

Celiac Disease: A Scientometric Analysis of World Publication Output, 2005-2014

Madhu Bansal¹, Ritu Gupta² and Jivesh Bansal^{3*}

ABSTRACT

The paper presents an analysis of 14317 world papers in celiac disease, retrieved from Scopus database for the period 2005-14, experiencing an annual average growth rate of 5.20% and citation impact of 12.53. The 15 most productive countries account for 83.89% share in world output, with largest share (21.40%) coming from U.S.A, followed by Italy (12.61%), U.K. (8.23%), Germany (5.41%) etc., during 2005-14. U.S.A achieved the global citation share (35.13%) followed by Italy (17.16%), U.K. (15.74%) etc. Medicine registered the highest publication share (87.93%), followed by biochemistry, genetics and molecular biology (13.56%), immunology and microbiology (6.73%), agricultural and biological sciences, (5.57%), nursing (3.07%), pharmacology, toxicology and pharmaceuticals (2.74%), neurosciences (2.26%), etc. Diarrhoea contributed the largest share (8.10%) in publications by symptoms during 2005-14, followed by abdominal pain (7.68%), insulin dependent diabetes mellitus (6.84%), Crohn disease (6.22%), enteritis (5.34%), etc. Gluten free diet contributed the largest share (18.47%) among significant keywords. The 15 most productive organisations, authors and journals accounted for 15.06%, 10.71% and 16.57% share of the world publication output respectively during 2005-14. It is concluded that individual countries must foster global research and development, by way of providing increased investment in R and D and increase their specialized manpower and provide adequate training courses and infrastructural facilities to scientists and researchers to control the challenges faced by the spread of this disease.

Keywords: Celiac disease, Global Publications, Scientometrics.

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History

- Submission Date: 11-10-2016;
- Review completed: 31-10-2016;
- Accepted Date: 12-11-2016.

DOI : 10.5530/ogh.2017.6.1.2

Article Available online

<http://www.oghreports.org/v6/1>

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INTRODUCTION

Celiac disease-also known as celiac sprue or gluten-sensitive enteropathy-is a digestive and autoimmune disorder that results in damage to the lining of the small intestine when foods with gluten are eaten. Gluten is a form of protein found in some grains. The damage to the intestine makes it hard for the body to absorb nutrients, especially fat, calcium, iron, and folate. Normally, the body's immune system is designed to protect it from foreign invaders. When people with celiac disease eat foods containing gluten, their immune system forms antibodies to gluten which then attack the intestinal lining. This causes inflammation in the intestines and damages the villi, the hair-like structures on the lining of the small intestine. Nutrients from food are normally absorbed by the villi. If the villi are damaged, the person cannot absorb nutrients properly and ends up malnourished, no matter how much he or she eats.^[1]

Celiac disease cannot be "caught," but rather the potential for celiac disease is in the body from birth. Its onset is not confined to a particular age range or gender, although more women are diagnosed than men. It is not known exactly what activates the disease, however three things are required for a person to develop celiac disease: (i) A genetic dis-

position: being born with the necessary genes. The Human Leukocyte Antigen (HLA) genes specifically linked to celiac disease are DR3, DQ2 and DQ8...and others; (ii) An external trigger: some environmental, emotional or physical event in one's life. While triggering factors are not fully understood, possibilities include, but are not limited to adding solids to a baby's diet, going through puberty, enduring a surgery or pregnancy, experiencing a stressful situation, catching a virus, increasing WBRO products in the diet, or developing a bacterial infection to which the immune system responds inappropriately, (iii) A diet: containing gluten and related polyamines, (iv) Auto-antigen enzyme, tissue transglutaminase (TG2) also TG4 and TG6 and (v) Production of pro-inflammatory cytokines, especially interferon (IFN- γ).^[2]

The signs and symptoms of celiac disease include: (1) Gastrointestinal Symptoms – (i) Diarrhea in 45-85% of patients, (ii) Flatulence in 28% of patients, (iii) Borborygmus in 35-72% of patients, (iv) Weight loss in 45% of patients; in infants and young children with untreated celiac disease, failure to thrive and growth retardation are common, (v) Weakness and fatigue in 78-80% of patients; usually related to general poor nutrition and (vi) severe abdominal pain in

Cite this article: Bansal M, Gupta R, Bansal J. Celiac Disease: A Scientometric Analysis of World Publication Output, 2005-2014. OGH Reports. 2017;6(1):8-15.

