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Global obesity research trends during 1999 to 2017

A bibliometric analysis

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Abstract

Background: The interest in obesity has considerably increased in the scientific community in the last 2 decades. We present a bibliometric analysis to find out the future research hotspot and trends of obesity.

Methods: Data were based on the Science Citation Index Expanded (SCI-E), from the Institute of Scientific Information Web of Science database and the 5-year impact factor of a journal were issued from the Journal Citation Reports (JCR) in 2017. Articles referring to obesity during 1999 to 2017 were concentrated on the analysis by scientific output characters and the frequency of author keywords used.

Results: Globally, 50,246 articles meet the inclusion criteria during 1999 to 2017. The cumulative number of publication about obesity followed exponential distribution ($R^2 = 0.9974$) from 2008. USA was the most productive countries in both independent and international collaborative papers, the countries/regions with the highest average Times Cited scores for independent articles was France and The United Kingdom scored the highest in average Times Cited for international collaborative papers. Collaboration among countries, playing an ever-growing role in contemporary scientific research. The 2 most prolific journals are Obesity Surgery and International Journal of Obesity, responsible for 3.95% of the publication.

Conclusion: Obesity has been a field of intense research in the last 19 years. By reasonably analyzing the author keywords and the distribution of journals, "bariatric surgery" (especially "sleeve gastrectomy") and "obese complications" (especially "diabetes mellitus," "metabolic syndrome," "depression," and "polycystic ovary syndrome") will undoubtedly maintain the hotspots of obesity research in the next few decades.

Abbreviations: % = the percentage of the author keyword, ↑ = percentage went up significantly over time, ↓ = percentage went down significantly over time, Av. NR = the average cited reference count per article, Av. PG = the average page count per article, Av. TC = average number of Times Cited per article, CP = the number of international collaborative articles, CP/TP = the percentage of international collaborative publications in total publications, IF = 5-year impact factor, IP = the number of independent articles, No. A = annual number of articles, No. Cr = the number of countries participated in obesity research, P = publications in the study period, Pal = participation index, QR = quartile rank, R = the rank of the author keyword, TC = Times Cited, TP = total articles.

Keywords: bariatric surgery, bibliometric analysis, obesity, research trends

1. Introduction

Obesity is a long-standing metabolic disorder caused by multiple factors, which can be traced back to 25,000 years ago, the earliest recorded in the Paleolithic statue.[1] Now obesity has become one of the key causes of public health, with the rapid development of the global economy, the improvement of people's living standards, coupled with unreasonable dietary structure, bad lifestyle, etc. Data from the World Health Organization[2] show that about 200 million men and nearly 300 million women are obese in 2008. According to a report[3] in the JAMA Journal of Internal Medicine, more than two-thirds of people in the United States are overweight or obese. In 2013, the American Medical Association[4] made it clear that obesity should not only be considered a disease risk factor, but also a real disease state. With the epidemics of obesity and obesity-related diseases, research on obesity is more and more popular. In this paper, we focus on summarizing the global research trends of obesity studies.

Over the past decades, the interest of bibliometric information in quantitative analysis for a given topic, and acquiring statistics to evaluate the contribution of scientific publications to the advancement of knowledge increased, especially in the medical research fields.[5–7] Mela and Cimmino[8] evaluate the distribution and scope of papers published by the European Union (EU) in rheumatological journals and the impact of rheumatological research in the EU in comparison with that produced elsewhere. Scientific publications indeed represent current research trends and can be used to identify the focus of present, past, or future

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research.[9] However, conventional bibliometric analysis in medical research has 2 inherent deficiencies: on the one hand, datasets used in analysis are incomplete. For instance, some studies only select several journals or categories to represent global research trends related to the topic[8,10]; on the other hand, citations or publication counts of countries and organizations, which are widely used in conventional bibliometric analysis, cannot comprehensively reveal the trend in a research field.[11] More information, which is closer to the research itself, such as source title, author keyword, and abstracts should be introduced in the study of research trend.

