Invited Article

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Atypical antipsychotic drugs in India: A scientometric study during 1998-2013

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ABSTRACT

Present a bibliometric analysis of 1432 publications in Indian research in atypical antipsychotic drugs during 1998-2013, using publications indexed in Scopus database. The study identified the global publication share and rank of Indian research output among the 15 most productive countries and examined the distribution of citations of the Indian research output, the share of international collaborative publications in Indian publication output and identification of the leading India's collaborating partners, the distribution of Indian research output by broad subject areas, by individual drugs and by disease; publication productivity and the citation impact of leading Indian institutions; the media of communication and the characteristics of the high cited publications.

Key words: Atypical antipsychotic drugs, India, publications, scientometrics

INTRODUCTION

Mental disorders are classified as a psychological condition marked primarily by sufficient disorganization of personality, mind, and emotions to seriously impair the normal psychological and often social functioning of the individual. Antipsychotic medications, introduced in the 1950's, is also widely used to treat some types of mental distress, mainly schizophrenia and manic depression (bipolar disorder), agitation associated with dementia, anxiety disorder, autism spectrum disorder, obsessive-compulsive disorders, etc.[1] Antipsychotic medications cannot "cure" the illness, but they can take away many of the symptoms or make them milder. In some cases, they can shorten the course of an episode of the illness as well. The first antipsychotic medications were introduced in the 1950s. Antipsychotic medications have helped many patients with psychosis lead a more normal and fulfilling life by alleviating such symptoms as hallucinations, both visual and auditory and paranoid thoughts. However, the early antipsychotic medications often have unpleasant side-effects, such as muscle stiffness, tremor, and abnormal movements, leading researchers to continue their search for better drugs.[2]

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Antipsychotic medications are thought to work by altering the effect of certain chemicals in the brain, called dopamine, serotonin, noradrenaline, and acetylcholine. These chemicals have the effect of changing your behavior, mood, and emotions. Dopamine is the main chemical

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that these medicines have an effect on. By altering the effects of these chemicals in the brain they can suppress or prevent you from experiencing: Hallucinations (such as hearing voices), delusions (having ideas not based on reality), thought disorder and extreme mood swings that are associated with bipolar disorder.[3] The development of antipsychotics over the last 60 years has come full circle. The first wave of effective antipsychotics was serendipitously discovered in the 1950s and had multiple mechanisms of action. The second wave (e.g. haloperidol) was rationally developed to have a specific and selective mechanism of action-dopamine D2 receptor blockade. The third wave completed the circle in that the newest antipsychotics ("atypical" antipsychotics) also have multiple mechanisms of action; specifically, they combine blockade of certain subtypes of serotonin (five hydroxytryptamine) receptors and blockade of the D2 receptor. In contrast to the first wave, the third wave was rationally designed to have multiple mechanisms of action.[4]

The 1990s saw the development of several new drugs called "atypical antipsychotics (AAP)" or "second generation antipsychotics" (SGAs) for controlling mental diseases. Because they have fewer side-effects than the older drugs, today they are often used as a first-line treatment. The first AAP, clozapine (clozaril), was introduced in the United States in 1989. Since then, six other AAPs have been introduced: Risperidone (1993), olanzapine (1996), quetiapine (1997), ziprasidone (2001), aripiprazole (2002), and paliperidone (2006), and several others followed them.[5] The group of atypical antipsychotic drugs (AADs) also have received regulatory approval (e.g. by the Food and Drug Administration of the US, the Therapeutic Goods Administration, of Australia, the Medicines and Healthcare products Regulatory Agency of the UK) for schizophrenia, bipolar disorder, autism and as an adjunct in major depressive disorder.[5]

The advances achieved in the field of antipsychotic drugs in the past 20 years have been incredibly important, with the clinical introduction of numerous SGAs (risperidone, olanzapine, quetiapine, ziprasidone, aripiprazole, etc.), which have notably improved the quality of life of psychotic patients and have contributed decisively to weakening the stigmatization that has traditionally accompanied psychiatric attention. With the clinical introduction of the new SGAs, research related to these drugs has advanced considerably, and this has led to a considerable growth in the publications on these drugs world-wide as well as in India.[6] The present study, therefore, quantitative analyzes the trends of research and characteristics of literature in the area of AADs in India.

Literature review

A few quantitative studies have been carried out in AADs research in some countries. Lopez-Munoz *et al*. performed a bibliometric study of 438 scientific publications in Australia[7] during 1993-2011, 656 scientific publications from Spain[8] during 1998-2011, 326 publications in South Korea[6] during 1993-2011 and 44 publications in Hong Kong[9] during 1993-2001 on AADs, using Embase and Medline databases. The authors applied some bibliometric indicators of paper production and dispersion with Price's law and Bradford's law, respectively. They also calculated the participation index of the different countries and correlated the bibliometric data with some social and health data. They have also identified the most widely used AADs.

Furthermore, few bibliometric analysis of Indian research has been carried out on few mental health diseases, such as dementia[10] research during 2002-2011 by Gupta, Harkaur and Kshitig, Alzheimer's disease,[11] Parkinson's disease,[12] epilepsy research[13] and schizophrenia[14] research by Gupta and Bala during 2002-2011, using Scopus database. Research in these publications have been carried output on different parameters including the growth, global publication share, citation impact, share of international collaborative publications, contribution of major collaborative partners, contribution of various subject fields and by type of research, productivity and citation impact of most productive Indian organizations and authors and pattern of research communication.

