

Evolution in scientific production in the area of vegetarian nutrition, 1907-2013.

Julio C. Acosta-Navarro^{1,2}, Adriana Midori Oki¹, Luiza Antoniazzi Gomes de Gouveia^{1,3*}, Valeria Hong¹, Maria Aparecida C. Bonfim¹, Raul D. Santos¹

1. Heart Institute (InCor), University Of São Paulo, Medical School, Brazil.
2. Osiris Florindo Coelho Regional Hospital Of Ferraz De Vasconcelos, Brazil.
3. Paulista University (UNIP), Brazil.

Abstract

The objective is to evaluate the scientific evolution of articles about vegetarian nutrition. We analyzed the publication of articles of vegetarian nutrition, using the key term 'vegetarian' in the National Institutes of Health MEDLINE bibliographic database between 1907 and 2013. We quantified the number of articles in vegetarian nutrition by 5-y time periods, and we classified the kind of journals, the affiliation of the first author, the origin of the study population and the type of articles. The number of articles found in MEDLINE is 3256. The publication rate of vegetarian articles increased steadily, except in periods of 2006-2010 and 2011-2013, and this was explained because the application of "embargo period" for the some publishers. Non-nutrition journals have published more articles on vegetarian nutrition for all periods. It is observed that after 1960 the articles on vegetarian nutrition are proportionately greater than the total published, except in the years 2007, 2008, 2011, 2012 and 2013. The majority of authors were located in Europe (41.7%), followed by North America (26.8%), Asia (16.1%) and Latin America (1.4%). The origin of the study population presented a similar trend being highest in Europe and lowest in Latin America. Original research and review articles represent 52.5% and 20.2% of all publications respectively. We noticed a marked increase in the publication of articles of vegetarian nutrition over the years in absolute and relative terms meaning a growing interest by publication type.

Corresponding author: Julio C. Acosta-Navarro, Heart Institute (InCor), University of São Paulo, Medical School, São Paulo, Brazil. Av. Dr. Enéas Carvalho de Aguiar 44, Cerqueira Cesar, São Paulo, SP 05403-900. 55-11-26615320.

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Introduction

Vegetarian diets, when properly planned, like all diets should be, promote proper growth and development and can be adopted in all cycles of life (1). Many studies have demonstrated the associations between meat consumption and hypertension, risk for heart disease, metabolic disorders and mortality (2,3) and the protective effect of a vegetarian diet, associated with healthy lifestyle and the maintenance of the adequate body weight in the protections against these chronic diseases (4,5). Vegetarian populations have 31% less heart disease, less than 50% diabetes, various cancers less, 88% less colon cancer and 54% less prostate cancer (6).

According to data from IBOPE (Institute of Public Opinion and Statistics), 8% of the population of major cities and metropolitan regions of Brazil declares himself vegetarian. This percentage is higher among people 65 to 75 years (10%) and lowest among young people 20-24 years (7%) (7).

The growing evidence of the health benefits of vegetarian diets has certainly increased the professional and scientific interest in the subject and consequently the production of papers related to it. Sabaté e col. (8) determined the annual number and proportion of vegetarian nutrition articles published in biomedical and nutrition literature from 1966 to 1995 with 652 records. Since his publication (8), the number of vegetarian nutrition articles increased and there are articles about motivations, psychological aspects, types of diets, health implications, prevalence of risk factors and chronic diseases among others.

The importance for the society of vegetarianism go further the effects on the prevention of chronic diseases. At present, there are major repercussions created by the rising animal source food intake on several related global crises linked with water, climate, and energy (9).

Given the increase in the number of adherents to the vegetarian practice and the scientific interest related it the objective of this study was to verify and quantify the production of papers about vegetarian nutrition published in the MEDLINE in a period more comprehensive.

Material and methods

To analyze the evolution of publishing articles on vegetarian nutrition we used the keyword 'vegetarian' in the database MEDLINE, which listed 3256 articles. The years were analyzed from 1907 which is the year's first published article until December 2013, being the period analyzed the data. Our research was carried out in January 2014.

We classify the number of articles for every five years period, except the first period that was by four years (1907-1910) and the last period that was by three years (2011-2013).

