Original Article

A bibliometric study of international scientific productivity in giardiasis covering the period 1971–2010

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Abstract

Introduction: Despite years of relative neglect, interest in *Giardia* infection seems to be recently growing, perhaps in part due to its inclusion into the World Health Organization's Neglected Diseases Initiative since 2004. The purpose of this study was to provide an overview of *Giardia* and giardiasis research over time, as represented by the quantity of published papers.

Methodology: Data for this study were collected from the electronic PubMed/Medline database of National Library of Medicine's (NLM), due to it is easily accessibility and wide use. It was accessed online between April and December 2011. Data for the period 1971–2010 were obtained and information was downloaded using the EndNote program developed by Thomson Reuters.

Results: During the study period, a total of 6,964 references (articles, reviews, editorials, letter to the editor, etc.) covering different aspects of *Giardia* and giardiasis were located in the PubMed database after applying the search strategy reported above. Most papers were original articles and published in English.

Conclusions: In this first effort to explore the development and research productivity on giardiasis over time (no previously published bibliometric studies on giardiasis exist), two interesting characteristics of the *Giardia* and giardiasis literature were discovered: the concentration of papers over journals disseminating the research results, and that research in this field is growing and will likely continue to grow in the coming years.

Key words: giardiasis; *Giardia*; bibliometric.

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Introduction

The etiological agent of human giardiasis, *Giardia lamblia* (syn. *G. duodenalis*, *G. intestinalis*), is the commonest pathogenic protozoan infection of the intestinal tract. *Giardia* is endemic throughout the world, and its prevalence varies by age and sanitary standards [1].

Despite years of relative neglect, interest in *Giardia* infection seems to be recently growing, perhaps in part due to the combination of its inclusion in the World Health Organization (WHO)'s Neglected Diseases Initiative since 2004 [2] and its re-emergence in industrialized countries, where it has been increasingly recognised as an etiological agent in numerous outbreaks of diarrheal disease in day-care centers and in water- and food-associated outbreaks [3-5]. *G. lamblia* is responsible for an estimated 2.8×10^8 cases per year. The prevalence of the infection is higher in developing countries, as the poor sanitary conditions favor the contamination of water and food with cysts. Approximately 200 million people have symptomatic giardiasis in Asia, Africa, and Latin America, and about 500,000 new cases are reported each year [6].

Bibliometrics, the scientific and quantitative study of publications, uses mathematical formulas to quantify productivity distribution and yield of communication output and enables predicting and studying scientific progress [6]. These kinds of studies are useful tools for assessment of the social and scientific relevance of a particular discipline or subject, since they permit analysis of the growth, size, and distribution of scientific literature on the topic during a period of time. Currently, estimates of global and regional productivity of ongoing research on giardiasis may be of interest. There are international bibliometric studies in tropical medicine and/or parasitic diseases [7-15]; however, these have not focused exactly on the field of giardiasis. The purpose of this study was to provide an overview of *Giardia* and giardiasis research over time, as represented by the quantity of published papers.

Methodology

Data for this study were collected from the electronic PubMed/Medline database of the National Library of Medicine (NLM), due to its accessibility and wide use. It was accessed online between April and December 2011. Data for the period 1971–2010 were obtained and information was downloaded using EndNote version 7.0 developed by Thomson Reuters.

The search terms used to retrieve data were "*Giardia*" OR "giardiasis" in all fields of the database, AND the years of study (1971–2010) in the publication date field. The subject content of the records was analyzed according to the structure of the United States of America National Library of Medicine's Medical Subject Headings (MeSH) thesaurus; thus, check tags, main headings, and sub-headings were also considered. Bibliographic data that were downloaded for analysis included author, title of article, name of journal, language of publication, date (year) of publication, and the document type.

As the period studied comprised 40 years, the evolution of the different topics analyzed in the study was possible, dividing the period in four ten-year time sub-periods: 1971–80, 1981–90, 1991–00, and 2001–10.

Two independent researchers (RA and RLV) collected the data in order to strengthen the methodological validity of the study. When there were disagreements between the two researchers, the results were discussed in meetings with the rest of the authors.