Objectives

The main objectives of the present study are to analyze the research performance of Indian research in AADs during 1998-2013, based on publications indexed in Scopus database. In particular, the study focuses on the following objectives: (i) To study the global research output and its growth; (ii) to study the contribution and citation impact of top 15 most productive countries; (iii) to examine the distribution of citations of the Indian research output; (iv) to study the share of international collaboration publications in Indian publication output and by the leading collaborating partners; (v) to study the distribution of Indian research output by broad subject areas; (vi) to study the distribution of Indian publications output by individual drugs and by disease; (vii) to study the publication productivity and the citation impact of leading institutions; (viii) to study the media of communication; and (ix) to study the characteristics of the high cited publications.

METHODOLOGY

The study retrieved the global publication data and of top 15 most productive countries in AADs from the Scopus database (http://www.Scopus.com) for 16 years during 1998-2013. The keyword "AAP" and "names of 15 AADs" were used in "title, abstract and keyword" field and "1998-2013" in the time field (as shown in following search strategy) was used for searching the main publication data used in the study and this become the main search string. Similar strings were used to generate publications output data of top 15 countries, including India by restricting the main search strategy to particular "country code" tag. For generating citation impact data, the 3 years, 2 years, 1 year citation window was used for publications during 1998-2011, 2012 and 2013. And the citation time was restricted until the end of April 2014. For analyzing institutional and journals output, the main search strategy was restricted to "institutional tag" and "journal tag" to generate the desired output.

[TITLE-ABS-KEY ("AAP") or TITLE-ABS-KEY (clozapine or risperidone or quetiapine) or TITLE-ABS-KEY (aripiprazole or amisulpride or ziprasidone) or TITLE-ABS-KEY (paliperidone or asenapine or iloperidone) or TITLE-ABS-KEY (blonanserin or zotepine or lurasidone) or TITLE-ABS-KEY (sertindole or perospirone or olanzapine)] and PUB YEAR >1997 and PUB YEAR <2014.

ANALYSIS

Global publication output, share, and rank

The global publication share of top 15 most productive countries in AADs in India varied from 1.79% to 36.01% during 1998-2013, with USA occupying the first rank and contributing the largest publication share (36.01%), followed by UK (9.06%, 2nd rank), Germany(7.17%, 3rd rank), Canada (5.56%, 4th rank), Italy (4.68%, 5th rank), Germany, France, Italy and India (from 4.05% to 4.63% publication share and rank from 6th to 9th), India and The Netherlands (from 2.5% to 2.86% publication share and rank from 10th to 11th) and Turkey, China, Switzerland and Belgium (from 1.60% to 1.90% publication share and rank from 12th to 15th). The global publication share has witnessed the largest increase of 2.90% in India, followed by China (1.64%), Turkey (1.42%), Italy (1.21%), Australia (1.12%), Japan (1.06%), Belgium (1.04%), Spain (1.01%), Canada (0.8%), The Netherlands (0.6%) and Switzerland (0.28%), as against decrease by 1.08% in USA, followed by Germany (0.85%), France (0.32%) and UK (0.07%) from 1998-2005 to 2006-2013. The countries which have increased their global publication rank among 15 most productive countries are: India (from 12th to 8th), China (from 15th to 13th), Turkey (from 13th to 12th), Australia (from 8th to 7th) and Spain (from 7th to 6th), as against decrease in France (from 6th to 10th), Switzerland (11th to 15th) and The Netherlands (from 10th to 11th) from 1998-2005 to 2006-2013 (Table 1).

Indian publications output and citation impact

India has published 1432 publications in AADs during 1998-2013, which increased from nine publications in 1998-2016 publications in 2013, witnessing an annual average growth rate of 22.76%. India's cumulative publication output in antipsychotic drugs increased from 183 publications during 1998-2005 to 1249 during 2006-2013, witnessing a growth rate of 23.71%. Compared to this, world has published 50119 publications in AADs during 1998-2013, which increased from 1325 in 1998-4006 publications in 2013, witnessing an annual average growth rate of 7.50%. The average citation impact (on 3 years citation window) made by all Indian publications in AADs during 1998-2013 was 2.43, which decreased from 3.14 during 1998-2005 to 2.32 during 2006-2013 (Table 2). The total Indian output (1432 publications) consisted of 904 articles (63.13%), 303 letters (21.16%), 180 reviews (12.57%), 18 notes (1.26%), 12 conference publications (0.84%), 8 editorials (0.56%), 6 short surveys (0.42%), and 1 erratum (0.07%) during 1998-2013.

Citation pattern of Indian research output

Citations of publications since their publication were examined from 1998 to April 2014. During this period, 9046 citations were received by 1432 publications, and the average rate of citations per publication is 6.32.35.89% of the total publications did not get any citations (zero citation) and the rest of the 64.11% publications were cited one or more times. Of the total cited publications, 0.84% publications (receiving more than 100 citations) contributed 22.71% citations share, 0.56% publications (receiving citations from 51 to 100) contributed 5.83% citations share, 2.58% publications (receiving citations from 31 to 50) contributed 15.65% citations share, 11.03% publications (receiving citations from 11 to 30) contributed 30.07% citations, and the rest 49.090% publications (receiving citations from 1 to 10) contributed 35.89% citations share (Table 3).

