      |                   |
|----------------------------|--------------|------|-------------------|------------|----------------|--------------|------|-------------------|------------|--------------|------|-------------------|
|                            | No. Articles | %    | Population index* | GDP index† | Obesity index‡ | No. Articles | %    | Population index* | GDP index† | No. Articles | %    | Population index* |
| North America              | 22 103       | 44.1 | 69.35             | 1.83       | 17.64          | 5783         | 46.1 | 19.10             | 0.65       | 16 320       | 43.4 | 48.76             |
| Europe & Central Asia      | 18 975       | 37.9 | 21.84             | 1.26       | 13.43          | 4931         | 39.3 | 5.74              | 0.48       | 14 044       | 37.4 | 15.97             |
| East Asia & Pacific        | 5 914        | 11.8 | 2.89              | 0.65       | 11.69          | 1301         | 10.4 | 0.66              | 0.18       | 4613         | 12.3 | 2.16              |
| Latin America & Caribbean  | 1 573        | 3.1  | 2.96              | 0.57       | 1.40           | 195          | 1.6  | 0.39              | 0.09       | 1378         | 3.7  | 2.42              |
| Middle East & North Africa | 929          | 1.8  | 2.88              | 0.76       | 1.30           | 186          | 1.5  | 0.63              | 0.24       | 743          | 2.0  | 2.12              |
| South Asia                 | 382          | 0.8  | 0.27              | 0.39       | 2.09           | 72           | 0.6  | 0.05              | 0.13       | 310          | 0.8  | 0.21              |
| Sub-Saharan Africa         | 244          | 0.5  | 0.33              | 0.40       | 0.79           | 79           | 0.6  | 0.12              | 0.21       | 165          | 0.4  | 0.20              |

\*Number of publications per million population.

†Number of publications per 1 billion US dollars of gross domestic product (GDP).

‡Number of publications per 100 000 patients estimated with obesity.

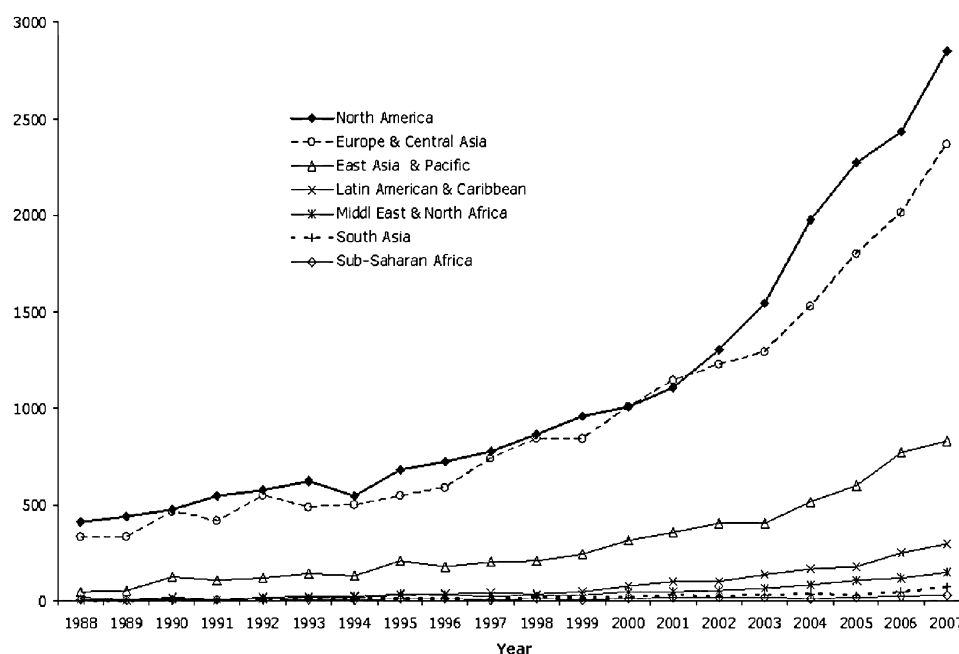
rapidly increasing worldwide prevalence of obesity both in industrialized countries and in developing countries (1,3,4,15,22). The appearance of new journals in the field in PubMed may have contributed to this increase.

The main language of obesity research was English. The number of publications in other languages (not English) was 12%; this percentage is similar to other bibliometric studies based on PubMed (23,24), lower than others (22%) (21), and higher than that observed in other studies based on the *Science Citation Index* (11). Journal articles were the most commonly retrieved document type, accounting for 90% of the total. Although randomized controlled trials offer the best evidence for the efficacy of medical interventions (24), in this study they represented only 1.0% of documents.

