



Using Google Maps to display the pattern of coauthor collaborations on the topic of schizophrenia: A systematic review between 1937 and 2017

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ABSTRACT

Schizophrenia is a severe mental disorder affecting more than 21 million people worldwide. Scientific collaborations are required to research schizophrenia. However, there have been limited publications to date investigating scientific collaborations in schizophrenia research or reporting individual researchers' achievements (IRA) for authors. This study aimed to investigate the pattern of coauthor collaborations in schizophrenia research. We conducted a bibliometric study of international scientific publications on schizophrenia. About 57,964 abstracts were identified and downloaded from MEDLINE. All were examined using social network analysis (SNA) on February 20, 2018. The clusters of author nationalities, the authors, and the medical subject headings (MESH) terms were presented on Google Maps. A total of 36,934 articles met the inclusion criteria. The mean number of authors per article increased from 4.5 in 2008 to 6.4 in 2017. The proportion of published articles decreased in North America from 46.7% in 2008, to 32.3% in 2017. In contrast, the proportion of published articles in Asia increased from 14.5% in 1998 to 23.9% in 2017. Among the countries generating schizophrenia research the most prominent is China (corr. = 0.98), followed by India (corr. = 0.94), and France (corr. = 0.93). The representative of the biggest cluster is the author Michael F Green from the United States. The top three MESH terms are physiopathology, schizophrenic psychology, and complications. The scientific interest in schizophrenia remains significant. The application of bibliometric indicators of production is evident in the growth of scientific literature on the topic of schizophrenia.

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1. Introduction

Schizophrenia is a severe mental disorder affecting more than 21 million people worldwide (WHO, 2016), with a lifetime prevalence rate of 1% in the general population (Wu and Duan, 2015). Schizophrenia characteristically presents as a series of clinical features (Van Os and Kapur, 2009; Phillips et al., 2004) and represents the paradigm of mental illness due to its high prevalence, the severity of its symptoms, and associated dysfunction (López-Muñoz et al., 2015).

According to reports in the literature mental disorder ranks highest regarding disability-adjusted life years and has surpassed that of cardiovascular disease, respiratory disease, and malignant tumors (Demyttenaere et al., 2004; Murray and Lopez, 1996; Shu, 2007). Although the pharmacological approach is one of many strategies that

contribute to the management of schizophrenia, there is widespread agreement about the importance of this strategy (López-Muñoz et al., 2004; López-Muñoz et al., 2005) and the requirement of it to prevent and treat schizophrenia.

Given the enormous complexity of this disease, it is necessary to gather specialists in psychiatry, neuroscience research, and biomedical science to ensure collaboration through resource sharing, exchange of ideas, knowledge dissemination, and information acquisition (Wu and Duan, 2015). However, there have been limited publications investigating scientific collaborations in schizophrenia, particularly on the patterns of author collaboration using visualization analysis or on the individual researchers' achievements (IRA) for authors.

Some researchers have applied visualization analysis to analyze author collaborations in schizophrenia, notably in genetic research which was identified as the primary collaborative field (Wu and Duan, 2015). However, the pattern of data display was a static jpg format picture, unlike the dynamic Google Maps dashboard. The latter would allow readers to see more detail on research topics by using the zoom-in and zoom-out functionality (Chien et al., 2018; Dasgupta et al., 2014; Kobayashi et al., 2010).

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In line with worldwide economic development, it is unknown whether the United States and Europe still dominate the publication output in science (Glänzel and Schlemmer, 2007; Leydesdorff et al., 2013). Whether the number of authors in schizophrenia research articles is higher than that in PubMed from 1.9 in 1975 to 5.67 in 2016 (US National Library of Medicine, 2017) or less than the leading general medical journals (JAMA, The Lancet, and New England Journal of Medicine) (from a range of 8–11 in 2005 to 11–18 in 2015) in 2005, 2010, and 2015 (Muth and Golub, 2017) is worthy of further investigation.

The objectives of this study are to report: (1) the mean number of authors in schizophrenia research articles and the national gross domestic product of the lead authors' country (GDP), (2) the relationship between the number of publications and the first authors' nationality, (3) the trend of dominant nations on schizophrenia research, (4) the greatest number of published papers per researcher, (5) the representation of the medical subject headings (MESH) terms in principal clusters of research on schizophrenia, and (6) the h-indexes (Hirsch, 2005) and x-indexes (Fenner et al., 2018) for all authors who published in the field of schizophrenia on Google Maps.