This paper presents alternative statistical methods in bibliometric analysis. Both citation and author keywords analyses in the Scientific Citation Index database were used to describe the global trends of obesity research during the period of 1999 to 2017. We attempted to provide all-around insights into the current state of global obesity research, including annual outputs characters, international collaborations, and author keywords analyses. Results provide a better understanding of trends in global obesity research and point to the direction for further studies.

2. Materials and methods

This study protocol was approved by the ethics committee of our college. Documents considered in this study come from Web of Science, published by the Institute for Scientific Information (ISI) in Philadelphia, USA. The ISI database provides a readily available and comprehensive data source for bibliometric analysis. Rodrigues et al[12] used a bibliometric indicator to map the Brazilian cancer, cardiovascular and malaria research areas from 1981 to 1995. They reported that the ISI databases can produce reliable performance indicators for the mapping of scientific capabilities and for monitoring scientific capabilities and activity in Brazil in the health-related areas. We do not use the Medline database, because it does not record all the address listed on a paper, but only that of the first author. Therefore, some authors are not always found and the articles retrieved are limited to those where country appears in at least one of the Medline search fields (address, title, abstract, etc.). Moreover, Medline does not provide information concerning citations of publications, while the performance of the articles can hardly be exhibited. One mesh term "obesity" already checked in PubMed mesh database was used to conduct searching titles, abstracts, and author keywords from 1999 to 2017. Our search formula was "TS = ("obese" or "obesity"), Databases = SCI-E, Time span = 1999–2017." Articles originating from England, Scotland, Northern Ireland, and Wales were categorized as being from the United Kingdom. The collaboration type was determined based on the address of each author, with the term "independent article" being assigned if the addresses of the researchers were only in 1 country. Articles were labeled as "international collaborative article," if they are co-signed by researchers from multiple countries.

This searching strategy located 62,943 publications on obesity in the SCI database, including 20 documents types. Because journal articles and the language of English represented the majority of publications and were of high quality due to rigorous peer-review processes, we thus focused on articles and proceedings papers written in English (50,246 papers in total) in the following analysis.

3. Results and discussions

3.1. Scientific outputs

Several publication outputs characters of current obesity research during the time span of 1999 through 2017 was summarized in Table 1. The length of the article fluctuates slightly, with an average of 7.5 pages. The number of references cited has increased slightly through the 19 years, with an average of 28 references in 1999 and 37 in 2017. Times Cited (TC) for an article is highly negatively correlated with the length of time since its publication. The number of published articles on obesity has increased significantly over the past decades, from 404 in 1999 to 6456 in 2017.

Table 1

Articles' characteristics by year of obesity research articles from 1999 to 2017.

Years	No. A	Av. NR	Av. TC	AV. PG	No. Cr
1999	404	28.0	43.8	7.0	44
2000	1096	28.8	43.9	6.9	61
2001	1098	28.7	48.4	6.7	62
2002	1178	29.7	40.8	7.1	61
2003	1115	29.9	44.6	7.0	60
2004	1213	31.0	45.4	7.3	59
2005	1292	30.7	48.4	7.0	59
2006	1452	30.6	46.4	7.0	69
2007	1731	30.9	35.0	7.1	73
2008	2110	31.9	29.3	7.4	71
2009	2540	31.0	26.2	7.3	79
2010	2807	32.5	22.6	7.5	79
2011	3194	33.0	18.3	7.6	80
2012	3664	34.3	16.8	7.8	86
2013	3993	35.6	11.9	8.0	91
2014	4543	35.5	9.2	8.1	89
2015	4998	36.2	7.1	8.2	95
2016	5362	37.5	5.5	8.6	103
2017	6456	37.4	2.4	8.7	112
Total	50,246	–	–	–	153
Average	2644.5	32.3	28.7	7.5	–

Av. NR = the average cited reference count per article, Av. PG = the average page count per article, Av. TC = average number of Times Cited per article, No. A = annual number of articles, No. Cr = the number of countries participated in obesity research.