International collaboration

The share of international collaborative publications in total Indian publication output in AADs during was

Table 1: Global publication output, share and rank in AADs in India, 1998-2013

Country	Number of publications			Global share of publications			Global publication rank		
	1998-2005	2006-2013	1998-2013	1998-2005	2006-2013	1998-2013	1998-2005	2006-2013	1998-2013
USA	6671	11378	18049	36.70	35.62	36.01	1	1	1
UK	1656	2886	4542	9.11	9.04	9.06	2	2	2
Germany	1402	2191	3593	7.71	6.86	7.17	3	3	3
Canada	918	1869	2787	5.05	5.85	5.56	4	4	4
Italy	711	1635	2346	3.91	5.12	4.68	5	5	5
Spain	551	1292	1843	3.03	4.04	3.68	7	6	6
Australia	526	1282	1808	2.89	4.01	3.61	8	7	7
Japan	501	1221	1722	2.76	3.82	3.44	9	9	8
France	650	1042	1692	3.58	3.26	3.38	6	10	9
India	183	1249	1432	1.01	3.91	2.86	12	8	10
Netherlands	385	869	1254	2.12	2.72	2.50	10	11	11
Turkey	181	773	954	1.00	2.42	1.90	13	12	12
China	142	772	914	0.78	2.42	1.82	15	13	13
Switzerland	275	572	847	1.51	1.79	1.69	11	15	14
Belgium	170	634	804	0.94	1.98	1.60	14	14	15
World	18178	31941	50119						

AADs: Atypical antipsychotic drugs

Table 2: World and Indian publications and citation impact in AADs in India, 1998-2013

Period	World	India				
	TP	TP	TC	ACPP	ICP	%ICP
1998	1325	9	23	2.56		0.00
1999	1563	11	29	2.64	3	27.27
2000	1658	12	11	0.92		0.00
2001	1837	16	55	3.44	2	12.50
2002	2278	17	40	2.35	1	5.88
2003	2809	27	87	3.22	5	18.52
2004	3222	40	103	2.58	5	12.50
2005	3486	51	226	4.43	9	17.65
2006	3640	77	212	2.75	15	19.48
2007	4137	96	334	3.48	15	15.63
2008	4103	101	516	5.11	17	16.83
2009	4000	153	393	2.57	19	12.42
2010	3939	156	425	2.72	18	11.54
2011	4083	222	675	3.04	22	9.91
2012	4033	228	241	1.06	16	7.02
2013	4006	216	105	0.49	14	6.48
1998-2005	18178	183	574	3.14	25	13.66
2006-2013	31941	1249	2901	2.32	136	10.89
1998-2013	50119	1432	3475	2.43	161	11.24

TP: Total publications, TC: Total citations, ACPP: Average citation per paper, AADs: Atypical antipsychotic drugs

11.24% (161 publications) during 1998-2013, which decreased from 13.66% (25 publications) during 1998-2005 to 10.89% (136 publications) during 2006-2013. In all 83 foreign countries collaborated with India, as reflected in India's collaborative publications during 1998-2013. During this period, United States contributed the largest share (49.69%) of international collaborative publications with India, followed by UK (26.09%), Australia (16.77%), Canada (8.70%), Malaysia (7.45%), Israel (6.83%), China (6.83%), Germany, South Korea, Switzerland and Thailand (6.21% each), Japan and Singapore (5.59% each), etc. India's international collaborative publication share has increased by 10.29% in Canada, followed by Malaysia (7.45%), Switzerland and Thailand (7.35% each), Japan and Singapore (6.62% each), China (3.35%), South Korea (2.62%), UK (2.47%0, USA (2.0%) and Australia (0.91%), as against decrease in Israel by 6.12% and in Germany by 2.12% from 1998-2005 to 2006-2013 (Table 4).

Table 3: Citations received by Indian publications in AADs in India, 1998-2013

Number of citations	Number of publications	Total citations	% publications	% citations
0	514	0	35.89	0
1-10	703	2329	49.09	25.75
11-30	158	2720	11.03	30.07
31-50	37	1416	2.58	15.65
51-100	8	527	0.56	5.83
>100	12	2054	0.84	22.71
Total	1432	9046	100.00	100.00

AADs: Atypical antipsychotic drugs

Subject-wise distribution

The India's publication output in AADs research during 1998-2013 has been published in the context of six sub-fields (as reflected in Scopus database classification), with highest publication output coming from medicine (871 publications, 60.82% share), followed by pharmacology, toxicology and pharmaceutics (536 publications, 37.43%), neurosciences (177 publications, 12.36%), chemistry (159 publications, 11.10%), biochemistry, genetics and molecular biology (147 publications, 10.27%) and psychiatry and psychology (101 publications, 7.05%) during 1998-2013.