Of these 3256 articles, we looked at what types of journals they were published (nutrition and non-nutrition journals). To qualify as newspapers nutrition was used in Medline site icon Journals in NCBI Databases, which listed all the journals indexed nutrition. Then, every newspaper and word *vegetarian* was typed. The non-nutrition journals included nursing, dental, among others. To compare the rate of publication of articles on vegetarian nutrition in relation to the total number of articles indexed in Medline, we use the keyword *all studies*.

Other variables were analyzed: the origin of the study population, the first author affiliation and type of article. For analysis of these variables were excluded that not applied to humans beings or that the word vegetarian was written randomly. MEDLINE records did not include authors addresses until 1986, so we studied these variables from that year until 2013. When only the abstract was available or just the title, the original article for analysis of these variables was searched individually and tabulated manually. Studies with the absence of essential information in order to account these variables were also excluded. With all these procedures, 816 were excluded and only 2440 articles were analyzed.

We used the operational program Excel chart for the database and the graphics construction. To verify the differences between linear trends the chi-square test was used test and to measure the strength of a linear correlation the Pearson's correlation coefficient was calculated. All calculations were carried out by using Stata version 10.0.

Results

The total number of articles published was 3256. The publication rate of articles on vegetarian nutrition steadily increased almost exponentially, except in the last two periods 2006-2010 and 2011-2013, as shown in **Figure 1**. Beginning from 1907 until 1960 the number in each period was around 1 papers/y. Indeed, in the sixth decade appears a sharp increase from 6 papers/y in the 1961-1965 period to 115 papers/y in the 2001-2005 period.

Nonnutrition journals published more articles in vegetarian nutrition (n=2440) than the nutrition journals (n=816). Nevertheless, the number of vegetarian nutrition articles published in nonnutrition and in nutrition journals shows strong correlation ($r = 0.9880$). As seen in **Figure 2**, the publication of articles in nonnutrition journals growing up steadily until the period 2001-2005; from 2001-2005 to 2006-2010 was shown to be equivalent, and in the period of 2010-2013 proved to be descending (273 articles published). In the same way, the publication in nutrition journals proved to be increased steadily until 2001-2005 and decreased in the last two periods.

The publication rate of articles on vegetarian

nutrition in relation to the total number of articles indexed in Medline by 5-y time periods, was equivalent to 1960, and from that year proportionally higher, except in the last two periods (2006-2010 and 2011-2013) (**Figure 3**). This may be due the “embargo period”, when some participating publishers will delay the release of their articles on PubMed Central for a set time after publication. Strong correlation ($r=0.9127$) was observed between number of articles on vegetarian nutrition and the total number of articles indexed in Medline in the period analyzed, showing the relevance and interest in publishing about vegetarian diets.

Over 90% of the vegetarian nutrition literature were written in English (92.41%, n=3009), in second place French (1.23%, n=40); Spanish (0.59%, n=19); followed by Japanese (0.31%, n=10); Portuguese (0.31%, n=10); German (0.24%, n=8); Italian (0.21%, n=7); unspecified (0.15%, n=5); Chinese (0.21%, n=7); and others (4.33%, n=141).

Several characteristics of the vegetarian nutrition articles published from 1986 to 2013 are summarized by 5-y periods in **Table 1**. We find information for 2440 papers. We note regarding affiliation of the first author is a predominance of the