2. Methods

2.1. Data source

We searched the database in Pubmed Center (PMC) using the title keyword "schizophrenia" on February 20, 2018. 57,964 articles published between 1937 and 2018 were identified. We made a Microsoft Excel VBA (visual basic for application) module to handle the data. All downloaded abstracts met the requirement for the type of journal article. Ethical approval was not necessary for this study as no human subjects or personal data was accessed.

2.2. Social network analysis and Pajek software

Social network analysis (SNA) (Bright et al., 2017) has been launched to explore the pattern of entities in a network. Pajek (Denooy et al., 2012) is a widely-used SNA software (Chien et al., 2018). In keeping with the Pajek guidelines, we defined an author (or keyword of the MESH term) as a node (or an actor) connecting to other nodes through the edge. Usually, the weight between two nodes is determined by the number of connections.

Centrality is a vital index to analyze the network. Any individual or keyword that lies in the center of the social network will determine its influence on the system and its ability to gain information (Han et al., 2017). We applied degree centrality to this study about the graphical process using SNA and Google Maps, see Multimedia Files 1 and 2.

2.3. To report the research results

2.3.1. The trend of author collaboration on schizophrenia

The cross table (i.e., columns for publication years and rows for the first author nationality) shows the distribution of author nationalities in schizophrenia research over the years. The mean number of authors per article each year was calculated using the descriptive statistics. The relationship between the number of publications by first author nationality and the national gross domestic product (GDP) was computed using the correlation coefficient (corr.) and the significance formula (i.e., $t = \text{corr.} \cdot \sqrt{\frac{n-2}{1-\text{corr.}^2}}$).

The results will be presented on Google Maps. The size of the bubble in Google Maps will correspond to the number of the published papers for the nation or the author while the width of the connecting line will correspond to the strength of the relationship between the two entities, i.e., the nation or the author. Clusters are separated by the algorithm of the partition communities and will be represented by different colored bubbles.

2.3.2. The dominant nations on schizophrenia

The existence of the author collaboration in schizophrenia research can be plotted on Google Maps. The trend of the papers for each continent and the nation presents the distribution of the article counts across countries and years using the correlation coefficient to evaluate.

2.4. Graphical representations to report

2.4.1. Authors to represent their clusters

The top 10 authors who published most frequently on schizophrenia were selected to represent their clusters. The cross table (i.e., columns for authors and rows for the journals) shows the distribution of author's publications in journals. The clusters of the coauthor's collaboration on schizophrenia research were shown on Google Maps.

2.4.2. Keywords to present the research domain

It is assumed that keywords represent the central topics in schizophrenia research; the relationship between two keywords can be highlighted and linked by the SNA, which is similar to the apocryphal story told the concept of co-occurrence that is about beer and diaper sales with a strong correlation on each Friday (Domingos, 2012; Power, 2017; Verhoef et al., 2016). The presentation for the bubble and the line is interpreted similarly to the previous section.

2.4.3. Definitions of terms related to the network density and the MESH

Google Maps and the SNA Pajek software were used to visualize the eminent author on schizophrenia. The author-made Excel VBA modules were applied to organize the data. We define several density-related terms regarding the network features as below:

- (1) Density: the ratio between the number without duplicated connections and the maximal possible connections ($=n(n-1)/2$).
- (2) D_Weight: density with the number of repeated connections.
- (3) E-I index: the difference between the External and internal contacts divided by the total number of connections, the less means the higher convergent centrality.
- (4) Count: the number of members ($=n$).
- (5) Link: the number of non-duplicated connections.
- (6) L_Weight: the number of duplicated connections.

The MESH terms were extracted from each paper using the MS Excel VBA function of split (MESH "/"). The SNA cluster analysis using Pajek was performed to obtain the maximal degree centrality, i.e., the most connections with others, from each MESH term in a cluster. We identified the top ten maximal degree centralities and plotted them on Google Maps.