On analyzing the trends in AADs research in India using activity index, it was found that research activity has increased in medicine (activity index from 59.29 to 99.38), pharmacology, toxicology and pharmaceutics (activity index from 79.06 to 100.53), neurosciences (activity index from 48.63 to 91.33) and chemistry (from 88.59 to 106.72), as against decrease in biochemistry, genetics and molecular activity (activity index from 127.76 to 100.61) and psychiatry and psychology (activity index from 185.94 to 86.27). In terms of citation impact per paper, it was found that neurosciences had scored the highest citation impact (3.56), followed by psychiatry or psychology (3.02), pharmacology, toxicology and pharmaceutics (2.95), biochemistry, genetics and molecular biology (2.90), chemistry (2.70) and medicine (2.06) during 1998-2013 (Table 5).

Drug-wise distribution of publications

Of the total Indian publications in AADs researched, 603 (42.11%) related to olanzapine, 543 (37.92%) to risperidone, 359 (25.07%) were related to clozapine, 244 (17.04%) to quetiapine, 162 (11.31%) to aripiprazole, 111 (7.75%) to ziprasidone, 99 (6.91%) to amisulpride, 46 (3.21%) to paliperidone, 20 (1.40%) to asenapine, 14 (0.98%) to iloperidone, 9 (0.63%) to zotepine, 5 (0.35%) to blonanserine, 4 (0.24%) each to lurasidone and perospirone during 1998-2013. The research interest in the use of these drugs have increased in quetiapine (from 8.74% to 18.25%), aripiprazole (from 2.19% to 12.65%), ziprasidone (from 7.10% to 7.85%), amisulpride (from 0.55% to 7.85%), paliperidone (from 0.00% to 3.68%), asenapine (from 0.0% to 1.60%), iloperidone (from 0.55% to 1.04%), zotepine (from 0.00% to 0.72%) and blonanserine (from 0.00% to 0.40%), as against decreased in olanzapine (from 43.72% to 41.87%), risperidone (from 46.99% to 36.59%), clozapine (from 43.72% to 22.34%), lurasidone and perospirone (from 0.55% to 0.24%) from 1998-2005 to 2006-2013 (Table 6).

Disease-wise distribution of publications

The Indian publications in AADs were studied according to the disease focused. The maximum number of drug publications were focused on schizophrenia (524 publications), followed by depression (216 publications), bipolar disorder (194 publications), movement disorder (146 publications), anxiety disorder (141 publications), insomnia (59 publications), dementia

Table 4: Share of various foreign countries in India's international collaborative publications in AADs during 1998-2013

Collaborating country	Number of international collaborative publications			Share of international collaborative publications		
	1998-2005	2006-2013	1998-2013	1998-2005	2006-2013	1998-2013
USA	12	68	80	48.00	50.00	49.69
UK	6	36	42	24.00	26.47	26.09
Australia	4	23	27	16.00	16.91	16.77
Canada	0	14	14	0.00	10.29	8.70
Malaysia	0	12	12	0.00	8.82	7.45
Israel	3	8	11	12.00	5.88	6.83
China	1	10	11	4.00	7.35	6.83
Germany	2	8	10	8.00	5.88	6.21
South Korea	1	9	10	4.00	6.62	6.21
Switzerland	0	10	10	0.00	7.35	6.21
Thailand	0	10	10	0.00	7.35	6.21
Japan	0	9	9	0.00	6.62	5.59
Singapore	0	9	9	0.00	6.62	5.59
Total of the country	25	136	161			

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Table 5: Subject-wise break-up of Indian publications in AADs, 1998-2013

Subject	Number of publications (TP)			Activity index		TC	ACPP	%TP
	2003-2007	2008-2012	2003-2012	2003-2007	2008-2012	1998-2013	1998-2013	1998-2013
Medicine	116	755	871	59.29	99.38	1796	2.06	60.82
Pharmacology, toxicology and pharmaceutics	66	470	536	52.56	100.53	1584	2.95	37.43
Neurosciences	36	141	177	48.63	91.33	631	3.56	12.36
Chemistry	11	148	159	88.59	106.72	430	2.70	11.10
Biochemistry, genetics and molecular biology	18	129	147	127.76	100.61	426	2.90	10.27
Psychiatry and psychology	24	76	101	185.94	86.27	305	3.02	7.05
Total of India	183	1249	1432					

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Table 6: Drug-wise break-up of Indian publications in AADs, 1998-2013

Name of drug	Number of publications			Share of publications		
	1998-2005	2006-2013	1998-2013	1998-2005	2006-2013	1998-2013
Olanzapine	80	523	603	43.72	41.87	42.11
Risperidone	86	457	543	46.99	36.59	37.92
Clozapine	80	279	359	43.72	22.34	25.07
Quetiapine	16	228	244	8.74	18.25	17.04
Aripiprazole	4	158	162	2.19	12.65	11.31
Ziprasidone	13	98	111	7.10	7.85	7.75
Amisulpride	1	98	99	0.55	7.85	6.91
Paliperidone	0	46	46	0.00	3.68	3.21
Asenapine	0	20	20	0.00	1.60	1.40
Iloperidone	1	13	14	0.55	1.04	0.98
Zotepine	0	9	9	0.00	0.72	0.63
Blonanserin	0	5	5	0.00	0.40	0.35
Lurasidone	1	3	4	0.55	0.24	0.28
Perospirone	1	3	4	0.55	0.24	0.28
	183	1249	1432			

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(43 publications), delirium (42 publications), personality disorders (26 publications), autism (15 publications) and post-traumatic stress disorder (4 publications) during 1998-2013. The drug-wise break-up of publications under these diseases are shown in Table 7.