$$Y = 1244.5X - 1100.6 \quad (1999 - 2007) \tag{1}$$

$$Y = 2889.6e^{0.152X} \quad (2008 - 2017) \tag{2}$$

For further study, a significant correlation was found between the yearly cumulative number of publications and the year from 1999 to 2017 (Fig. 1). In this study period, the growth of cumulative publication number followed a linear trend before 2006, while this figure had increased exponentially in the last decade, which can be expressed as follows: where Y is the number of publication, X denotes the corresponding year, and e is the Napier's constant. Due to the high coefficients of determination of both Eq. (1) ($R^2 = 0.9948$) and Eq. (2) ($R^2 = 0.9974$), the world publications related to obesity research could be estimated using this model. It can be predicted that the number of scientific articles on the topic of obesity is still growing at a high rate in the future. Moreover, it can be calculated that, by the time of 2022, the number of scientific articles on the topic of obesity will be twice of the number of publications in 2017.

3.2. Collaboration type

The mainstream of participation and collaboration on obesity research was obtained after analyzing all the countries producing

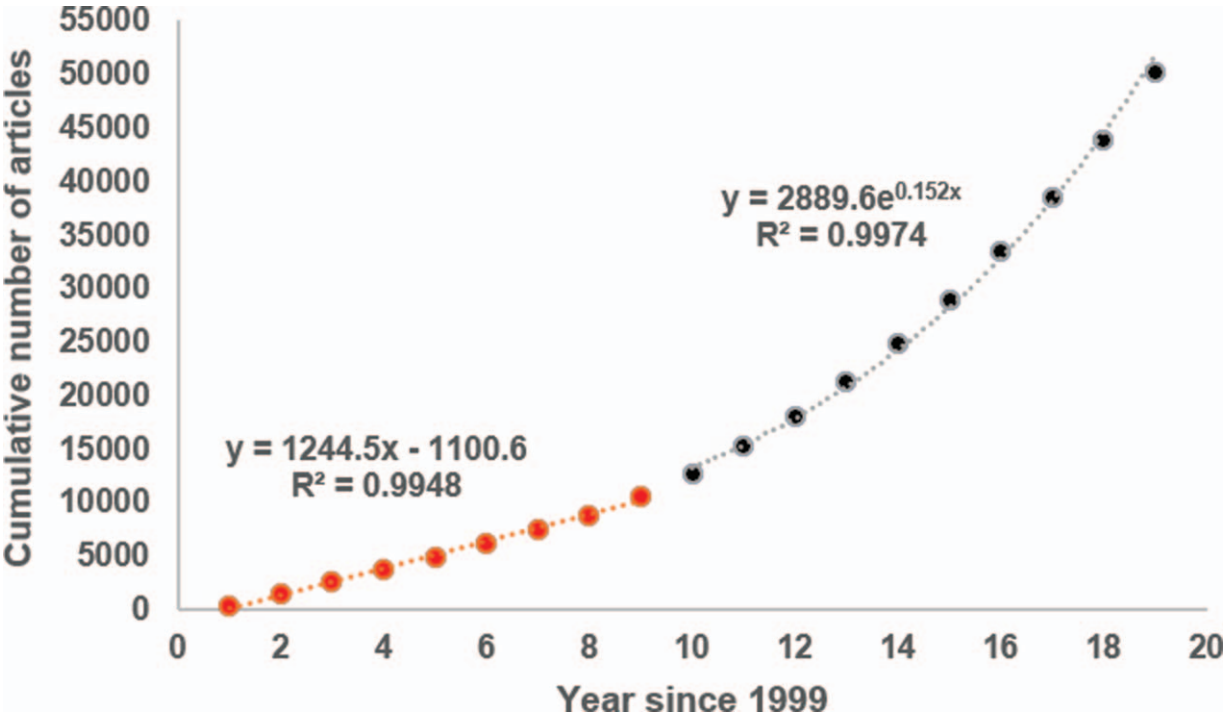

Figure 1. Cumulative number of obesity research articles by year.

obesity papers. Among the total 153 countries/territories over the investigation period, 47 countries/territories had no publication output during 1999 to 2017, and 10 countries/territories have just begun to publish papers in the year 2017. Top 15 most productive countries/territories participated in >78% of all world obesity articles from ISI database, while 26 countries published only 1 article. Domination and imbalance in publication from mainstream countries was not surprising since this pattern occurred in most scientific fields.