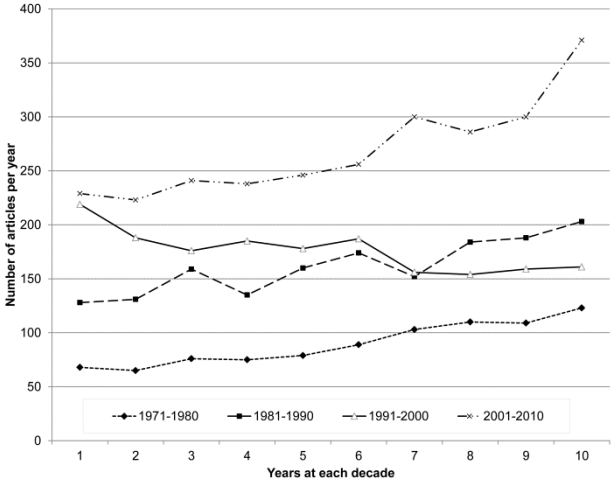
Results

During the study period, a total of 6,964 references (articles, reviews, editorials, letter to the editor, etc.) covering different aspects of *Giardia* and giardiasis were located in the PubMed database after applying the search strategy reported above. Figure 1 shows the growth of *Giardia* and giardiasis literature over the years studied.

There was an increase in publication output, mainly in the last decade, where the scientific output reached values of more than 200 articles per year (Figure 1). Despite the lack of research observed during the first three decades, the advances in proteomics, the study of domestic animals as reservoirs of potentially zoonotic agents, the effect of climate change on the incidence of infectious diseases, the analysis of environmental risk factors, among other aspects, allowed the study on *Giardia* and giardiasis to experience growth during the last period.

The most common type of documents on *Giardia* and giardiasis were original articles, accounting for 78.49% of the total (5,466) studies. Reviews were the second most common type of document (n = 601; 8.63%), followed by case reports (6.81%) and letters to the editors (3.60%). The rest were < 1%, corresponding to other types of studies (Table 1).

Figure 1. Scientific output per year during four decades on *Giardia* and giardiasis in PubMed, 1971–2010*



*1971–1980: 897 articles; 1981–1990: 1,614 articles; 1991–2000: 1,763 articles; 2001–2010: 2,690 articles

Table 1. Characterization of the scientific output on giardiasis covered by PubMed 1971–2010 (type of articles and clinical research)

Type of articles	n	%	Clinical research	n	%
Original article	5,466	78.49	Total of clinical research	1,102	15.82
Review	601	8.63	Comparative study	719	10.32
Case report	474	6.81	Clinical trial	127	1.82
Letter	251	3.60	Evaluation study	103	1.48
Comment	66	0.95	Randomized controlled trial	79	1.13
Editorial	30	0.43	Controlled clinical trial	37	0.53
Historical article	18	0.26	Multicenter study	27	0.39
News	16	0.23	Validation study	9	0.13
Others*	42	0.60	Clinical trial, phase II	1	0.01

*Biography, congress, meta-analysis, book chapter, clinical conference, guideline, portrait, address, corrected and republished article, duplicate publication, newspaper article, patient education handout, retracted publication, bibliography, interview, introductory journal article, retraction of publication

Table 2. Evolution per decade of the different languages involved in the scientific output on giardiasis covered by PubMed, 1971–2010