34-64% of patients and (ii) *Extraintestinal Symptoms* – (I) Anemia in 10-15% of patients, (II) Osteopenia and osteoporosis in 1-34% of patients, (III) Neurologic symptoms in 8-14% of patients; include motor weakness, paresthesias with sensory loss, and ataxia; seizures may develop, (III) Skin disorders in 10-20% of patients; including dermatitis herpetiformis, a condition with pruritic, papulovesicular skin lesions involving the extensor surfaces of the extremities, trunk, buttocks, scalp, and neck, (iv) Hormonal disorders - Including amenorrhea, delayed menarche, and infertility in women and impotence and infertility in men and (v) A bleeding diathesis is usually caused by prothrombin deficiency, due to impaired absorption of fat-soluble vitamin K.^[3] Approximately 3 million people in Europe and another 3 million people in the United States are estimated to be affected by celiac disease. Celiac disease is prevalent in European countries with temperate climates. The highest prevalence of celiac disease is in Ireland and Finland and in places to which Europeans emigrated, notably North America and Australia. In these populations, celiac disease affects approximately 1 in 100 individuals. The incidence of celiac disease is increasing among certain populations in Africa (Saharawui population), Asia (India), and the Middle East. Celiac disease is most prevalent in Western Europe and the United States, with an increasing incidence in Africa and Asia. Females are affected slightly more than males. The age distribution of patients with celiac disease is bimodal, the first at 8-12 months and the second in the third to fourth decades. The mean age at diagnosis is 8.4 years (range, 1-17 y). Celiac disease might become apparent in infants when gluten ingestion begins. Symptoms of celiac disease might persist throughout childhood if untreated but usually diminish in adolescence. Symptoms often reappear in early adulthood, between the third and fourth decades of life. Approximately 20% of patients with celiac disease are older than 60 years.^[4] Adolescents with celiac disease frequently present with extra intestinal manifestations, including short stature, behavioral problems, fatigue, and skin problems. The diagnosis of celiac disease is often not established until middle age or old age.^[4]

Literature Review

Only few quantitative studies are carried out on celiac disease publications. Among such studies, Master, Lebowitz, Ludvigsson and Green^[5] demonstrated that the quality and complexity of celiac disease research in both *Journal of Pediatric Gastroenterology and Nutrition* and *Journal of Gastroenterology* is comparable based on the similarities between the study topic and scope, funding, study design, and statistical methods. Good clinical research practices can be seen for celiac disease research on both the pediatric and adult levels. Narolsky, Green and Lebowitz^[6] analysed the temporal and geographic trends in celiac disease publications for the period 1960-2009. The authors analyzed CD publication output with respect to its degree of diffusion among journals and authors, and assessed for an association between economic parameters and output. A similar bibliometric study on global output (13536 papers) on celiac disease was conducted by Bhardwaj^[7] for the period 2001-12, with focus on publication growth, population age-group, country-wise and subject-wise scatter of publications and productivity of leading organizations, authors and journals. The present studies cover much larger dimensions than earlier studies.

OBJECTIVES

The main objective of this study is to analyse the global research output in celiac disease during 2005-14 with specific focus on (i) World Research output, its growth, rank and share of leading countries, (ii) the share of international collaboration papers, (iii) output and impact by different types of research, symptoms treatment methods and by different age groups (iv) publications productivity and citation impact of 15

leading institutions and authors; and (v) media of communication of the global research output in the most productive journals.

MATERIALS AND METHODS

This study used the Scopus international database to extract relevant publications in celiac disease research of the world and 15 most productive countries, for a period of 10 years (2005-14). A well defined search strategy involving 'Celiac' as the key-word in "TITLE-ABS-KEY" tag was used to search and download data resulting in 14317 global publications in celiac disease. The main search strategy was limited to affiliation tag and period tag to get the output in India and other countries. Papers were analysed by subfields by using classification as provided in Scopus database. Celiac disease research output was classified according to population age groups, symptoms, important keywords using different search strategies. Different tags under search strategy were used to analyse significant institutions, authors and journals.

ANALYSIS

The world publication output on celiac disease during 2005-2014 consisted of 14317 papers, which steadily increased from 1097 papers in 2005 to 1729 papers in 2014, witnessing an annual average growth rate of 5.20%. The world cumulative publication output has increased from 6209 papers during 2005-09 to 8108 papers during 2010-14, registering a growth rate of 30.58%. In terms of impact and citation quality, the average citation registered by world publication was 12.53 during 2005-14 which decreased from 18.71 during 2005-09 to 7.81 during 2010-14. (Table 1)

The articles constituted 65.48% share (9375) of the total world publications on celiac disease during 2005-14, followed by reviews (16.11%, 2307 papers), letters (6.70%, 960 papers), conference papers (2.25%, 323 papers), book chapter (1.70%, 244), and others appearing as articles in short survey, article in press, erratum, book conference review etc. The 85.45% (12238 papers) of the world publications in celiac disease appeared in English followed by Spanish (2.86%, 410 papers), German (2.14%, 307 papers), French (1.98%, 284 papers), Chinese (1.84%, 263 papers) and in 29 other languages.