Collaboration among countries, playing an ever-growing role in contemporary scientific research, can usually manifest itself in internationally coauthored papers tracked by bibliometric tools. Among the 50,246 articles with address information, 86.1% were publications from single country, and others were international collaborative work. A joint interpretation of our current findings and other bibliometric analyses of medical fields suggest that the collaboration rates in medical fields are significantly less than other science fields. This is probably due to nature of medical research, as it is generally more difficult for medical institution to carry out international collaborations, because of constraints of national regulations, standards, communications, and time effects. In Fig. 2, international collaborative articles were more prevalent in recent years than earlier years, from a 14.9% percentage of world ISI articles in 1999 to 16.5% in 2017. In general, the ascending trend of collaborative article proportion to world publication was somewhat owing to the rising number of the institutes and countries that engaged in the research, and the increased ease of communication in a technologically connected world. Moreover, TC indicators of international collaborative articles are much higher than that of independent publications all through the study period, which indicates that international collaborative articles have higher visibility than others. Among all the 50,246 articles, 6964 papers are international collaborative publications. These articles had an average TC of 23.3, while the others by single countries had a lower average TC of 18.1. Therefore, it would be reasonable to assume that more international collaboration would lead to more powerful articles due to the sharing of ideas and workloads.

The top 25 countries/territories were ranked by number of publications, including the number and TC of single country articles and international collaborated articles (Table 2). Two North American countries, 12 European countries, 8 Asian countries/regions, 2 Latin American country and Australia were ranked the top 25 of publications. There are still no African countries getting into the top 30 productive countries. These 25 productive countries occupied 83% of international collaborated articles, which indicated their great ability in the laparoscopy research fields. Although the USA was the most productive countries in both independent and international collaborative papers, the countries/regions with the highest average TC scores for independent articles were France and the United Kingdom scored the highest in average TC for international collaborative papers. Iran and South Korea had the lowest average TC per article among the top 25 countries/regions in independent articles and international collaborative articles, respectively. As been stated above, the average TC indicators for international collaborative articles of all 25 countries are higher than their national independent articles, except for Turkey, Australia, South Korea, Brazil, France, Sweden, Denmark, Mexico. Large increase in average TC can be easily found between the independent and international collaborative articles of USA, the United Kingdom, Switzerland, and Finland, which indicates that these countries benefit a lot in the international cooperation.

3.3. Distribution of output in journals

In total, 50,246 articles were published in 5156 journals, including not only specialty journals, but also journals of other disciplines. The top 20 productive journals through the recent 19