Language	1971–1980	%	1981–1990	%	1991–2000	%	2001–2010	%
English	598	66.67	1,264	78.31	1,487	84.34	2,378	88.40
Russian	58	6.47	26	1.61	15	0.85	33	1.23
Polish	46	5.13	58	3.59	33	1.87	23	0.86
German	43	4.79	39	2.42	33	1.87	23	0.86
Spanish	29	3.23	81	5.02	73	4.14	62	2.30
French	26	2.90	51	3.16	34	1.93	34	1.26
Romanian	15	1.67	11	0.68	1	0.06	3	0.11
Italian	12	1.34	24	1.49	15	0.85	18	0.67
Slovak	12	1.34	10	0.62	3	0.17	1	0.04
Portuguese	10	1.11	3	0.19	24	1.36	16	0.59
Danish	8	0.89	1	0.06	3	0.17	0	0
Czech	7	0.78	4	0.25	6	0.34	2	0.07
Swedish	6	0.67	4	0.25	2	0.11	1	0.04
Dutch	5	0.56	3	0.19	6	0.34	6	0.22
Turkish	5	0.56	5	0.31	3	0.17	52	1.93
Japanese	4	0.45	6	0.37	12	0.68	13	0.48
Ukrainian	3	0.33	0	0	0	0	0	0
Croatian	2	0.22	0	0	1	0.06	0	0
Hungarian	2	0.22	4	0.25	1	0.06	1	0.04
Serbian	2	0.22	1	0.06	2	0.11	0	0
Finnish	1	0.11	0	0.00	0	0	1	0.04
Hebrew	1	0.11	2	0.12	0	0	0	0
Korean	1	0.11	6	0.37	2	0.11	0	0
Macedonian	1	0.11	0	0	0	0	0	0
Chinese	0	0	13	0	5	0.28	18	0.67
Icelandic	0	0	0	0	1	0.06	0	0
Norwegian	0	0	0	0	1	0.06	7	0.26

A significant pattern observed, especially during the last decade, was the increase of clinical research. Comparative studies, clinical trials, and evaluation studies of different therapeutic strategies against giardiasis were the main type of clinical research identified.

Language of publication

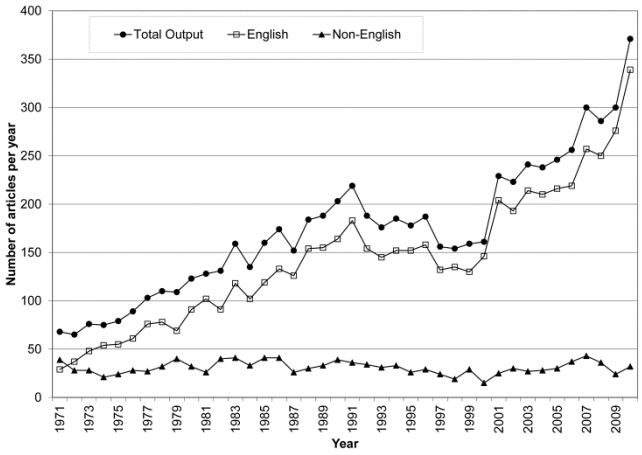
The articles identified were published in 27 languages (Table 2). Over the entire period, the main language was English (Figure 2), which increased from 66.67% to 88.40% over the years. The other languages (i.e., Russian, Polish and German, which were the most common non-English languages during the period 1971–1980) were replaced in the next decades by Spanish and French. Spanish was the second most important language since the 1980s. A surprising position during the last decade was occupied by Turkish (the third position, 1.93% of articles published).

Journals of publication

A total of 1,224 scientific journals published the 6,964 articles on *Giardia* and giardiasis during the period of 1971–2010. Only 30 (2.4%) journals published 2,234 (32.1%) articles of the whole scientific output, while the rest was spread over 1,194 journals (Table 3).

This journal's core was headed by *Parasitology Research* (Germany), which covered a high number of research on *Giardia* and giardiasis during the entire period. Five journals (*Transactions of the Royal Society of Tropical Medicine and Hygiene*, United Kingdom; the *American Journal of Tropical Medicine and Hygiene*, the United States (USA); the *Southeast Asian Journal of Tropical Medicine and Public Health*, Thailand; *Med Parazitol* (Moscow), Russia; and *Wiad Parazytol*, Poland) were found to have frequent publications on *Giardia* and giardiasis during the four decades analyzed. The rest of journals, with some exceptions (*Lancet*, United Kingdom; *Journal of Infectious Diseases*, USA; *Annals of Tropical Medicine and Parasitology*, United Kingdom; *Gut*, United Kingdom; and *Gastroenterology*, USA) had the most publications on *Giardia* and giardiasis during the last decade. Only the *American Journal of Tropical Medicine and Hygiene*, USA was in the top ten of the most productive journals on *Giardia* and giardiasis during the four decades studied (Table 4). The third most productive journal, *Veterinary Parasitology*, the Netherlands, was also the most productive during the first 10 years of this century.