Global publication and citation share of 15 most productive countries

The global publication share of the top 15 most productive countries in celiac disease varied from 2.21% to 21.40% during 2005-14, with USA (1st rank) contributing the largest publication share of 21.40% during 2005-14, followed by Italy (12.61% and 2nd rank), United Kingdom (8.23% share and third rank), Germany (5.41% and fourth rank), Spain (5.06% and fifth rank), Japan (4.04% share and sixth rank), Netherlands, France, China and Sweden (with publication shares ranging from 3.20 to 3.87% and ranks from the 7th to 10th), Turkey, India, Canada, Australia and Finland (with publication shares ranging from 2.21% to 2.86% and ranks from 11th to 15th). The global publication share increased by 1.48% in India, USA (1.42%), China (0.53%), Turkey (0.47%), Sweden (0.44%), Australia (0.25%), Finland (0.24%) and Italy (0.08%), as against decrease by 0.87% in France, Netherlands (0.59%), U.K. (0.52%), Germany (0.38%), Japan (0.32%) and Canada (0.29%) from 2005-09 to 2010-14. The global citation share of top 15 most productive countries varied from 1.57% to 35.13%, with largest citation share (35.13%) coming from USA, followed by Italy (17.16%), U.K. (15.74%), Netherlands (8.70%), Germany (7.13%), Canada, Sweden, Spain, France, Finland and Australia (with share varying from 3.86% to 5.95%), Japan, China, India and Turkey (with citation share varying from 1.10% to 2.40%) during 2005-14. Only 11 out of 15 countries registered relative citation index above 1: Netherlands (2.25), Canada (2.11), Finland (2.06), U.K. (1.91), Sweden

(1.74), Australia (1.62), USA (1.42), France (1.39), Italy (1.36), Germany (1.32) and Spain (1.08) during 2005-14 (Table 2).

International Collaboration

The countries have collaborated globally on celiac disease research in varying degrees. The highest international collaboration in cumulative publication output of top 15 most productive countries in celiac disease during 2005-14 was registered by Sweden (51.31%), followed by Finland (40.38%), Netherlands (39.35%), Germany (37.73%), Canada (36.72%), Australia (35.78%), UK (34.97%), France (29.92%), USA (26.24%), Italy (21.72%), Spain (21.41%), China (14.00%), India (12.38%), Japan (9.69%), Turkey (4.16%). (Table 3)

Celiac disease publication output in context of different subjects

The global publication output in celiac disease research has been published in context of different subject as retrieved from Scopus database. The highest publication share came from Medicine (12589 papers, 87.93%), followed by biochemistry, genetics and molecular biology (1942 papers, 13.56%), immunology and microbiology (964 papers, 6.73%), agricultural and biological sciences (797 papers, 5.57%), nursing (440 papers, 3.07%), pharmacology, toxicology and pharmaceuticals (393 papers, 2.74%), neurosciences (324 publications, 2.26%) and other subjects have share of less than 2 percent. The publication activity, as reflected in activity index, increased in medicine, biochemistry, genetics and molecular biology, immunology and microbiology, agricultural and biological sciences, nursing, chemistry and engineering, as against decrease in pharmacology, toxicology and pharmaceuticals, neurosciences and health profession from 2005-09 to 2010-14. Immunology and microbiology has scored the highest citation impact per paper of 22.40, followed by nursing (17.76), biochemistry, genetics and molecular biology (15.63), neuroscience (15.13), agricultural and biological sciences (14.40), pharmacology, toxicology and pharmaceuticals (14.00), chemistry (13.52), medicine (12.03), health professions (11.84) and engineering (6.48) during 2005-14 (Table 4).

World celiac disease research output by type of population group

In the classification of global celiac disease research by population by age-group, the greatest focus was on adults (with 36.29% share), followed by the middle-aged (22.74% share), adolescent (16.64% share), children (17.75% share), aged above 80 years (6.58% share). The publication share has increased in adolescents (from 16.62% to 16.66%), children (from 16.39% to 18.83%) and aged above 80 (from 6.37% to 6.75%), as against decrease in adults (from 37.68% to 35.22% and middle aged (from 22.94% to 22.54%) from 2005-09 to 2010-14 (Table 5).