Scientometric profile of top 20 most productive Indian organizations

The total Indian research output in AADs was published from several organizations, of which the top 15 most productive Indian organizations have published 14-206 publications each during 1998-2013 and together contributed 50.21% (719 publications) share in the cumulative Indian publications. The scientometric profile of these 15 Indian organizations is presented in Table 8. The average publication productivity per organization reported by the top 15 Indian organizations was 47.93 and only three organizations have registered higher output than the group average. These are National Institute of Mental Health and Neurosciences (NIMHANS), Bangalore with 206 publications, followed by Central Institute of Psychiatry, New Delhi (98 publications) and Postgraduate Institute of Medical Education and Research (PGIMER), Chandigarh (95 publications).

The average citation per paper registered by the total publications of these 15 Indian organizations was 2.14 during 1998-2013 and four Indian organizations have registered higher citation impact than the group average. They are Institute of Technology, Banaras Hindu University (BHU), and Varanasi with citation impact per paper of 6.13, followed by Panjab University, University Institute of Pharmaceutical Sciences, Chandigarh (5.53), Dr. Ram Manohar Lohia Hospital, New Delhi (3.09) and Maharaj Medical University, Lucknow (2.24).

The average h-index value of these 15 Indian organizations was 7.13 and six organizations have achieved higher h-index value than the group's average. These are NIMHANS, Bangalore with h-index value of 17, followed by Central Institute of Psychiatry, New Delhi (12), PGIMER, Chandigarh (10), Christian Medical College, Vellore (8), Dr. Ram Manohar Lohia Hospital, New Delhi (8) and Institute of Technology, BHU, Varanasi (8).

The average share of international collaborative publications of top 15 Indian organizations was 15.40 and four Indian organizations have achieved higher international collaborative publications (ICP) share than the group's average. These are CS Maharaj Medical University, Lucknow with ICP share of 52.38%, followed by Dr. Ram Manohar Lohia Hospital, New Delhi (39.13%), Christian Medical College, Vellore (22.86%) and NIMHANS, Bangalore (15.53%).

Media of communications

The top 15 foreign and Indian journals contributed 343 and 268 publications in Indian AADs research, accounting for 23.95% and 18.02% share of the total Indian publications in AADs during 1998-2013. The share of Indian publications in foreign journals has increased from 22.95% to 24.10%, in contrast to decrease in Indian journals from 18.03% to 18.01% from 1998-2005 to 2006-2013. The top 15 foreign journals reported an average citation impact per paper of 4.09, compared to 2.75 in Indian journals during 1998-2013. The journal receiving the highest citation impact per

Table 7: Disease-wise break-up of Indian publications in AADs, 1998-2013

Disease (publications)	Drug (publications)	Disease (publications)	Disease (publications)	Disease (publications)	Disease (publications)
Schizophrenia (524 publications)	Olanzapine (257)	Movement disorders (146 publications)	Olanzapine (71)	Dementia (43 publications)	Olanzapine (21)
	Risperidone (272)		Risperidone (69)		Risperidone (17)
	Clozapine (217)		Clozapine (61)		Clozapine (11)
	Quetiapine (106)		Quetiapine (37)		Quetiapine (17)
	Aripiprazole (83)		Aripiprazole (28)		Aripiprazole (5)
	Ziprasidone (57)		Ziprasidone (19)	Delirium (42 publications)	Olanzapine (26)
	Amisulpride (63)		Amisulpride (21)		Risperidone (22)
	Paliperidone (16)		Paliperidone (3)		Clozapine (10)
	Asenapine (2)		Asenapine (2)		Quetiapine (10)
	Iloperidone (4)		Iloperidone (3)		Aripiprazole (4)
	Zotepine (6)		Zotepine (3)		Ziprasidone (3)
	Blonanserin (2)		Blonanserin (1)		Blonanserin (1)
	Lurasidone (2)		Lurasidone (1)	Personality disorders (26 publications)	Olanzapine (11)
	Perospirone (4)	Anxiety disorder (141 publications)	Olanzapine (64)		Risperidone (13)
Depression (216 publications)	Olanzapine (105)		Risperidone (77)		Clozapine (7)
	Risperidone (106)		Clozapine (40)		Quetiapine (9)
	Clozapine (60)		Quetiapine (34)		Aripiprazole (4)
	Quetiapine (59)		Aripiprazole (28)		Ziprasidone (3)
	Aripiprazole (33)		Ziprasidone (16)		Amisulpride (2)
	Ziprasidone (28)		Amisulpride (15)		Paliperidone (4)
	Amisulpride (24)		Paliperidone (4)	Autism (15 publications)	Risperidone (12)
			Asenapine (2)		Clozapine (9)
			Iloperidone (3)		Aripiprazole (7)
			Blonanserin (1)		Olanzapine (6)
Bipolar disorder (194 publications)	Olanzapine (118)		Lurasidone (1)		Quetiapine (4)
	Risperidone (86)	Insomnia (59 publications)	Risperidone (32)		Ziprasidone (4)
	Clozapine (50)		Clozapine (20)	Post-traumatic Stress disorder (4 publications)	Olanzapine (2)
	Quetiapine (50)		Quetiapine (16)		Risperidone (2)
	Aripiprazole (29)		Aripiprazole (13)		
	Ziprasidone (18)		Ziprasidone (10)		
	Amisulpride (14)				
	Paliperidone (4)				
	Asenapine (3)				
	Blonanserin (3)				
	Lurasidone (9)				