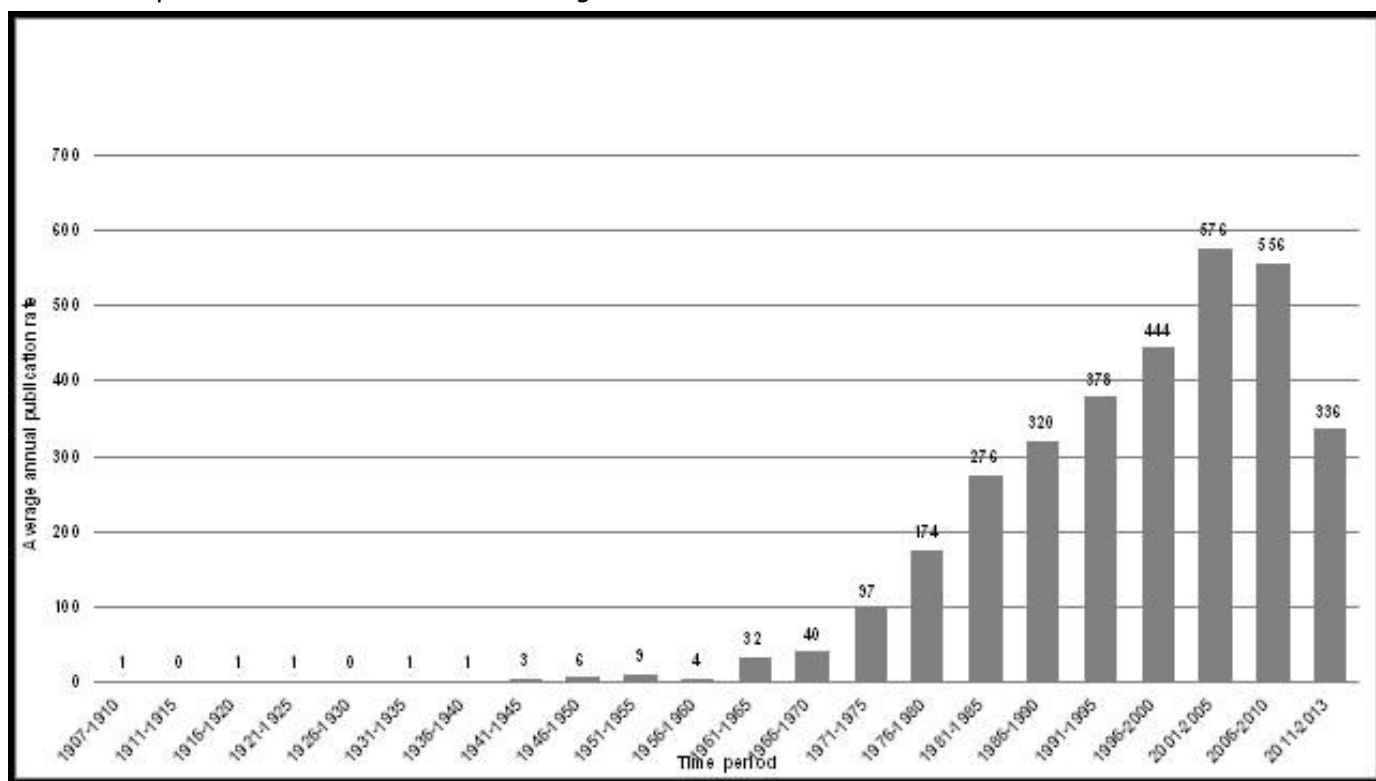


Figure 1. Average annual publication rate of vegetarian articles, since 1907 to 2013.