Figure 2. Total number of giardiasis research publications in PubMed in any language (black circles), in English (squares), and in non-English languages (black triangles) between 1971 and 2010



Research topics

The analysis of MeSH terms used by indexers in PubMed completed the current view of the *Giardia* and giardiasis research. The description of articles through MeSH terms is less complete and accurate in articles published before the 1990s. Regardless, it is an important approach to be taken into account in bibliometric analysis.

Humans (66.33%) and animals (58.36%) have been studied in similar proportions by the international scientific community (Table 5). Both terms were used together in 2,063 articles (29.6%), which is related, on the one hand, to the analysis of prevalence and clinical manifestations of the disease, and to the zoonotic significance of this infection on the other hand. The research on *Giardia* and giardiasis in animals was very strong during the 2001–2010 period.

A different view offers the descriptors related to gender. Despite both terms being used in similar proportions (male, 31.81%; female, 30.869%), the coincidence of terms is significantly high (a total of 2,150 articles using both terms). This clearly indicates that there were no identified gender differences in clinical research on *Giardia* and giardiasis during this period.

Infants were the most studied age group in the scientific literature on *Giardia* and giardiasis, according to the keywords used to describe this aspect (child; child, preschool; infant; infant, newborn). Infants were studied specifically in 2,000 articles (28.7%), which demonstrates the importance of this age group in clinical research.

Table 3. The top 30 journals with a large coverage on giardiasis research during the period 1971–2010

Journal	Country	n	%	Output per decade			
				1971–1980	1981–1990	1991–2000	2001–2010
Parasitol Res	GER	137	1.97	0	5	29	103
Trans R Soc Trop Med Hyg	UK	133	1.91	22	55	30	26
Vet Parasitol	NED	130	1.87	0	6	18	106
J Egypt Soc Parasitol	EGY	121	1.74	0	38	30	53
Appl Environ Microbiol	USA	116	1.67	1	27	38	50
Am J Trop Med Hyg	USA	113	1.62	23	24	27	39
Mol Biochem Parasitol	NED	107	1.54	1	21	62	23
Exp Parasitol	USA	102	1.46	2	23	31	46
Int J Parasitol	UK	101	1.45	0	10	41	50
J Parasitol	USA	99	1.42	5	25	30	39
J Clin Microbiol	USA	95	1.36	2	32	38	23
Southeast Asian J Trop Med Public Health	THA	95	1.36	28	13	16	38
Infect Immun	USA	77	1.11	1	29	23	24
Med Parazitol (Mosk)	RUS	68	0.98	19	14	10	25
Lancet	UK	64	0.92	21	29	10	4
J Infect Dis	USA	63	0.90	11	30	13	9
Turkiye Parazitol Derg	TUR	58	0.83	0	0	0	58
Wiad Parazytol	POL	56	0.80	11	18	14	13
Parasitology	UK	55	0.79	0	10	20	25
Water Res	UK	54	0.78	0	0	0	54
J Biol Chem	USA	53	0.76	0	4	17	32
J Eukaryot Microbiol	USA	49	0.70	0	0	25	24
Ann Trop Med Parasitol	UK	46	0.66	7	16	12	11
J Water Health	UK	38	0.55	0	0	0	38
J Pediatr Gastroenterol Nutr	USA	37	0.53	0	20	11	6
Gut	UK	36	0.52	13	10	8	5
Indian J Med Res	IND	34	0.49	9	22	3	0
Rev Inst Med Trop Sao Paulo	BRA	33	0.47	4	1	10	18
Acta Trop	NED	32	0.46	0	3	14	15
Gastroenterology	USA	32	0.46	15	11	3	3

Table 4. The top ten of most productive journals on giardiasis by decade, 1971–2010