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paper (19.33) was Schizophrenia Research, followed by British Journal of Psychiatry (14.67), Progress in Neuro Psychopharmacology and Biological Psychiatry (9.73), Journal of Clinical Psychopharmacology (7.56), Neurology India (5.71), etc. (Table 9).

High cited publications

There are 12 high cited publications which have received more than 100 citations since the publication of the paper until April 2014. These 12 high cited publications together received 2054 citations registering an average citation per paper of 171.17. These 12 publications have received citations in the range of: 304-359 (two publications), 152-184 (three publications) and 108-135 (four publications). Of the 12 high cited publications, five are reviews and seven articles. These 12 high cited publications are published in eight professional journals: Journal of Controlled Release (five publications), Lancet, World Psychiatry, British Journal of Psychiatry, Biological Psychiatry, Pharmacological

Table 8: Scientometric profile of top 15 Indian organizations in AADs, 1998-2013

Name of Institute	TP	TC	ACPP	h-index	ICP	%ICP
NIMHANS, Bangalore	206	429	2.08	17	32	15.53
Central Institute of Psychiatry, New Delhi	98	208	2.12	12	3	3.06
PGIMER, Chandigarh	95	193	2.03	10	6	6.32
Kasturba Medical College, Manipal	36	11	0.31	4	3	8.33
Christian Medical College, Vellore	35	75	2.14	8	8	22.86
AIIMS, New Delhi	35	54	1.54	7	1	2.86
GB Pant Hospital, New Delhi	34	50	1.47	6	2	5.88
Panjab University, University Institute of Pharmaceutical Sciences, Chandigarh	32	177	5.53	6	2	6.25
Jawaharlal Nehru Technological University, Hyderabad	30	58	1.93	6	0	0.00
University of Mysore	25	29	1.16	5	1	4.00
Dr. Ram Manohar Lohia Hospital, New Delhi	23	71	3.09	8	9	39.13
CS Maharaj Medical University, Lucknow	21	47	2.24	5	11	52.38
Indira Gandhi Medical College	20	17	0.85	2	0	0.00
Institute of Technology, BHU, Varanasi	15	92	6.13	8	1	6.67
Dr. Reddy's Lab Ltd., Hyderabad	14	26	1.86	3	0	0.00
Total of 15 organizations	719	1537	2.14	7.13	79	15.40
Total of the country	1432					
Share of 15 organizations in country output	50.21					

TP: Total publications, TC: Total citations, ACPP: Average citation per paper, ICP: International collaborative publications, NIMHANS: National Institute of Mental Health and Neurosciences, PGIMER: Postgraduate Institute of Medical Education and Research, AIIMS: All India Institute of Medical Sciences, AADs: Atypical antipsychotic drugs

Table 9: Top 15 foreign and Indian journals contributing to Indian AADs research during 1998-2013

Foreign journals	TP			TC	ACPP	Indian journals	TP			TC	ACPP
	1998-2005	2006-2013	1998-2013	1998-2013			1998-2005	2006-2013	1998-2013	1998-2013	
Journal of Neuropsychiatry and Clinical Neurosciences	0	59	59	91	1.54	Indian Journal of Psychiatry	0	56	56	104	1.86
Australian and New Zealand Journal of Psychiatry	18	26	44	176	4.00	Indian Journal of Pharmacology	12	25	37	103	2.19
German Journal of Psychiatry	5	26	31	23	0.74	Indian Drugs	6	10	16	47	2.94
Primary Care Companion to the Journal of Clinical Psychiatry	0	28	28	44	1.57	Indian Journal of Medical Sciences	2	13	15	75	5.00
Journal of ECT	3	23	26	44	1.69	Neurology India	8	6	14	80	5.71
General Hospital Psychiatry	1	23	24	94	3.92	Asian Journal of Chemistry	2	11	13	35	2.69
Journal of Clinical Psychiatry	7	16	23	111	4.83	International Journal of Pharmtech Research	0	13	13	44	3.38
International Journal of Pharmacy and Pharmaceutical Science	0	18	18	51	2.83	International Journal of Pharmaceutical Sciences Review and Research	0	13	13	50	3.85
Asian Journal of Psychiatry	0	16	16	7	0.44	Indian Journal of Psychological Medicine	0	13	13	7	0.54
Journal of Clinical Psychopharmacology	1	15	16	121	7.56	Journal of Postgraduate Medicine	2	10	12	36	3.00
Schizophrenia Research	3	12	15	290	19.33	Journal of Chemical and Pharmaceutical Research	0	12	12	5	0.42
British Journal of Psychiatry	3	9	12	176	14.67	Indian Journal of Pharmaceutical Sciences	1	10	11	74	6.73
Progress in Neuro Psychopharmacology and Biological Psychiatry	1	10	11	107	9.73	International Journal of Chemtech Research	0	11	11	66	6.00
Der Pharmaacia Lettre	0	10	10	16	1.60	Research Journal of Pharmacy and Technology	0	11	11	2	0.18
Psychiatry and Clinical Neurosciences	0	10	10	53	5.30	Research Journal of Pharmaceutical, Biological and Chemical Sciences	0	11	11	8	0.73
Total of 15 journals	42	301	343	1404	4.09	Total of 15 journals	33	224	258	736	2.75
Total of the country	183	1249	1432			Total of the country	183	1249	1432		
Share of top 15 journals in country output	22.95	24.10	23.95			Share of top 15 journals in country output	18.03	18.01	18.02		