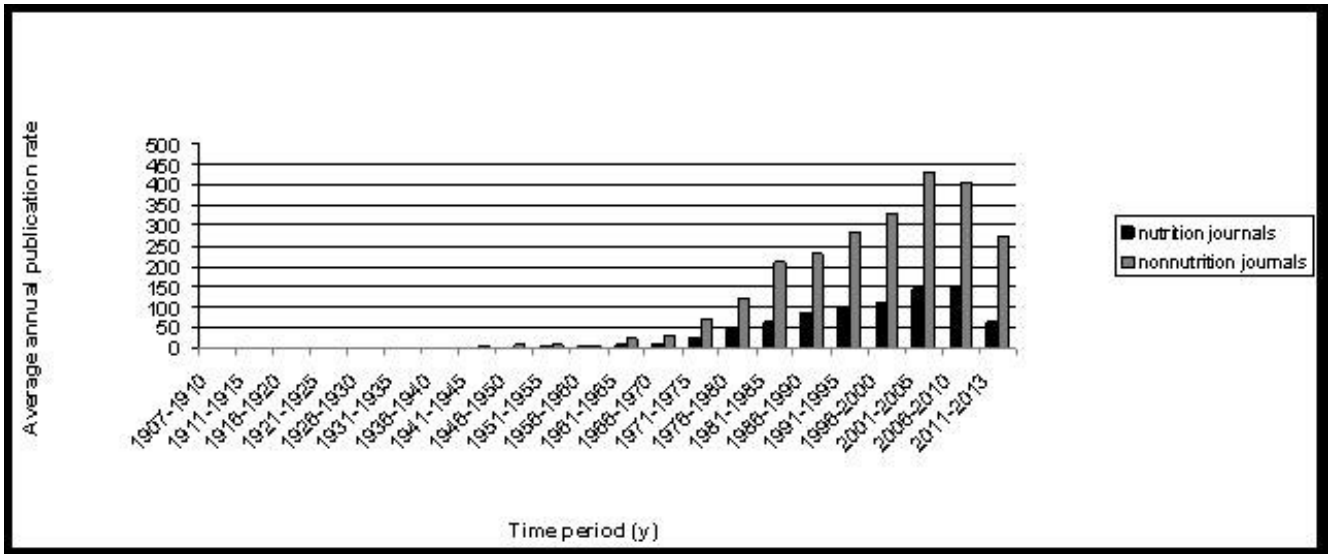


Figure 2. Scientific production in the area of vegetarian nutrition, by type of journal, since 1907 to 2013.

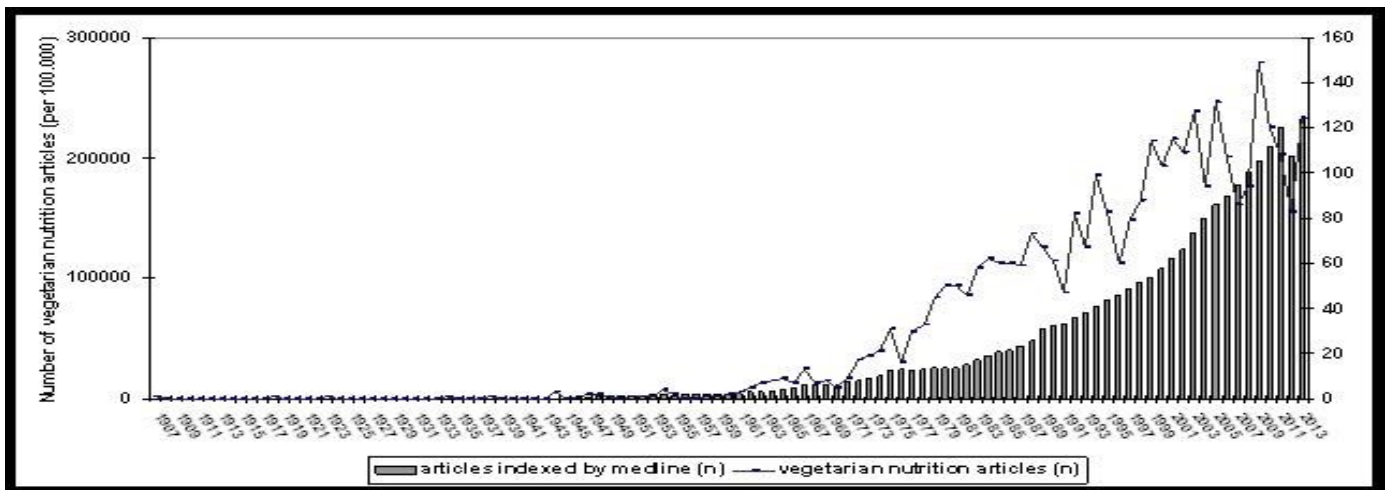


Figure 3. Ratio of vegetarian nutrition articles (per 100.000) to the total number of articles indexed by Medline annually between 1907 to 2013.

European continent (41.7%), followed respectively the North American continent (26.8%), Asia (16.1%) and Latin America (1.4%). The origin of the study population presented a similar trend being highest in Europe and lowest in Latin America, but we should note that in all periods the number of absents is high. Original research and review articles represent 52.5% and 20.2% of all publications respectively. Clinical cases (5.5%) and letters (3.3%) in general were lower in the period studied.