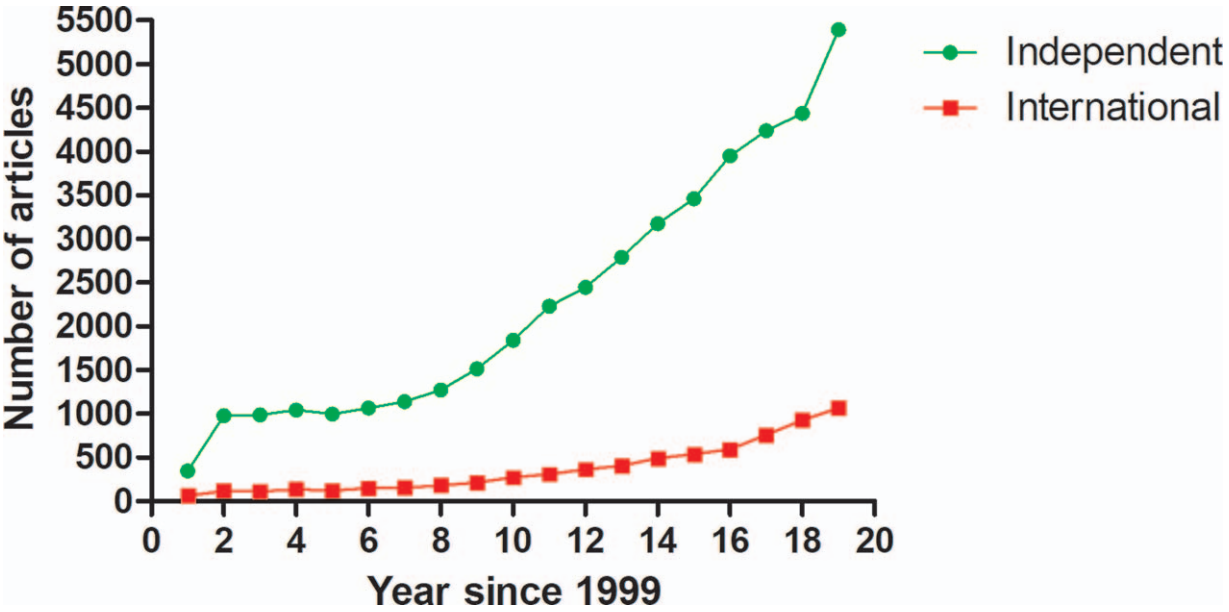

Figure 2. Comparison of the growth trends of international collaborative and independent obesity articles in the world in number during 1999 to 2017.

years are presented in Table 3. As the leading journal of this particular research field, Obesity Surgery published 1414 articles, comprising 2.81% of all the articles, followed by International Journal of Obesity and Obesity, contributing 1.14 and 0.81% of all the journal articles, respectively, with impact factor is 3.386, 5.453, and 4.181. Remarkably, 60% (12/20) of journals publishing on obesity are "Endocrinology & Metabolism" and "Nutrition & dietetics," with the remaining (8/20, 40%) belonging to other fields such as surgery or public health, which may indicate the significant relationship between weight loss and

Table 2

Most productive countries/regions in obesity research from 1999 to 2017.

		Independent			International			
Country/Region	TP	IP	TC	Av.TC	CP	TC	Av.TC	CP/TP
USA	14,632	13,213	327,430	24.8	1419	47,424	33.4	9.70%
Japan	3492	3261	62,935	19.3	231	5494	23.8	6.62%
Italy	2562	2221	44,820	20.2	341	7901	23.2	13.31%
The United Kingdom	2488	1858	42,855	23.1	630	26,722	42.4	25.32%
Turkey	1855	1809	17,500	9.7	46	398	8.7	2.48%
Peoples R China	1760	1513	12,423	8.2	247	2428	9.8	14.03%
Australia	1745	1402	24,331	17.4	343	5750	16.8	19.66%
South Korea	1651	1494	13,757	9.2	157	1146	7.3	9.51%
Germany	1526	1204	23,152	19.2	322	7800	24.2	21.10%
Brazil	1389	1267	11,260	8.9	122	1075	8.8	8.78%
France	1335	1070	27,394	25.6	265	6733	25.4	19.85%
Canada	1295	1025	15,816	15.4	270	5621	20.8	20.85%
Spain	1182	992	14,152	14.3	190	3633	19.1	16.07%
India	1133	1043	8439	8.1	90	1072	11.9	7.94%
Netherlands	1109	900	21,444	23.8	209	6279	30	18.85%
Poland	782	707	5094	7.2	75	598	8	9.59%
Iran	741	675	3613	5.4	66	498	7.5	8.91%
Greece	679	563	9665	17.2	116	2367	20.4	17.08%
Taiwan	673	613	6269	10.2	60	757	12.6	8.92%
Sweden	611	469	9827	21	142	2833	20	23.24%
Israel	609	519	9854	19	90	1717	19.1	14.78%
Denmark	464	380	7992	21	84	1618	19.3	18.10%
Switzerland	444	302	7481	24.8	142	5562	39.2	31.98%
Mexico	391	336	3082	9.2	55	406	7.4	14.07%
Finland	359	292	6000	20.5	67	1977	29.5	18.66%

Av.TC = average number of Times Cited per article, CP = the number of international collaborative articles, CP/TP = the percentage of international collaborative publications in total publications, IP = the number of independent articles, TP = total articles.

Table 3

The top 20 productive journals during 1999 to 2017.