TP: Total publications, TC: Total citations, ACPP: Average citation per paper, AADs: Atypical antipsychotic drugs

Table 10: List of high cited publications in Indian AADs research during 1998-2013

Name of authors	Title of the article	Source	Affiliations	Number of citations
Mundargi RC, Babu VR, Rangaswamy V, Patel P, Aminabhavi TM	Nano/micro technologies for delivering macromolecular therapeutics using poly (d, l-lactide-co-glycolide) and its derivatives (Review)	Journal of Controlled Release 2008;125(3):193-20	Reliance Life Sciences Pvt. Ltd., Mumbai, India	359
Patel V, Flisher AJ, Hetrick S, McGorry P	Mental health of young people: A global public-health challenge (Review)	Lancet 2007;369 (9569): 1302-1313	London School of Hygiene and Tropical Medicine, London, UK; Sangath Center, Alto Porvorim, Goa, India; etc.	304
Venkateswarlu V, Manjunath K	Preparation, characterization and in vitro release kinetics of clozapine solid lipid nanoparticles (Article)	Journal of Controlled Release 2004;95 (3):627-638	Kakatiya University, NDDS Laboratory, Univ. Coll. of Pharmaceutical Sci., Warangal-506 009, Andhra Pradesh, India	184
De Hert M, Correll CU, Bobes J, Cetkovich-Bakmas M, Cohen DAN, Asai I, Detraux J, Gautam S, Möller HJ, Ndetei DM, Newcomer JW, Uwakwe R, Leucht S	Physical illness in patients with severe mental disorders. I. Prevalence, impact of medications and disparities in health care (Review)	World Psychiatry 2011;10(1):52-77	University Psychiatric Center, Catholic University Leuven, Leuvensesteenweg, Belgium; Japanese Society of Transcultural Psychiatry, Medical College, Jaipur, India; Psychiatric Centre, Medical College, Jaipur, India; etc.	158
Kaur IP, Bhandari R, Bhandari S, Kakkar V	Potential of solid lipid nanoparticles in brain targeting (Review)	Journal of Controlled Release 2008;127(2):97-109	Panjab University, University Institute of Pharmaceutical Sciences, Chandigarh,; A.S.B.A.S.J.S.M. College Of Pharmacy, Ropar, India	152
Manjunath K, Venkateswarlu V	Pharmacokinetics, tissue distribution and bioavailability of clozapine solid lipid nanoparticles after intravenous and intraduodenal administration (Article)	Journal of Controlled Release 2005;107(2):215-228	NDDS Laboratory, University College of Pharmaceutical Sciences, Kakatiya University, Warangal 506 009, Andhra Pradesh, India	147
Khanna S, Vieta E, Lyons B, Grossman F, Eerdekens M, Kramer M	Risperidone in the treatment of acute mania: Double-blind, placebo-controlled study (Article)	British Journal of Psychiatry 2005;187(SEPT):229-234	Psychiatric Clinic, Vasant Vihar, New Delhi, India; Department of Psychiatry, Hospital Clinic, University of Barcelona, Barcelona, Spain, *et al.*	139
Arvindakshan M, Sitasawad S, Debsikdar V, Ghate M, Evans D, Horrobin DF, Bennett C, Ranjekar PK, Mahadik SP	Essential polyunsaturated fatty acid and lipid peroxide levels in never-medicated and medicated schizophrenia patients (Article)	Biological Psychiatry 2003;53(1):56-64	National Chemical Laboratory, Division of Biochemical Sciences, Pune, India; National Center for Cell Sciences, Pune, India; Kripamayee Inst. of Mental Health, Miraj, India; Department of Psychiatry, MIMER Medical College, Talegaon, India; Laxdale Research Institute, Stirling, United Kingdom, *et al.*	139
Sonkusare SK, Kaul CL, Ramarao P	Dementia of Alzheimer's disease and other neurodegenerative disorders - Memantine, a new hope (Review)	Pharmacological Research 2005;51(1):1-17	Natl. Inst. Pharmaceutical Educ. R., Dept. of Pharmacology and Toxicology, S.A.S. Nagar, 160 062, Mohali, India	135
Agnihotri SA, Aminabhavi TM	Controlled release of clozapine through chitosan microparticles prepared by a novel method (Article)	Journal of Controlled Release 2004;96(2):245-259	Drug Delivery Division, Ctr. of Excellence in Poly. Science, Karnatak University, Dharwad - 580 003, India	118
Smulevich AB, Khanna S, Eerdekens M, Karcher K, Kramer M, Grossman F	Acute and continuation risperidone monotherapy in bipolar mania: A 3 weeks placebo-controlled trial followed by a 9 weeks double-blind trial of risperidone and haloperidol (Article)	European Neuropsychopharmacology 2005;15(1):75-84	Natl. Mental Health Research Center, Moscow, Russia, Russian Federation; Department of Psychiatry, Natl. Inst. Mental Health. N., Bangalore, India, India, *et al.*	111
Banerjee R, Bhatt PM, Ravindra NV, Desiraju GR	Saccharin salts of active pharmaceutical ingredients, their crystal structures, and increased water solubilities (Article)	Crystal Growth and Design 2005;5(6):2299-2309	School of Chemistry, University of Hyderabad, Hyderabad 500046, India; Informatics Division, GVK Biosciences	108