Discussion

We presented a comprehensive review on

production of literature on vegetarian nutrition over time from the first paper published in 1907 until 2013. We noticed a marked increase in the publication of articles of vegetarian nutrition over the years in absolute and relative terms meaning a growing interest by publication type by nutrition and nonnutrition journals.

Previously, Sabaté e col. (8) had documented publication trends of vegetarian nutrition articles in biomedical literature between 1966 and 1995 using the MEDLINE bibliographic database. They worked with 652 records. In our study with 3256 records, the same way as the study cited, the publication rate of articles on vegetarian nutrition steadily increased over time, except in the last two periods 2006-2010 and 2011-2013 but it

Table 1. Characteristics of the articles indexed in Medline, since 1986 to 2013.

Variables	1986-1990	1991-1995	1996-2000	2001-2005	2006-2010	2011-2013	p ¹
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	
Affiliation of the first author							
Europe	117 (41.2)	161 (44.2)	197 (45.1)	243 (43.3)	182 (38.2)	117 (36.8)	0,103
North America	90 (31.7)	96 (26.4)	108 (24.7)	143 (25.5)	138 (29.0)	80 (25.1)	0,256
Ásia	25 (8.8)	31 (8.5)	55 (12.6)	81 (14.4)	108 (22.7)	93 (29.2)	<0.001
Latin America	0 (0)	1 (0.3)	5 (1.1)	7 (1.3)	11 (2.3)	10 (3.2)	0,003
Others (oceanic, african)	28 (9.8)	14 (3.8)	26 (5.9)	23 (4.1)	17 (3.6)	8 (2.5)	<0.001
Ausent	24 (8.5)	60 (16.5)	46 (10.5)	64 (11.4)	20 (4.2)	10 (3.2)	<0.001
Mixed	0 (0)	1 (0.3)	0 (0)	0 (0)	0 (0)	0 (0)	0,336
Origin of study population							
European	82 (28.9)	49 (13.5)	60 (13.7)	152 (27.1)	122 (25.6)	83 (26.1)	<0.001
North American	67 (23.6)	29 (8.0)	38 (8.7)	54 (9.6)	57 (12)	46 (14.5)	<0.001
Asian	26 (9.1)	26 (7.1)	45 (10.3)	61 (10.9)	98 (20.6)	77 (24.2)	<0.001
African	2 (0.7)	3 (0.8)	7 (1.6)	6 (1.1)	7 (1.5)	0 (0)	0,296
Ocean	15 (5.3)	2 (0.5)	15 (3.4)	14 (2.5)	8 (1.6)	4 (1.2)	0,001
Latin	0 (0)	0 (0)	1 (0.2)	2 (0.3)	7 (1.5)	5 (1.6)	0,006
Ausent	86 (30.3)	250 (68.7)	268 (61.3)	268 (47.8)	173 (36.4)	102 (32.1)	<0.001
Mixed	6 (2.1)	5 (1.4)	3 (0.7)	4 (0.7)	4 (0.8)	1 (0.3)	0,227
Type of articles							
Review	58 (20.4)	66 (18.1)	85 (19.5)	122 (21.7)	108 (22.7)	54 (17.0)	0,323
Original research	125 (44.0)	163 (44.8)	240 (54.9)	287 (51.2)	255 (53.6)	211 (66.3)	<0.001
Clinical case	34 (12.0)	9 (2.5)	26 (5.9)	33 (5.9)	17 (3.6)	15 (4.8)	<0.001
Letter	15 (5.3)	10 (2.7)	22 (5.0)	6 (1.1)	19 (4)	8 (2.5)	0,003
Others (editorial)	44 (15.5)	42 (11.5)	25 (5.7)	16 (2.8)	52 (10.9)	21 (6.6)	<0.001
Ausente	8 (2.8)	74 (20.4)	39 (8.9)	97 (17.3)	25 (5.2)	9 (2.8)	<0.001
Total	284	364	437	561	476	318	

n = number

¹Chi-square of linear trends

could be explained by a possible delay in the MEDLINE system registers. This observation is only apparent because some participating publishers will delay the release of their articles on PubMed Central for a set time after publication; this is often referred to as an "embargo period", and can range from a few months to a few years depending on the journal (10). The same reason could explain that the publication of articles in nutrition and nonnutrition journals growing up steadily until the last two periods.