The nucleus journals (those with high productivity) usually contain the articles with the highest impact in their respective areas (9), and thus, subscriptions to such journals in indexing and abstracting services would be justified scientifically (24). Most top journals publishing in obesity are from the subject categories 'Endocrinology & metabolism' and 'Nutrition & dietetics'. The main sub-headings reported in obesity articles may indicate the major areas of interest in obesity research, although the title were of very broad scope and not mutually exclusive. From the 61 top journals, there were only four containing 'obesity' in the title of the journal: the *International Journal of Obesity*, *Obesity Surgery*, *Obesity* and *Obesity Reviews*. It is to note that four of the 61 top journals had no impact factor in the JCR and three of them were non-English publications (Japanese, Danish and German), publishing in the field for a long time.

North America and Europe are the World's leading areas in scientific production on obesity. The above finding is unsurprising given the long tradition of agencies and institutions of the US (25), Canada (26) and West European countries (27), in implementing research and health programmes. The contribution of all different geographic areas of the World increased over the study period although our data show that the relative contribution of North America and Europe with respect to the other areas fell in the second half of the study period. The relative decline of North America in obesity research is lower than that found in other medical disciplines such as 'tuberculosis' (21), 'infectious diseases' (6) or 'respiratory medicine' (11). On the other hand, the contribution of the developing world in obesity research productivity was rather disappointing although this has also been observed for all biomedical publications (28), and in other specific biomedical fields (7,11,21,29). The relative contribution of Asia increased in the second half of the study period similar to the growth in scientific production in other fields such as 'oncology' (9) or 'respiratory medicine' (11). These results may be explained by the fact that the economies of these regions, especially China, Korea, and Thailand have substantially improved.





**Figure 2** Number of obesity research publications in PubMed between 1988 and 2007 by worldwide geographic areas.

However, other areas with high prevalence of obesity such as the Middle East & North Africa showed low production compared with other countries of similar economic condition (30).

Our results should be a call for the developed countries to give support and promote research efforts to the developing areas of the World now facing increasing prevalence of obesity, especially Latin America and Middle East & North Africa. Thus, it has been suggested that the developed countries should support the research infrastructure in developing countries (31), and to create networks of scientists in developed and developing countries (21,28,31).

When analysing the research production of different countries, the US was the leading country in publication output in obesity as has also been described in more than 20 different fields of the literature (10,12,32); the prevalence of obesity and the available resources for research would justify this position in the ranking. Noteworthy was the fact that Sweden, Finland and Denmark produced more scientific research than other countries when an adjustment was made for population, GDP and estimated cases of obesity. The Nordic countries appear to have the highest output in other fields of research per capita (10,23). Moreover, Japan, Singapore, Switzerland and other West European countries were among the most productive countries although they did not present the highest prevalence of obesity. Some small countries of the Pacific Islands such as Nauru, Tonga or Micronesia, with the highest prevalence of obesity, had a small obesity research production even when they were standardized by obesity index; the excep-

tion was Vanuatu, a country with a low GDP made and a relatively important effort in the field of obesity. When research production was normalized by GDP, the Gambia, a country with a very low GDP and prevalence of obesity, became the most productive country.

Medline via PubMed and the Science Citation Index were found to be the most suitable databases for searching and retrieving references for bibliometric studies (30). We used the Medline via PubMed database. However, the method we used may have several limitations. For example, the database mainly includes journals published in English, and the countries with journals in their native language are less likely to be found on PubMed. Another limitation is that in PubMed only the address of the first author appears in the journal articles; whereas in 'letters' and 'editorials' the address field is not recorded. Moreover, it was not possible to estimate the quantity of articles that resulted from multinational collaborations. This may cause some problems when estimating research productivity in developing countries such as those from Latin America, Africa and Middle East. Furthermore, the search system was not able to retrieve the addresses of all the manuscripts. The accuracy of the address of the first author in PubMed is lower than in the Web of Science databases (*Science Citation Index*, *Social Science Citation Index*, and *Arts & Humanities Citation Index*) (10). Even though the bibliometric methodology used may present some limitations and the results could, in some way, be biased (32), we believe that this study represents a useful tool for scientists and public health policy makers in planning and organizing