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Research, European Nueropsychopharmacology and Crystal Growth and Design (one paper each). The 12 high cited publications involve 20 Indian organizations, including Kakatiya University, University College of Pharmaceutical Science, Warangal (two publications), Reliance Life Sciences Pvt. Ltd., Mumbai (one paper), NIMHANS, Bangalore (one paper), Sangath Center, Goa (one paper), Medical College, Jaipur (one paper), Panjab University, University Institute of Pharmaceutical Science, Chandigarh (one paper), National Institute of Pharmaceutical Education and Research, Mohali (one paper), etc. The 12 high cited publications involve five international collaborative publications and two national collaborated publications (Table 10).

SUMMARY

In AADs research, India has produced 1432 publications during 1998-2013, which increased from 9 to 216 publications from the year 1998-2013, registering an annual average growth rate of 22.76%**.** India's global publication rank was 10th among the 15 most productive countries with global publication share of 2.86% during 1998-2012. India's global publication share and rank increased from 1.01% to 3.91% and from 12th to 8th from 1998-2005 to 2006-2013. The citation impact per paper registered by Indian publications in AADs was 2.43, which decreased from 3.14 to 2.32 from 1998-2005 to 2006-2013. Of the total publications, 35.89% of the total publications did not get any citations (zero citation) and 64.11% publications were cited one or more times. Of the cited publications, only 0.84% of the publications (receiving more than 100 citations) contributed 22.71% citations share, as against 49.090% publications (receiving citations from 1 to 10) contributing 35.89% citations share. Only 11.24% of the total Indian publications were internationally collaborative during 1998-2013, which decreased from 13.66% to 10.89% from 1998-2005 to 2006-2013. Among the leading foreign collaborative partners, USA contributed the largest share of 49.69% during 1998-2013, followed by UK (26.09%), Australia (16.77%), Canada (8.70%), Malaysia (7.45%), Israel (6.83%), China (6.83%), etc. Among the subjects, medicine contributed the largest share of 60.82% during 1998-2013, followed by pharmacology, toxicology and pharmaceutics (37.43%), neurosciences (12.36%), chemistry (11.10%), biochemistry, genetics and molecular biology (10.27%) and psychiatry and psychology (7.05%). Research activity has increased in medicine, pharmacology, toxicology and pharmaceutics, neurosciences and chemistry, as against decrease in biochemistry, genetics and molecular activity and psychiatry and psychology from 1998-2005 to 2006-2013. The most widely studied drug was olanzapine with 42.11% publication share, followed by risperidone (37.92%), clozapine (25.07%), quetiapine (17.04%), aripiprazole (11.31%), ziprasidone (7.75%), amisulpride (6.91%), paliperidone (3.21%), asenapine (1.40%), iloperidone (0.98%), zotepine (0.63%), blonanserine (0.35%), lurasidone (0.24%) and perospirone (0.24%) during 1998-2013. The research interest in the use of these drugs have increased in quetiapine, aripiprazole, ziprasidone, amisulpride, paliperidone, asenapine, iloperidone, zotepine and blonanserine, as against decrease in olanzapine, risperidone, clozapine, lurasidone and perospirone from 1998-2005 to 2006-2013. Among the diseases reported for the use of these drugs, the largest number of publications (524) were in schizophrenia, followed by depression (216 publications), bipolar disorder (194 publications), movement disorder (146 publications), anxiety disorder (141 publications), insomnia (59 publications), dementia (43 publications), delirium (42 publications), personality disorders (26 publications), autism (15 publications) and post-traumatic stress disorder (4 publications) during 1998-2013. The top 15 most productive Indian organizations together account for 50.21% (719 publications) share to the cumulative Indian publications output in AADs research during 1998-2013. The largest number of publications (206 publications) were contributed by NIMHANS, Bangalore, followed by Central Institute of Psychiatry, New Delhi (98 publications) and PGIMER, Chandigarh (95 publications), etc. Among various journals contributing to AADs research, the top 15 foreign and Indian journals contributed accounts for 23.95% and 18.02% share of the total Indian publications during 1998-2013. The share of Indian publications in foreign journals has increased from 22.95% to 24.10%, in contrast to decrease in Indian journals from 18.03% to 18.01% from 1998-2005 to 2006-2013.

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