Regardless of the period and the total production, it is important to note that the highest rates of vegetarian nutrition articles were published in non-nutrition journals, which may be due to the greater number of journal in that category since it encompasses various topics journals, but can also reflect the interest of professionals from various fields on this subject. The publication rate of articles on vegetarian nutrition in relation to the total number of articles indexed in Medline by 5-y time periods, was equivalent until 1960, and from that year, it was proportionally higher, except in the last two periods (2006-2010 and 2011-2013). The increase of vegetarian nutrition articles in scientific literature mainly in the past 50 years, indeed reflects the interest in this issue, of professionals both in areas of nutrition and other interdisciplinary areas of health. Despite this, the number of vegetarian nutrition articles published in nonnutrition and in nutrition journals have strong correlation, showing that there is a trend in publishing this type of article followed by both nonnutrition and nutrition journals.

We observed with respect to affiliation of the first author a predominance of the European continent, followed respectively the North American continent, Asia and finally Latin America. The origin of the study population presented a similar trend being highest in Europe and lowest in Latin America. It could be related to presence of most developed countries in the first two continents, and also justifies the fact that most of the articles are published in English. We present at first time date from Latin America indicating a trend of grown up of published papers about vegetarian nutrition on our continent.

By other hand, original research and clinical trials on vegetarian diets are increasing whereas case series reports of vegetarians are declining reflecting the

predominance of studies with stronger methodological designs that generate more robust evidence on the benefits of a vegetarian diet and thus may be the basis for campaigns and public policy for disease prevention and health promotion.

Sabaté e col. (8) had affirmed that the MEDLINE has advantage of having most of the leading journals in the biomedical and health sciences, in spite of the bias in favor of medical science journals and those coming from United States, Canada and United Kingdom relative to other health science journals and Non-English journal (11,12). Because of these advantages exposed, we decided in this study to keep the search in the database MEDLINE, which also facilitates comparisons to be made with the results of this study and with that single with similar objective available in the literature.

The advantage of the present study is the very comprehensive period in bibliographic, since the first publication on the subject of vegetarianism, which allows us to evaluate the evolution of the production of the literature on this topic in the most appropriate possible.

The importance for the society of vegetarianism go further the effects on the prevention of chronic diseases of high mortality as cardiovascular, metabolic and neoplastic diseases, but also it influences on the planet. At present, there are major repercussions created by the rising animal source food intake on several related global crises linked with water, climate, and energy (1). The critical issue to understand is that since meat is much further up the food chain, the estimates are that water use is 2 to 5 times greater for animal source food than for basic crops (eg, legumes, grains) across the globe (13). One estimate is that 23% of the world's water goes to livestock use in total; their more conservative marginal additional use for livestock is about 15% of the world's water. The effects of livestock production on water pollution, however, is far greater. In the United States, livestock production accounts for 55% of the erosion process, 37% of pesticides applied, 50% of antibiotics consumed, and a third of total discharge of nitrogen and phosphorus to surface water (14). For fossil fuel use and global climate control, the recent United Nations report suggests that livestock are responsible for 18% of greenhouse gas emissions, far greater than that of transportation.(14).

Overall, scholars first question the sustainability of modern agriculture in general, and second, they question the much higher energy use of producing animal foods (15).

The acknowledgement that studies on vegetarian nutrition has grown over the past decades, presenting strong correlation between number of articles on vegetarian nutrition and the total number of articles indexed in Medline in the period analyzed, shows the relevance and interest in publishing about vegetarian diets. The most of these studies are of high methodological quality and carrying generate useful evidence, helps break down barriers that confront this topic to be surrounded by the prejudices of the scientific community and society.

Conclusion

We noticed a marked increase in the production of papers about vegetarian nutrition published in the MEDLINE in absolute and relative terms that was proportionally higher than medium production in other areas of scientific interest meaning a growing interest by this publication type. Most studies are composed of original research and review articles, have been published by non-nutritional journals, in English, and in European continent. Given the growing interest in the vegetarian nutrition subject, it is expected that in the future bibliographical evolution studies observe even more promising results.

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Conflict of interest: none

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