World Celiac disease publications by symptoms

Among the various symptoms of celiac disease, the largest emphasis was on diarrhoea (8.10%), followed by abdominal pain (7.68%), insulin dependent diabetes mellitus (6.84%), Crohn disease (6.22%), enteritis (5.34%), weight reduction (4.42%), mal-absorption (4.34%) anaemia (3.76%), ulcerative colitis (3.58%), enteropathy (3.30%), irritable colon (3.12%), rheumatoid arthritis (3.09%), inflammation (3.05%), gastrointestinal symptom (2.96%), celiac artery stenosis (2.79%), osteoporosis (2.61%), dermatitis herpetiformis (2.58%), systemic lupus erythematosus (2.50%), pancreatic neoplasm (2.57%) and constipation (2.46%) during 2005-14. The publication share increased in diarrhoea, abdominal pain, insulin dependent diabetes mellitus, Crohn disease, weight reduction, anaemia, ulcerative colitis, dermatitis herpetiformis, systemic lupus erythematosus and pancreatic neoplasm (2.57%), as against decrease in enteritis, malabsorption, enteropathy and Osteoporosis from 2005-09 to 2010-14 (Table 6).

Celiac disease publications by other important keywords

Of the total world publications in celiac disease by important keywords during 2005-14, the largest share is occupied by gluten free diet (18.47%), followed by computer assisted tomography (9.51%), protein glutamine gamma glutamyl transferase antibody (9.08%), immunoglobulin A (8.75%), histopathology (8.65%), intestine biopsy (7.52%), duodenum biopsy (7.12%), unclassified drug (6.73%), pathology (6.42%), transglutaminases (6.34%) biopsy (6.32%), immunology (5.04%), diet therapy (4.56%), gastrointestinal endoscopy (3.89%), endoscopy (3.14%), Echography (3.09%), angiography (3.07%) and genetics (3.0%) (Table 7).

Research profile of the highly productive institutions in celiac disease research

The top 15 most productive institutions involved in celiac disease research individually published 112 to 219 papers and together published 2157 papers, accounting for 15.06% share of world publications during 2005-14. The scientometric profile of these 15 organizations along with their research output, citations received, and h-index values are presented in Table 8. Six institutions have registered a higher publication share than the group average productivity of 143.8 articles per institution: The University of Naples Federico II, Naples, Italy with 219 papers followed by Mayo Clinic, Rochester, USA (206 papers), V.U University Medical Centre, Netherlands (174 papers), University Hospital of Tampere, Finland (174 papers), *Università degli Studi di Roma "La Sapienza"*, Rome, Italy, (154 papers) and The Örebro County Council, Sweden (147 papers) during 2005-14. The average citation per paper of top 15 organizations varied from 17.00 to 39.80, with an average of 25.84 during 2005-14. Eight organizations have registered a higher citation impact than the group average citation impact: Leiden University Medical Centre, Leiden, Netherlands (39.80), VU University Medical Centre, Netherlands (31.13), Royal Hallamshire Hospital, South Yorkshire, U.K. (30.60), University of Milan, Italy (28.44), Harvard Medical School (27.77), Karolinska University Hospital (26.93), University of Tampere, Finland (26.23) and The University of Naples Federico II, Naples, Italy (26.01). The average h-index value of these 15 highly productive organizations was 31 and five organizations have scored a higher h-index value than the groups average h-index: Mayo clinic, Rochester, USA (41), The University of Naples Federico II, Italy (39), V.U University Medical Centre, Leiden, Netherlands (36), Leiden University Medical Centre, Leiden, Netherlands (36) and University Hospital of Tampere, Finland (35) (Table 8).

Contribution and impact of highly productive authors in celiac disease research

The top 15 most productive authors involved in celiac disease research individually published 58 to 155 papers and together published 1533 papers, accounting for 10.71% share of world publications during 2005-14. The scientometric profile of these 15 authors along with their research output, citations received, and h-index values are presented in Table 9. Six authors have published a higher number of articles than the group average (102.2): K. Kaukineh with 155 papers followed by Joseph Anthony Murray (153 papers), Markku Maki (150 papers), Jonas Flip Ludvigsson (128 papers), D S. Sanders (123 papers), Peter Hr R Green (109 papers) during 2005-14. Six authors have registered a higher impact than the average impact per paper (31.55) of all authors: Cisca Wijmenga (60.93), Alessio Fasano (54.21), Carlo Catassi (51.75), Joseph Anthony Murray (38.31), Ludvig Magne Sollid (35.37) and R. Troncone (33.45) during 2005-14. Nine authors have achieved a higher h-index value than the group average of 28.6: Joseph Anthony Murray (39), Alessio Fasano (36), K. Kaukineh (34), Cisca Wijmenga and Markku Maki (33 each), Ludvig Magne Solid (32), Jonas Flip Ludvigsson, D.S. Sanders and Pekkaolin (29 each) during 2005-14 (Table 9).