Journal	TP	Pal	IF	QR	Journal category
Obesity Surgery	1414	2.81%	3.386	Q1	Surgery
International Journal of Obesity	574	1.14%	5.453	Q1	Endocrinology and metabolism; nutrition and dietetics
				Q1	
Obesity	406	0.81%	4.181	Q2	Endocrinology and metabolism; nutrition and dietetics
				Q1	
Metabolism-Clinical and Experimental	343	0.68%	3.506	Q1	Endocrinology and metabolism
Surgery for Obesity and Related Diseases	335	0.67%	3.848	Q1	Surgery
Bioorganic & Medicinal Chemistry Letters	329	0.65%	2.303	Q3	Medical chemistry; Organic chemistry
				Q2	
Appetite	321	0.64%	3.658	Q2	Behavioral sciences;
				Q1	Nutrition and dietetics
Journal of Clinical Endocrinology & Metabolism	274	0.55%	6.061	Q1	Endocrinology and metabolism
Obesity Research & Clinical Practice	248	0.49%	1.535	Q3	Endocrinology and metabolism; nutrition and dietetics
				Q3	
Nutrition & Metabolism	247	0.49%	2.441	Q3	Endocrinology and metabolism; nutrition and dietetics
				Q2	
Nutrition Research	231	0.46%	2.983	Q2	Nutrition and dietetics
Nutricion Hospitalaria	223	0.44%	1.473	Q3	Nutrition and dietetics
Diabetes Research and Clinical Practice	208	0.41%	3.352	Q2	Endocrinology and metabolism
BMC Public Health	204	0.41%	2.746	Q2	Public environmental and occupational health
Diabetes Care	203	0.40%	9.015	Q1	Endocrinology and metabolism
Medical Hypotheses	198	0.39%	1.111	Q4	Medicine research and experimental
Diabetology & Metabolic Syndrome	183	0.36%	2.287	Q3	Endocrinology and metabolism
Journal of Pediatric Endocrinology & Metabolism	183	0.36%	0.912	Q4	Endocrinology and metabolism; pediatrics
				Q4	
Surgical Endoscopy and Other Interventional Techniques	182	0.36%	3.499	Q1	Surgery
Biochemical and Biophysical Research Communications	179	0.36%	2.392	Q3	Biochemistry and molecular biology; biophysics
				Q2	

IF = 5-year impact factor, Pal = participation index, QR = quartile rank, TP = total paper.

metabolic improvement. Hence, our analysis can help specialists to identify the most relevant journals among a large panel.

3.4. Keywords analysis

Author keywords, by supplying "reasonably" details of the articles' subject, could offer the information of research trend which is most concerned by researchers. Bibliometric method concerning author keywords analysis can only be found in recent years. The technique of statistical analysis of keywords might be aimed at discovering directions of science and prove important for monitoring development of science and programs. Author keywords appeared in the articles refer to an obesity research from 1999 to 2017 were calculated and ranked by total 19-year study. Because the different keywords sometimes represent one meaning, the mesh database is used to integrate the author keywords with the same meaning, which appeared >100 times. Those keywords that appeared >350 times in the last 19 years are displayed in Table 4, and research changes can be found occurred.

4. Discussion

Obviously, the 2 most frequent occurrences in the search term are "obesity" (10,077, 20.06%) and "body mass index" (3121, 6.21%). The diagnosis of obesity is often based on body mass index (BMI), calculated as weight in kilograms divided by height in meters squared (kg/m^2). Individuals with BMI 18.5 to 24.9 are considered as having normal weight, those with BMI 25 to 29.9 are considered overweight, and those with BMI >30 are considered obese. Obesity is further categorized into grade I (BMI 30–34.9), grade II (BMI 35–39.9), and grade III (BMI >40).[13,14] Although these categories for defining overweight and obesity are widely used, it is noteworthy that the BMI values for overweight and obesity are different for Asians.