2.4.4. The most cited authors in schizophrenia

An authorship-weighted scheme (AWS) was developed using the Rasch rating scale model (Andrich, 1978) for quantifying author contributions as the Eq. (1):

$$W_j = \frac{\exp(\gamma_j)}{\sum_{j=0}^m \exp(\gamma_j)} = \frac{2.72^{\gamma_j}}{\sum_{j=0}^m 2.72^{\gamma_j}}, \quad (1)$$

Considering a paper of $m + 1$ authors with the last being the corresponding author, W_j in Eq. (1) denotes the weight for an author on the order j in the article byline. The power γ_j is an integer number from m to 0 in descending order.

$$\text{The sum of author weights in a byline} = \sum_{k=0}^m \frac{\exp(\gamma_j)}{\sum_{j=0}^m \exp(\gamma_j)}, \quad (2)$$

The sum of authorships equals 1 for each paper referred to Eq. (2). This is a basic concept which ensures that all papers have an equal

weight irrespective of the number of coauthors (Vavryčuk, 2018). Accordingly, more importance is given to the first (=exp.(m), primary) and the last (=exp.(m-1), corresponding or supervisory) authors, while it is assumed that the others (the middle authors) have made smaller contributions (Lindsey, 1982). In Eq. (2), the smallest portion (=exp.(0) = 1) is assigned to the last second author with the odds = 1 as the basic reference.

A total number of 1130 authors with at least one cited papers were collected for calculating their h-indexes and x-indexes in 2017 based on citable papers in PMD in 2015 and 2016, see Multimedia 3. All h-indexes, x-indexes and the composited score using principal component analysis (PCA) to gain the weights were located on Google Maps.

3. Results

3.1. The mean number of authors and the relation to the GDP

Author collaboration on schizophrenia research is increasing (= 0.89, p < .001; see Table 1). The mean number of authors per article has increased from 4.5 in 2008 to 6.4 in 2017. The correlation coefficient with the national GDP per the United Nations (2016) is 0.90.

3.2. The distribution of publications by author nationality

Table 1 presents 36,934 papers that included the author's nationality. It is evident that the United States has published most frequently, accounting for 12,522(33.9%), while the United Kingdom accounts for the seconded largest number of publications at 2678(17.3%). The trend in the number of publications is presented in Table 1.

The proportion of published articles has decreased in North America from 46.7% in 2008 to 32.3% in 2017. Conversely, for Asia, the article

proportion has increased from 14.5% in 2008 to 23.9% in 2017. Among the countries generating schizophrenia research in trend (see Table 1), the most prominent nation is China (corr. = 0.98), followed by India (corr. = 0.94), and France (corr. = 0.93).

Fig. 1 displays the coauthor collaboration among nations based on schizophrenia research. Overall, the most productive nations are the United States and Europe, see Fig. 1. International coauthors who collaborated with other nations are shown with a blue line. Further information is available at reference (Chien, 2018a) by clicking on each bubble.

3.3. Published papers for authors and journals

The representative of the biggest cluster is the author, Michael. F. Green, from the United States, see Table 2 and Fig. 2. The link on the website was at the reference (Chien, 2018b) or the QR-code on Fig. 2.

The top 10 journals with the highest numbers of publications on schizophrenia have an Impact Factor of 2 or above, see Table 3. Schizophrenia Research has published the most articles on schizophrenia (329, 35.26%) among the top 10 journals), and has an impact factor of 3.986 (JCR, 2018).

3.4. The representatives of MESH terms in clusters

The top three MESH terms are physiopathology, schizophrenic psychology, and complications, see Fig. 3 or linked to the reference (Chien, 2018c). We can see that the keywords in the past years.

3.5. The most cited authors in schizophrenia

The most cited author in schizophrenia was Jason Smucny, h = 1.99, g = 3.99, x = 1.99, composite score = 7.66, from the US (see the bigger

Table 1
The number of published papers in Schizophrenia across years & nations.