Table 1: Growth of publications and citations of the world output in celiac disease, 2005-14

Year	TP	TC	ACPP
2005	1097	25390	23.14
2006	1129	23790	21.07
2007	1237	23624	19.10
2008	1317	21562	16.37
2009	1429	21781	15.24
2010	1421	16915	11.90
2011	1576	16938	10.75
2012	1658	15399	9.29
2013	1724	9927	5.76
2014	1729	4112	2.38
2005-09	6209	116147	18.71
2010-14	8108	63291	7.81
2005-14	14317	179438	12.53

TP=Total Publications; TC=Total Citations; ACPP=Average Citation Per Paper

Table 2: World publication output and global publication and citation share of top 15 most productive countries in celiac disease, 2005-14

Name of the Country	Total Publications (TP)			Share of Total Publications			TC	ACPP	GCS	RCI
	2005-09	2010-14	2005-14	2005-09	2010-14	2005-14				
USA	1279	1785	3064	20.60	22.02	21.40	63037	20.57	35.13	1.64
Italy	780	1025	1805	12.56	12.64	12.61	30790	17.06	17.16	1.36
UK	529	649	1178	8.52	8.00	8.23	28238	23.97	15.74	1.91
Germany	349	425	774	5.62	5.24	5.41	12799	16.54	7.13	1.32
Spain	325	399	724	5.23	4.92	5.06	9836	13.59	5.48	1.08
Japan	262	316	578	4.22	3.90	4.04	4301	7.44	2.4	0.59
Netherlands	261	293	554	4.20	3.61	3.87	15620	28.19	8.7	2.25
France	251	257	508	4.04	3.17	3.55	8872	17.46	4.94	1.39
China	195	298	493	3.14	3.68	3.44	2819	5.72	1.57	0.46
Sweden	183	275	458	2.95	3.39	3.20	10006	21.85	5.58	1.74
Turkey	161	248	409	2.59	3.06	2.86	1970	4.82	1.1	0.39
India	123	281	404	1.98	3.47	2.82	2635	6.52	1.47	0.52
Canada	185	218	403	2.98	2.69	2.81	10675	26.49	5.95	2.11
Australia	139	202	341	2.24	2.49	2.38	6930	20.32	3.86	1.62
Finland	129	188	317	2.08	2.32	2.21	8198	25.86	4.57	2.06
Total of 15 countries	5151	6859	12010	82.96	84.60	83.89				
Total of the world	6209	8108	14317				179438	14.94		

TP=Total Publications; TC=Total Citations; ACPP=Average Citation Per Paper; GCS=Global Citation Share; RCI=Relative Citation Index

Table 3: Number and share of international collaborative papers of top 15 most productive countries in celiac disease, 2005-14

Country	TP	ICP	Share of ICP
USA	3064	804	26.24
Italy	1805	392	21.72
UK	1178	412	34.97
Germany	774	292	37.73
Spain	724	155	21.41
Japan	578	56	9.69
Netherlands	554	218	39.35
France	508	152	29.92
China	493	69	14.00
Sweden	458	235	51.31
Turkey	409	17	4.16
India	404	50	12.38
Canada	403	148	36.72
Australia	341	122	35.78
Finland	317	128	40.38

Table 4: Subject-wise distribution of World publications in Celiac disease research, 2005-14.

Subject	Number of Publications			Activity Index		TC	ACPP	%TP
	2005-09	2010-14	2005-14	2005-09	2010-14			
Medicine	5415	7174	12589	99.18	100.63	151408	12.03	87.93
Biochemistry, Genetics and Molecular Biology	739	1203	1942	87.75	109.38	30353	15.63	13.56
Immunology and Microbiology	403	561	964	96.40	102.76	21595	22.4	6.73
Agricultural and Biological Sciences	303	494	797	87.66	109.45	11475	14.4	5.57
Nursing	156	284	440	81.75	113.97	7813	17.76	3.07
Pharmacology, Toxicology and Pharmaceutics	191	202	393	112.07	90.76	5502	14	2.74
Neuroscience	170	154	324	120.99	83.93	4903	15.13	2.26
Health Professions	157	92	249	145.39	65.24	2947	11.84	1.74
Chemistry	61	156	217	64.82	126.94	2934	13.52	1.52
Engineering	44	130	174	58.31	131.93	1128	6.48	1.22
	6209	8108	14317					