Apart from "obesity" and "Body Mass Index," the most frequently searching keyword was "Diabetes Mellitus, Type 2" (2808, 5.59%). Surgeon Pories is the first person in history to associate diabetes with obesity. In 1981, Pories accidentally found that obese patients with type 2 diabetes mellitus received bariatric surgery, whose blood sugar quickly returned to normal dancing to significant weight loss. After 14 years of clinical research, an article[15] named "Who would have thought it? An operation proves to be the most effective therapy for adult-onset diabetes mellitus" has attracted attention. Many observational studies[16–18] have shown glycemic lasting improvement in obese patients with type 2 diabetes mellitus after bariatric surgery. Although surgical efficacy is better than pharmacological or behavioral intervention, however, surgery is not an attractive therapeutic option for many individuals suffering from obesity and its consequences. Therefore, it is both scientifically and clinically imperative that we identify molecular mechanisms responsible for weight loss and other metabolic improvements so we can target affected pathways in a less-invasive manner. Through the statistical results of Table 4, we found that "inflammation" (704, 1.40%) and "Oxidative Stress" (370, 0.74%) and "Adiponectin" (595, 1.18%) have extremely high increasing rate in both ranking and percentage of all author keyword in the study period. Obesity induced by high-fat (HF) feeding is associated with low-grade inflammation in peripheral

Table 4

Frequency of author keywords used more than 350 times in world obesity research articles.

Keywords	CP	%	1999–2008			2009–2017		
			P	*R*	%	*P*	*R*	%
Obesity	10,077	20.06%	1964	1	15.48%	8113	1	21.60%
Body mass index	3121	6.21%	631	4	4.97%	2490	2	6.63%
Diabetes mellitus, type 2	2808	5.59%	655	2	5.16%	2153	3	5.73%
Insulin resistance	1852	3.69%	495	6	3.90%	1357	5	3.61%
Metabolic syndrome ↑↑	1850	3.68%	184	17	1.45%	1666	4	4.44%
Exercise	1629	3.24%	285	9	2.25%	1344	6	3.58%
Child	1471	2.93%	261	11	2.06%	1210	7	3.22%
Leptin ↓	1465	2.92%	637	3	5.02%	828	11	2.20%
Bariatric surgery	1375	2.74%	327	7	2.58%	1048	9	2.79%
Overweight	1278	2.54%	189	16	1.49%	1089	8	2.90%
Obesity, morbid	1207	2.40%	567	5	4.47%	640	15	1.70%
Adolescent	1095	2.18%	169	19	1.33%	926	10	2.47%
Nutrition ↑	1030	2.05%	217	13	1.71%	813	12	2.16%
Weight loss	1001	1.99%	295	8	2.32%	706	13	1.88%
Hypertension ↓	924	1.84%	265	10	2.09%	659	14	1.75%
Risk factors	809	1.61%	210	14	1.65%	599	17	1.59%
Inflammation ↑↑	704	1.40%	81	35	0.64%	623	16	1.66%
Gastric bypass	703	1.40%	172	18	1.36%	531	18	1.41%
Adipose tissue	646	1.29%	204	15	1.61%	442	20	1.18%
Adiponectin ↑↑	595	1.18%	98	30	0.77%	497	19	1.32%
Insulin	535	1.06%	233	12	1.84%	302	30	0.80%
Epidemiology	525	1.04%	123	23	0.97%	402	22	1.07%
Body composition	516	1.03%	168	20	1.32%	348	26	0.93%
Diet	507	1.01%	132	22	1.04%	375	25	1.00%
Polycystic ovary syndrome ↑↑↑	497	0.99%	105	27	0.83%	392	23	1.04%
Prevalence	481	0.96%	101	29	0.80%	380	24	1.01%
Pregnancy	432	0.86%	102	28	0.80%	330	28	0.88%
Sleeve gastrectomy ↑↑↑	429	0.85%	15	262	0.12%	414	21	1.10%
Childhood obesity	376	0.75%	44	69	0.35%	332	27	0.88%
Blood pressure ↓	372	0.74%	107	26	0.84%	265	35	0.71%
Oxidative stress ↑	370	0.74%	60	47	0.47%	310	29	0.83%
Depression ↑	356	0.71%	56	51	0.44%	300	31	0.80%
Body weight	355	0.71%	112	25	0.88%	243	38	0.65%
Cardiovascular diseases ↑	352	0.70%	71	40	0.56%	281	33	0.75%