Journal	1971–1980	%	Journal	1981–1990	%
Southeast Asian J Trop Med Public Health (THA)	28	3.12	Trans R Soc Trop Med Hyg (UK)	55	3.41
Am J Trop Med Hyg (USA)	23	2.56	J Egypt Soc Parasitol (EGY)	38	2.35
Trans R Soc Trop Med Hyg (UK)	22	2.45	J Clin Microbiol (USA)	32	1.98
Lancet (UK)	21	2.34	J Infect Dis (USA)	30	1.86
Br Med J (UK)	21	2.34	Lancet (UK)	29	1.80
Med Parazitol (Mosk) (USSR)	19	2.12	Infect Immun (USA)	29	1.80
Med J Aust (AUS)	18	2.01	Appl Environ Microbiol (USA)	27	1.67
Gastroenterology (USA)	15	1.67	J Parasitol (USA)	25	1.55
N Engl J Med (UK)	14	1.56	Am J Trop Med Hyg (USA)	24	1.49
Ann Intern Med (USA)	13	1.45	Am J Public Health (USA)	23	1.43
Journal	**1991–2000**	**%**	**Journal**	**2001–2010**	**%**
Mol Biochem Parasitol (NED)	62	3.52	Vet Parasitol (NED)	106	3.94
Int J Parasitol (UK)	41	2.33	Parasitol Res (GER)	103	3.83
Appl Environ Microbiol (USA)	38	2.16	Turkiye Parazitol Derg (TUR)	58	2.16
J Clin Microbiol (USA)	38	2.16	Water Res (UK)	54	2.01
Exp Parasitol (USA)	31	1.76	J Egypt Soc Parasitol (EGY)	53	1.97
J Egypt Soc Parasitol (EGY)	30	1.70	Appl Environ Microbiol (USA)	50	1.86
Trans R Soc Trop Med Hyg (UK)	30	1.70	Int J Parasitol (UK)	50	1.86
J Parasitol (USA)	30	1.70	Exp Parasitol (USA)	46	1.71
Parasitol Res (GER)	29	1.64	Am J Trop Med Hyg (USA)	39	1.45
Am J Trop Med Hyg (USA)	27	1.53	J Parasitol (USA)	39	1.45

Table 5. Samples, gender, age groups, and animal models most frequently studied in articles on giardiasis covered by PubMed, 1971–2010

	n	%	1971–1980	1981–1990	1991–2000	2001–2010
Humans	4,619	66.33	794	1,189	1,115	1,521
Animals	4,064	58.36	162	708	1,213	1,981
Gender						
Male	2,215	31.81	368	567	532	748
Female	2,149	30.86	315	528	524	782
Age groups						
Child	1,510	21.68	288	395	350	477
Child, preschool	1,370	19.67	238	402	325	405
Adult	1,370	19.67	275	354	322	419
Infant	1,076	15.45	188	329	258	301
Adolescent	1,075	15.44	203	273	254	345
Middle aged	809	11.62	161	174	201	273
Aged	423	6.07	65	88	120	150
Infant, newborn	276	3.96	28	73	72	103
Older adult, 80 and over	99	1.42	0	9	33	57
Young adult	80	1.15	0	0	0	80
Adult, Pregnant	59	0.85	7	18	18	16
Student	22	0.32	1	4	7	10
Youth	19	0.27	0	5	14	0
Animal models						
Mice	401	5.76	64	140	106	91
Dogs	265	3.81	11	53	52	149
Cattle	199	2.86	1	24	57	117
Cats	146	2.10	6	29	28	83
Rats	109	1.57	22	43	20	24
Mice, inbred BALB C	79	1.13	4	25	25	25
Animals, domestic	63	0.90	2	8	9	44
Rabbits	60	0.86	13	19	19	9
Animals, wild	46	0.66	2	4	4	36
Mice, inbred strains	44	0.63	7	25	7	5
Animals, newborn	36	0.52	0	1	11	24
Swine	35	0.50	3	2	10	20
Mice, inbred C57BL	29	0.42	1	2	12	14
Birds	22	0.32	1	8	7	6
Mice, nude	21	0.30	4	11	5	1
Rats, inbred strains	20	0.29	2	15	3	0
Guinea pigs	20	0.29	7	7	3	3
Horses	19	0.27	0	4	10	5
Animals, zoo	18	0.26	0	3	3	12
Mammals	15	0.22	1	6	1	7
Mice, inbred C3H	15	0.22	2	5	5	3

Table 6. List of the keywords (MeSH terms) most frequently used in articles on giardiasis covered by PubMed, 1971–2010