Table 5: Celiac Disease Research Output by Different Age Group during 2005-14

Population Age Group	Number of Publications			Percentage of Papers		
	2005-09	2010-14	2005-14	2005-09	2010-14	2005-14
Adults	2276	2704	4980	37.68	35.22	36.29
Middle Aged	1386	1731	3121	22.94	22.54	22.74
Adolescent	1004	1279	2283	16.62	16.66	16.64
Children	990	1446	2436	16.39	18.83	17.75
Aged above 80 years	385	518	903	6.37	6.75	6.58
Total	6041	7678	13723	100.0	100.0	100.00

Table 6: Distribution of World Celiac disease research publications by signs and symptoms during 2005-14

S. No.	Celiac Disease by symptoms	Number of Papers			Percentage share of papers		
		2005-09	2010-14	2005-14	2005-09	2010-14	2005-14
1.	Diarrhoea	442	718	1160	7.12	8.86	8.10
2.	Abdominal pain	431	750	1100	6.94	9.25	7.68
3.	Insulin dependent Diabetes-Mellitus	417	562	979	6.72	6.93	6.84
4.	Crohn Disease	354	536	890	5.70	6.61	6.22
5.	Enteritis	342	423	765	5.51	5.22	5.34
6.	Weight reduction	248	385	633	3.99	4.75	4.42
7.	Malabsorption	292	330	622	4.70	4.07	4.34
8.	Anaemia	229	310	539	3.69	3.82	3.76
9.	Ulcerative colitis	175	338	513	2.82	4.17	3.58
10.	Enteropathy	258	215	473	4.16	2.65	3.30
11.	Irritable colon	163	284	447	2.63	3.50	3.12
12.	Rheumatoid arthritis	147	296	443	2.37	3.65	3.09
13.	Inflammation	177	259	436	2.85	3.19	3.05
14.	Gastrointestinal symptom	177	247	424	2.85	3.05	2.96
15.	Celiac artery stenosis	171	229	400	2.75	2.82	2.79
16.	Osteoporosis	192	181	373	3.09	2.23	2.61
17.	Dermatitis herpetiformis	154	215	369	2.48	2.65	2.58
18.	Systemic lupus erythematosus	126	236	358	2.03	2.91	2.50
19.	Pancreatic neoplasm	159	209	368	2.56	2.58	2.57
20.	Constipation	111	241	352	1.79	2.97	2.46
	Total of world	6209	8108	14317			

Research communication in highly productive journals

The fifteen highly productive journals on celiac disease individually published 109 to 253 papers and together contributed 2274 papers, constituting 16.57% share of world output, which decreased from 17.86% to 15.56% from 2005-09 to 2010-14 (Table 10). *Journal of Paediatric Gastroenterology and Nutrition* was the highly productive journal with 253 papers, followed by *World Journal of Gastroenterology* (225 papers), *Alimentary Pharmacology and Therapeutics* (179 papers), etc during 2005-14 (Table 10).

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SUMMARY AND CONCLUSIONS

The world has contributed 14317 papers in celiac disease, during 2005-2014 which increased from 1097 papers in 2005 to 1729 papers in 2014, witnessing an annual average growth rate of 5.20%. The average citation impact per paper registered by global publications in celiac

Table 7: Distribution of world celiac disease publications by important keywords 2005-14

S. No.	Significant Keywords	TP	%TP
1.	Gluten free diet	2645	18.47
2.	Computer assisted tomography	1362	9.51
3.	Protein glutamine gamma glut amyl transferase antibody	1300	9.08
4	Immunoglobulin A	1253	8.75
5.	Histopathology	1238	8.65
6.	Intestine biopsy	1076	7.52
7.	Duodenum biopsy	1019	7.12
8.	Unclassified drug	964	6.73
9.	Pathology	919	6.42
10.	Transglutamenases	907	6.34
11.	Biopsy	905	6.32
12.	Immunology	722	5.04
13.	Diet Therapy	653	4.56
14.	Gastrointestinal endoscopy	557	3.89
15.	Endoscopy	450	3.14
16.	Echography	443	3.09
17.	Angiography	440	3.07
18.	Genetics	430	3.00
	Total of the world	14317	

Table 8: Productivity and impact of top 15 most productive world institutions in celiac disease, 2005-14