% = the percentage of the author keyword, ↑ = percentage went up significantly over time, ↓ = percentage went down significantly over time, CP = total publications in the study period, P = publications in the study period, R = the rank of the author keyword.

tissues that predisposes to insulin resistance (1852, 3.69%).[19] In peripheral tissues, the deleterious metabolic consequences of obesity arise in part via cellular inflammation triggered by nutrient (1030, 2.05%) excess.[20–23] Excess visceral adiposity is accompanied by chronic low-grade inflammation affecting liver, adipose tissue, skeletal muscle, and the vasculature and is ultimately accompanied by increased circulating levels of proinflammatory cytokines and acute-phase reactants. According to metabolic regulation, the body should have a complete set of signal system of hunger and fullness. High free fatty acids (FFAs) stimulate adipose tissue inflammation to reduce leptin (1465, 2.92%) and adiponectin secretion through the TLR4 pathway, resulting in obesity and insulin resistance.[24] A research[25] in New England Journal of Medicine revealed that mutations in the gene encoding leptin typically lead to an absence of circulating leptin and early-onset extreme obesity, which validates the reliability of this conclusion again. With an in-depth study of obesity-related molecular and cellular mechanisms, a great many obesity-related diseases become research hotspots. From Table 4 we can see: among the 35 searching author keywords, 8 are about the obesity related diseases, including diabetes mellitus, metabolic syndrome (1850, 3.68%), hypertension (924, 1.84%), cardiovascular diseases (352, 0.70%), polycystic ovary syndrome (497,0.99%), and depression (356, 0.71%), which indicates obesity is mainly studied as a cause, not a disease itself at present. However, another question which Obesity can cause inflammation, but why inflammation will induce cardiovascular disease, diabetes, cancer, and other diseases is coming. Takii[26] owned the main mechanism of inflammation to gene mutation and protein inactivation as a risk factor for multiple diseases. Further analysis found that "metabolic syndrome," "depression," and "polycystic ovary syndrome" grew at a faster rate in the studies of obesity-related disease, but "hypertension" had a downward trend, which may indicate the main research direction and hot spots of obesity-related complications in future.

Another important finding is the shift in obesity treatment. "diet" and "exercise" maintain a clear leading position in both ranking and percentage of all author keywords in the study period, which suggests that lifestyle management is still the main way to lose weight today. Ochner et al[27] found that approximately 80% to 95% of the obese people will activate a variety of biological systems by reducing calorie intake artificially, which in turn stimulate people to eat more high-calorie foods, so that the weight tends to fluctuate. In contrast to

the uncertain impact of diet and exercise, most individuals that lose weight with bariatric surgery (1375, 2.74%) maintain reduced levels of body fat for many years.[28] In 1967, Mason and Ito[29] introduced "gastric bypass" (703, 1.40%) surgical procedure into weight loss, after occasionally noting that patients with peptic ulcer had a sustained weight loss after "gastric bypass." Surprisingly, postoperative significant effect of weight loss makes "gastric bypass" surgical procedure become the standard surgery for bariatric surgery. In 2004, Almogy et al[30] reported some patients gain significant weight loss with sleeve gastrectomy (429, 0.85%), who failed to implement gastric bypass due to special reasons. Since then, a many literatures[31–35] reported that the 3 to 5-year follow-up results show that sleeve gastrectomy, as an independent surgery, is not inferior to other surgical procedures in weight loss and complications improvement. Compared with gastric bypass, sleeve gastrectomy has the advantages of simple operation, short learning curve, short operation time, less postoperative complications, and single variable, so that it is widely used in clinical and experimental research, which can be seen from Table 4.

Author contributions

Ning Zhao and Zefeng Xia made contributions to the study design. Ning Zhao and Kaixiong Tao completed the literature search, collection of the data, data analysis, and the initial manuscript. Zefeng Xia and Guobin Wang reviewed and revised the final manuscript.

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