**Table 3** Top 30 countries ranked according to total number of publications, publications per inhabitant, per gross domestic product (GDP) and estimated cases of obesity in 50 120 obesity manuscripts with institutional address of the first author published during the period 1988-2007

| Country        | No. Articles | %    | Country           | Population index* | Country              | GDP index† | Country        | Obesity index‡ |
|----------------|--------------|------|-------------------|-------------------|----------------------|------------|----------------|----------------|
| United States  | 20 294       | 40.5 | Sweden            | 155.02            | Gambia, The          | 7.60       | Denmark        | 156.66         |
| United Kingdom | 3 205        | 6.4  | Denmark           | 140.91            | Sweden               | 4.02       | Sweden         | 134.35         |
| Japan          | 2 609        | 5.2  | Finland           | 119.67            | Finland              | 3.38       | Japan          | 123.75         |
| Italy          | 2 520        | 5.0  | Switzerland       | 100.15            | Israel               | 3.21       | Singapore      | 99.83          |
| France         | 1 940        | 3.9  | Australia         | 75.48             | Denmark              | 3.16       | Finland        | 64.30          |
| Germany        | 1 826        | 3.6  | United States     | 70.68             | Vanuatu              | 2.83       | Switzerland    | 62.43          |
| Canada         | 1 809        | 3.6  | Israel            | 66.57             | Serbia               | 2.68       | Netherlands    | 53.52          |
| Australia      | 1 492        | 3.0  | Netherlands       | 60.02             | Czech Republic       | 2.63       | Belgium        | 46.07          |
| Spain          | 1 407        | 2.8  | New Zealand       | 57.93             | Poland               | 2.50       | France         | 43.67          |
| Sweden         | 1 395        | 2.8  | Canada            | 57.46             | Jamaica              | 2.42       | Norway         | 41.65          |
| Netherlands    | 960          | 1.9  | Iceland           | 54.89             | New Zealand          | 2.40       | Italy          | 33.29          |
| Brazil         | 821          | 1.6  | United Kingdom    | 53.71             | Australia            | 2.39       | Israel         | 29.81          |
| Denmark        | 757          | 1.5  | Belgium           | 53.64             | Switzerland          | 2.16       | Australia      | 29.15          |
| Switzerland    | 733          | 1.5  | Austria           | 47.03             | Tunisia              | 1.97       | Iceland        | 25.79          |
| Poland         | 721          | 1.4  | Norway            | 44.33             | Lebanon              | 1.92       | Canada         | 23.34          |
| China          | 648          | 1.3  | Italy             | 43.35             | Canada               | 1.84       | United Kingdom | 22.93          |
| Finland        | 624          | 1.2  | Spain             | 33.32             | United States        | 1.84       | Austria        | 22.14          |
| Belgium        | 558          | 1.1  | France            | 32.36             | Hungary              | 1.82       | Eritrea        | 20.65          |
| Israel         | 433          | 0.9  | Czech Republic    | 28.68             | Netherlands          | 1.68       | New Zealand    | 20.14          |
| Korea, Rep.    | 394          | 0.8  | Greece            | 27.49             | Bosnia & Herzegovina | 1.68       | Sri Lanka      | 20.06          |
| Austria        | 383          | 0.8  | Bahrain           | 26.46             | Bahrain              | 1.61       | Spain          | 19.97          |
| Turkey         | 383          | 0.8  | Germany           | 22.22             | Belgium              | 1.60       | United States  | 17.27          |
| Mexico         | 350          | 0.7  | Kuwait            | 21.54             | United Kingdom       | 1.58       | Ireland        | 17.00          |
| India          | 332          | 0.7  | Japan             | 20.55             | Trinidad and Tobago  | 1.56       | Gambia, The    | 16.74          |
| Taiwan         | 308          | 0.6  | Poland            | 18.80             | Italy                | 1.53       | Czech Republic | 14.61          |
| Greece         | 302          | 0.6  | Ireland           | 17.91             | Fiji                 | 1.45       | Poland         | 12.26          |
| Czech Republic | 296          | 0.6  | Singapore         | 16.94             | Spain                | 1.41       | Korea, Rep.    | 11.43          |
| New Zealand    | 232          | 0.5  | Hungary           | 16.42             | Chile                | 1.31       | Germany        | 10.75          |
| Norway         | 202          | 0.4  | Trinidad & Tobago | 15.28             | Austria              | 1.31       | Hungary        | 10.41          |
| Hungary        | 167          | 0.3  | Qatar             | 12.96             | Antigua and Barbuda  | 1.25       | Greece         | 10.34          |

\*Number of publications per million population.

†Number of publications per 1 billion US dollars of gross domestic product (GDP).

‡Number of publications per 100 000 estimated cases of obesity.



research in the field of obesity. We should emphasize that the method we used to find research production has been used by other authors and our results may be comparable with others in the future.

In conclusion, we have found a great increase in the number of publications in the field of obesity over the period 1988–2007, and particularly in the second decade (1998–2007), in all likelihood as a result of the worldwide obesity epidemic. The US, a country with a very high prevalence of obesity, led scientific production on obesity research. Several countries from the North West of Europe, with a not very high prevalence of obesity were main producers after adjusting for economic and population indexes. Efforts should be made to help developing countries with the highest prevalence of obesity such as in Latin America and North Africa, to come to terms with this problem.

### Conflict of Interest Statement

The authors declare no conflict of interest.

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