S. No.	Name of the Organization	TP	TC	ACPP	h-Index
1	The University of Naples Federico II , Naples, Italy	219	5697	26.01	39
2	Mayo Clinic, Rochester, USA	206	5290	25.68	41
3	VU University Medical Center, Netherlands	174	5417	31.13	37
4	University Hospital of Tampere, Finland	174	4046	23.25	35
5	Università degli Studi di Roma "La Sapienza", Rome, Italy	154	2622	17.03	23
6	The Örebro County Council, Sweden	147	3004	20.44	31
7	Leiden University Medical Center (LUMC),Leiden, Netherlands	128	5094	39.80	36
8	Alma Mater Studiorum - Università di Bologna, Italy	127	2159	17.00	26
9	Karolinska University Hospital, Sweden	125	3366	26.93	31
10	Harvard Medical School. USA	121	3360	27.77	31
11	Karolinska Institute, Solna, Sweden	119	3047	25.61	28
12	University of Milan, Italy	118	3356	28.44	27
13	Royal Hallamshire Hospital, South Youkshire, U.K	117	3580	30.60	29
14	The University of Pavia, Italy	116	2523	21.75	26
15	University of Tampere , Finland	112	2938	26.23	25
	Total of 15 organizations	2157	55499	25.73	31
	Total of the world	14317	179438		
	Share of 15 organizations in world total	15.07	30.93		

disease research was 12.53 during 2005-14, which has decreased from 18.71 during 2005-09 to 7.81 during 2010-14. The global publication share of top 15 most productive countries in celiac disease varied from 2.21% to 21.40%, with highest publication share (21.40%) coming from USA, followed by Italy (12.61%), U.K (8.23%), Germany (5.24%), Spain (5.06%), Japan (4.04%) etc during 2005-14. The global publication share has increased in India, USA, China, Turkey, Sweden, Australia, Finland as against decrease in France, UK, Netherlands, Germany, Spain, Japan, Canada and Finland from 2005-09 to 2010-14. The combined global publication share of top 15 most productive countries was 83.89%, which increased from 82.96% to 84.60% from 2005-09 to 2010-14. The global citation share of top 15 most productive countries varied from 1.57% to 35.13%, with largest citation share (35.13%) coming from USA, followed by Italy (17.16%), U.K. (15.74%), Netherlands (8.70%), Germany (7.13%), etc during 2005-14. Eleven countries registered relative citation index above 1: Netherlands (2.25), Canada (2.11), Finland (2.06), U.K. (1.91), Sweden (1.74) , Australia (1.62), USA (1.42), France (1.39), Italy (1.36), Germany (1.32) and Spain (1.08) during 2005-14. The highest international collaborative publications share among the leading 15

most productive countries was registered by Sweden (51.31%) followed by Finland (40.38%), Netherlands (39.35%), Germany (37.73%), Canada (36.72%), Australia (35.78%) etc. Among the various subjects contributing to global celiac disease research during 2005-14, medicine registered the highest publication share (87.93%), followed by biochemistry, genetics and molecular biology (13.56%), immunology and microbiology (6.73%), agricultural and biological sciences, (5.57%), nursing (3.07%), pharmacology, toxicology and pharmaceuticals (2.74%), neurosciences (2.26%), etc. The publication activity increased in medicine, biochemistry, genetics and molecular biology, immunology and microbiology, agricultural and biological sciences, nursing, chemistry and engineering, as against decrease in pharmacology, toxicology and pharmaceuticals, neurosciences and health profession from 2005-09 to 2010-14. Immunology and microbiology among various subjects scored the highest citation impact per paper of 22.40, followed by nursing (17.76), biochemistry, genetics and molecular biology (15.63), neuroscience (15.13), agricultural and biological sciences (14.40), pharmacology, toxicology and pharmaceuticals (14.00), chemistry (13.52), medicine (12.03), health professions (11.84) and engineering (6.48) during 2005-14. The research activity has

Table 9: Productivity and impact of top 15 most productive world authors in celiac disease, 2005-14