Key words	n	%	1971–1980	%	1981–1990	%	1991–2000	%	2001–2010	%
Parasitology	2,773	39.8	172	19.2	536	33.2	701	39.8	1,364	50.7
Isolation & purification	1,970	28.3	181	20.2	301	18.6	490	27.8	998	37.1
Epidemiology	1,919	27.6	209	23.3	389	24.1	463	26.3	858	31.9
Feces	1,610	23.1	176	19.6	361	22.4	368	20.9	705	26.2
Diagnosis	1,141	16.4	176	19.6	293	18.2	276	15.7	396	14.7
Intestinal diseases, parasitic	1,088	15.6	200	22.3	326	20.2	228	12.9	334	12.4
Genetics	1,038	14.9	16	1.8	75	4.6	294	16.7	653	24.3
Immunology	924	13.3	96	10.7	299	18.5	279	15.8	250	9.3
Drug therapy	917	13.2	248	27.6	210	13.0	202	11.5	257	9.6
Metabolism	889	12.8	67	7.5	139	8.6	236	13.4	447	16.6
Complications	881	12.7	212	23.6	237	14.7	213	12.1	219	8.1
Etiology	855	12.3	201	22.4	301	18.6	170	9.6	183	6.8
Therapeutic use	837	12.0	238	26.5	179	11.1	193	10.9	227	8.4
Analysis	822	11.8	75	8.4	243	15.1	199	11.3	305	11.3
Diarrhea	794	11.4	120	13.4	217	13.4	211	12.0	246	9.1
Microbiology	750	10.8	128	14.3	164	10.2	148	8.4	310	11.5
Methods	692	9.9	45	5.0	65	4.0	131	7.4	451	16.8
Prevalence	648	9.3	0	0	32	2.0	204	11.6	412	15.3
Chemistry	563	8.1	2	0.2	7	0.4	151	8.6	403	15.0
Pharmacology	528	7.6	29	3.2	106	6.6	158	9.0	235	8.7
Veterinary	526	7.6	21	2.3	77	4.8	117	6.6	311	11.6
Drug effects	504	7.2	24	2.7	94	5.8	140	7.9	246	9.1
Pathology	491	7.1	122	13.6	123	7.6	119	6.7	127	4.7
Cryptosporidium	476	6.8	0	0	27	1.7	88	5.0	361	13.4
Molecular sequence data	472	6.8	0	0	18	1.1	189	10.7	265	9.9
Growth & development	465	6.7	24	2.7	100	6.2	127	7.2	214	8.0
Metronidazole	459	6.6	128	14.3	105	6.5	110	6.2	116	4.3
Physiology	454	6.5	15	1.7	89	5.5	122	6.9	228	8.5
Transmission	443	6.4	55	6.1	136	8.4	83	4.7	169	6.3
Classification	438	6.3	16	1.8	32	2.0	100	5.7	290	10.8
Cryptosporidiosis	397	5.7	0	0	46	2.9	116	6.6	235	8.7
Enzymology	391	5.6	30	3.3	60	3.7	136	7.7	165	6.1
Antiprotozoal agents	378	5.4	29	3.2	29	1.8	113	6.4	207	7.7
Protozoan proteins	358	5.1	0	0	15	0.9	114	6.5	229	8.5
Protozoan infections	341	4.9	68	7.6	64	4.0	76	4.3	133	4.9
Antigens, protozoan	329	4.7	0	0	88	5.5	127	7.2	114	4.2
Ultrastructure	323	4.6	21	2.3	84	5.2	91	5.2	127	4.7
DNA, protozoan	305	4.4	0	0	1	0.1	111	6.3	193	7.2

In *Giardia* and giardiasis research, the most studied animal models were mice (5.76%), dogs (3.81%), cattle (2.86%), cats (2.10%), and rats (1.57%). Mice and rats are classical biological models used in pre-clinical studies, and their use in articles during the first two decades is significant. However, domestic animals, especially dogs and cats, were intensively studied during the last ten years.

In general, the most frequently used keywords revealed the most important research trends in the field (Table 6). Major descriptors relating to "parasitology", "isolation and purification" or "epidemiology" aspects of *Giardia* and giardiasis research were present during the whole study period. However, these research fronts changed during the different periods studied. "Drug therapy", "therapeutic use" and "complications"; and "parasitology", "epidemiology" and "feces" were the three major descriptors during the periods 1971–1980 and 1981–1990, respectively. "Isolation and purification" and "epidemiology" were the three major descriptors for the last two periods studied.

Main authors

A total of 16,864 authors were involved in the scientific research on *Giardia* and giardiasis during the 40-year period. Taking into account the activity of authors (27,244 entries of authors in 6,964 articles), the average number of authors per article was 3.91. Only 26 of these authors published more than 30 articles during the whole period, and 11 of them had an average higher than one article per year (Table 7).

The top 26 authors were led by the Americans F. D. Gillin and T. E. Nash and the Australian R. C. Thompson, all of them highly productive during the three last decades. The United States of America included 10 authors in the ranking, followed by Australia (5), India (3), and Canada (3). Europe was represented by three authors, one each from the United Kingdom, Sweden, and Norway. Latin America included two authors, one each from Argentina and Mexico.

Discussion

Systematic monitoring and evaluation of research on parasitic infections – in this case, *Giardia* and giardiasis, currently part of the WHO's Neglected Diseases Initiative – is becoming essential to help public health policies, decision makers, and related

Table 7. Authors with 30 or more papers on *Giardia* or giardiasis during the period 1971–2010

Author	Country	n	%	Output per decade			
				1971–1980	1981–1990	1991–2000	2001–2010
Gillin, FD	USA	97	1.39	1	32	34	30
Nash, TE	USA	89	1.28	0	28	37	24
Thompson, RC	AUS	89	1.28	0	10	35	44
Upcroft, P	AUS	61	0.88	0	8	37	16
Upcroft, JA	AUS	55	0.79	0	7	35	13
Wang, CC	USA	50	0.72	0	12	23	15
Farthing, MJ	UK	45	0.65	0	20	23	2
Ganguly, NK	IND	44	0.63	0	27	12	5
Jarroll, EL	USA	44	0.63	2	13	20	9
Reiner, DS	USA	43	0.62	0	18	13	12
Mahajan, RC	IND	43	0.62	0	27	14	2
Olson, ME	CAN	40	0.57	0	2	20	18
Erlandsen, SL	USA	39	0.56	1	22	12	4
Vinayak, VK	IND	38	0.55	8	17	11	2
Graczyk, TK	USA	38	0.55	0	0	11	27
Svard, SG	SUE	37	0.53	0	0	9	28
Faubert, GM	CAN	36	0.52	0	18	13	5
Edwards, MR	AUS	34	0.49	0	3	20	11
Boreham, PF	AUS	33	0.47	0	24	9	0
Dupont, HL	USA	33	0.47	6	13	6	8
Belosevic, M	CAN	32	0.46	0	16	10	6
Lujan, HD	ARG	31	0.45	0	0	13	18
Adam, RD	USA	31	0.45	0	4	15	12
Fayer, R	USA	30	0.43	0	0	8	22
Cedillo-Rivera, R	MEX	30	0.43	0	2	8	20
Robertson, LJ	NOR	30	0.43	0	0	3	27

research workers. Bibliometric studies, despite their methodological limitations, are useful tools for assessing the social and scientific relevance of a particular discipline or subject, since they allow the analysis of the growth, size, and distribution of scientific literature on the topic in question during a given time period. According to Boreham *et al*. [17], research on *Giardia* and giardiasis has evolved through three phases: the observational and descriptive approach, the use of quantitative experimental and survey methods, and the use of molecular tools.

This study was a purely descriptive analysis of the publications related to *Giardia* and giardiasis indexed in the PubMed database over four decades, as well as their evolution during this period [1-17]. According to the present study, there has been a steady growth of literature dedicated to *Giardia* and giardiasis throughout the 40-year period analyzed. Part of this could related to the progressive improvement in sanitation and the fading of the role of fatal epidemic infections and other public health problems that seemed to be more pressing as overwhelming everyday health concerns. Additionally, it should be mentioned that the extension of giardiasis to industrialized countries, the expansion of its range of symptoms, the search for better diagnostic procedures, and the increase in therapeutic failures with the drugs currently in use, may also have renewed the interest in this protozoan disease, as well as the increase in research on its molecular aspects and the incorporation of new journals in PubMed devoted to the study of parasitic and tropical diseases in recent years, including a wide diversity of geographical regions.