S. No.	Name	Organization	TP	TC	ACPP	h-Index
1	K. Kaukineh	University Hospital of Tampere, Finland	155	4399	28.38	34
2	Markku Maki	University Hospital of Tampere, Finland	150	4606	30.71	33
3	Joseph Anthony Murray	Mayo Medical School, USA	153	5861	38.31	39
4	Jonas Flip Ludvigsson	The Örebro County Council, Sweden (Örebro läns landsting)	128	2636	20.59	29
5	D. S. Sanders	Sheffield Teaching Hospitals NHS Foundation Trust, Sheffield, U.K	123	3688	29.98	29
6	Pekka O Collin	University Hospital of Tampere, Finland	100	2835	28.35	29
7	Gino Roberto Oberto Corazza	The University of Pavia, Italy (Università degli studi di Pavia, Italy)	94	2139	22.76	26
8	Ludvig Magne Sollid	University of Oslo, Norway	86	3042	35.37	32
9	Alessio Fasano	Massachusetts General Hospital Mucosal Immunology and Biology Research Center, USA	84	4554	54.21	36
10	Cisca Wijmenga	University Medical Center Groningen, Netherlands	80	4874	60.93	33
11	R. Troncone	European Laboratory for the Investigation of Food Induced Diseases (ELFID), University of Naples Federico II, Naples, Italy	80	2676	33.45	28
12	Peter Hr R Green	Columbia University, College of Physician and surgeons, New York, USA	109	2017	18.5	24
13	Vincenzo Villanacci	Spedali Civili di Brescia, Italy	70	1199	17.13	17
14	Carlo Catassi	Marche Polytechnic University , Ancana, Italy	63	3260	51.75	26
15	Benjamin Lebwohl	Karolinska university hospital stockholm sweden	58	576	9.93	14
Total of 15 authors			1533	48362	31.55	28.6
Total of World			14317	179438		
Share of 15 authors in world output			10.71	26.95		

Table 10: World: Media of communication in Most Productive Journals in celiac disease research, 2005-14

S. No.	Name of the Journal	Number of Papers		
		2005-09	2010-14	2005-14
1	Journal of Paediatric Gastroenterology and Nutrition	100	153	253
2	World Journal of Gastroenterology	110	115	225
3	Alimentary Pharmacology and Therapeutics	66	113	179
4	American Journal of Gastroenterology	67	103	170
5	Scandinavian Journal of Gastroenterology	103	62	165
6	Digestive Disease And Sciences	88	69	157
7	Journal of Vascular Surgery	53	91	144
8	Clinical Gastroenterology and Hepatology	68	71	139
9	Gastroenterology	88	47	135
10	Digestive and liver disease	67	64	131
11	Gut	74	44	118
12	Journal of Clinical Gastroenterology	53	65	118
13	European Journal of gastroenterology and Hepatology	75	43	118
14	Gastrointestinal Endoscopy	57	56	113
15	PLOS One	10	99	109
Total of 15 journals		1079	1195	2274
Total of world		6041	7678	13723
Share of 15 journals in world output		17.86	15.56	16.57

increased in medicine, biochemistry , genetics and molecular biology, agriculture and biological sciences, immunology and microbiology, in contrast to decrease in health professions and neuroscience from 2005-09 to 2010-14. Immunology and Microbiology had achieved the highest citation impact (22.40 citations per article).

Among the world celiac disease research publications by symptoms, during 2005-2014, diarrhoea registered the largest publication share (8.10%), followed by abdominal pain (7.68%), insulin dependent diabe-

tes mellitus (6.84%), Crohn disease (6.22%), enteritis (5.34%), weight reduction (4.42%), mal-absorption (4.34%), etc during 2005-14. In terms of various significant keywords, the largest share (18,74%) is registered by gluten free diet, followed by computer assisted tomography (9.51%), protein glutamine gamma glutamyl transferase antibody (9.08%), immunoglobulin A (8.75%), etc during 2005-14. The major focus of global celiac disease research by population age groups in terms of research output during 2005-14 was on adults (36.9%) share, followed by middle

aged (22.74%) , Children (17.75%), adolescent (16.64%) and aged above 80 years (6.58%) during 2005-14. The 15 most productive organisations, authors and journals accounted for 15.06%, 10.71% and 16.57% share of the world publication output respectively during 2005-14.

It can be concluded that celiac disease is growing at an alarming rate throughout the world. The afflicted persons suffer throughout the life because of lack of standard treatment for the disease. Patients are kept on a strict gluten free diet throughout the life. Celiac Disease Foundation (CDF) promoting research, in celiac disease creating awareness and providing support to affected people. U.S National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) also supports clinical research on celiac disease. The global research output on celiac disease is quite low. World Health Organisation and United Nations should take stringent actions to create awareness and provide preventive treatment of the disease.

It is concluded that individual countries must foster global research and development, by way of providing increased investment in RandD and increase their specialized manpower and provide adequate training courses and infrastructural facilities to scientists and researchers to control the challenges faced by the spread of this disease.

CONFLICT OF INTEREST

The authors declare none.

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Cite this article: Bansal M, Gupta R, Bansal J. Celiac Disease: A Scientometric Analysis of World Publication Output, 2005-2014. *OGH Reports*. 2017;6(1):8-15.