One of the important consequences of giardiasis is the potential persistence of symptoms after treatment, probably due to this parasitic infection triggering post-infectious syndromes such as celiac disease, lactose intolerance, food intolerance/allergies, or others. Some cases may be reinfection or relapse. Recognition of those consequences could be another possible reason behind the increasing number of publications on *Giardia* and giardiasis [18].

Another reason behind the increased number of publications may be the recent and increasing occurrence of outbreaks in more developed settings, such as Norway, with important long-term sequelae [19]; thus more research may be driven by its occurrence in these settings [20].

As expected, original articles were the most common type of document retrieved. This increased number of published original articles is mainly attributed to the research on molecular and basic aspects, as well as to the extension to the area of veterinary medicine, and the search of new diagnostic tools, which seems to be a continuous stimulus for the development of research in this field.

The introduction, in the last decades, of new journals (particularly non-English journals) in PubMed could also have had an impact on this. The core of journals with high productivity usually contains more relevant articles in the area. *Parasitology Research*, a journal that is devoted to parasites, published the highest number of articles, while the *Transactions of the Royal Society of Tropical Medicine and Hygiene*, the *American Journal of Tropical Medicine and Hygiene* – which were in the top ten of the most productive journals on *Giardia* and giardiasis during the four decades studied – the *Southeast Asian Journal of Tropical Medicine and Public Health*, *Med Parazitol*, and *Wiad Parazytol* had frequent publications on *Giardia* and giardiasis during the four decades analyzed. It is interesting to observe the importance that is conferred to veterinary giardiasis; *Veterinary Parasitology* was the third most productive journal, and also the most productive during the first 10 years of this century. The steady increase in the literature on *Giardia* and giardiasis and its diffusion in some of the most prestigious scientific journals suggest that giardiasis is a disease whose development is in full swing, from clinical and basic research perspectives.

The fact that a high number of articles was written in English language is not surprising; as stated by Meneghini and Packer [18], English has become the modern *lingua franca* of scientific activities in a world that is economically, scientifically, and culturally largely dominated by Anglo-American countries. However, it is well known that the PubMed database is biased in favor of English-language journals; thus, our survey may have penalized those researchers and countries that have a tradition of publishing their work in journals of their own language. This could be the case for non-English-speaking researchers from Eastern Europe and Japan, who tend to publish their findings in regional journals in their mother tongue, which leads to the risk that results might be ignored simply because they are not readily accessible to the international scientific community. Surprisingly, Spanish and German are taking a relevant place, perhaps as a reflection of some initiatives created to overcome this dilemma, the main aim of which is to strengthen the impact and quality of national journals with the goal of gaining greater international visibility

for articles published in languages other than English [17].

A further consideration regarding a problem that affects many biomedical topics should be noted; the analysis of keywords revealed a high heterogeneity of terms. Perhaps if all keywords were re-elaborated in order to group together concepts expressed with similar terms, a more synthetic picture of current research trends within *Giardia* and giardiasis could have been found. On the other hand, the ranking of the most productive authors involves some of the most influential and prestigious researchers devoted to the study of the disease, including classics such as Nash, Thompson, Farthing, and Faubert.

Potential limitations of the study are related to the database used to retrieve articles. Further studies should include other databases such as the Science Citation Index and Scopus, as well regional databases such as Latin American Literature in Health Sciences (LILACS) and the Scientific Electronic Library Online (SciELO). The PubMed database does not represent all scientific and biomedical journals published; in fact, many articles of importance may appear in journals other than those indexed in the PubMed database or may not be indexed, as in the cases of contributions made to scientific conferences and meetings. However, the recognized quality of the publications included in these databases and their coverage means that the documents selected constitute a more than representative sample of the international research on *Giardia* and giardiasis.

Despite its methodological limitations, this study represents the first effort to explore the development and research productivity of *Giardia* and giardiasis over time and has pointed out two interesting characteristics of the *Giardia* and giardiasis literature: the concentration of papers over journals disseminating the research results, and that research in this field growing and will likely continue to grow in the future.

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