Nation	1937–08	09	10	11	12	13	14	15	16	17	18	Total	%	Growth
Africa	51	8	10	7	17	17	14	13	18	20	2	177	0.48	0.80
Nigeria	25	4	3	2	6	7	1	5	8	13	1	75	0.20	0.65
Tunisia	4	2	5	2	2	3	8	3	4	3		36	0.10	0.21
Egypt	3		1	1	5	4	2	2	4	2		24	0.06	0.44
Others	19	2	1	2	4	3	3	3	2	2	1	42	0.11	0.21
Asia	2493	320	363	436	475	540	561	637	629	740	84	7296	19.75	0.99
Japan	980	94	119	130	118	141	128	107	126	145	17	2110	5.71	0.54
China	278	54	68	89	126	135	167	239	218	277	40	1698	4.60	0.98
India	187	36	34	40	63	62	72	80	72	84	7	740	2.00	0.94
Israel	436	40	24	37	45	30	28	33	20	21	2	717	1.94	-0.60
Taiwan	200	35	36	49	41	64	54	59	55	64	5	663	1.80	0.84
Others	412	61	82	91	82	108	112	119	138	149	13	1368	3.70	0.97
Europe	5855	600	654	768	826	807	730	842	831	919	96	12,951	35.07	0.85
U.K.	1422	131	138	139	163	133	138	135	125	140	12	2678	7.25	-0.16
Germany	1113	104	134	121	160	162	120	117	130	137	10	2314	6.27	0.17
France	480	46	42	63	60	74	62	85	83	96	8	1104	2.99	0.93
Italy	378	54	41	61	71	73	62	79	75	77	10	983	2.66	0.81
Spain	342	54	58	63	48	74	56	71	76	74	11	929	2.52	0.70
Others	2120	211	241	321	324	291	292	355	342	395	45	4943	13.38	0.86
N. America	7853	638	705	750	750	742	688	703	667	717	82	14,311	38.75	0.05
U.S.	7043	552	606	649	656	611	575	590	571	589	66	12,522	33.90	-0.20
Canada	773	75	91	92	90	121	107	105	89	118	13	1676	4.54	0.63
Mexico	19	8	6	6	4	9	5	7	6	10	3	83	0.22	0.26
Others	18	3	2	3	0	1	1	1	1	0	0	30	0.08	-0.73
Oceania	801	87	70	75	90	100	82	108	110	117	9	1655	4.48	0.83
Australia	732	81	62	71	80	93	80	99	102	107	9	1522	4.12	0.85
New Zealand	65	6	7	4	8	5	2	6	7	9		119	0.32	0.22
Others	4	0	1	0	2	2	0	3	1	1	0	14	0.04	0.35
S. America	145	26	15	26	37	54	48	62	54	67	8	543	1.47	0.92
Brazil	99	20	9	21	22	41	28	44	32	50	7	374	1.01	0.83
Chile	12	3	3	2	7	7	5	6	7	11	1	64	0.17	0.82
Argentina	17	1	2	2	3	2	5	3	4	3		42	0.11	0.68
Others	18	2	1	1	5	4	10	9	11	3	0	64	0.17	0.64
Total	17,199	1679	1817	2062	2195	2260	2123	2365	2309	2580	281	36,934	100.00	0.93
# of author per paper	4.5	6.0	6.1	6.1	6.1	6.1	6.2	6.7	6.9	7.1	7.7	145,193	6.4	0.89

Note. Correlation coefficient with the nation GDP per the United Nations (2016) = 0.90.

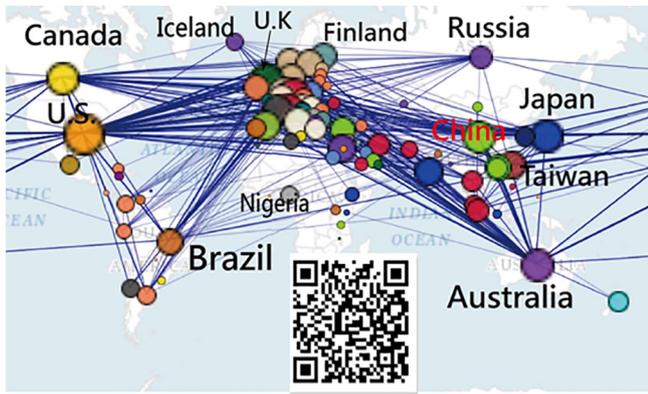


Fig. 1. Author nationality distribution on the Google Map.

white bubble at the top-right corner in Fig. 4), whose h-index with four cited weights (i.e., 1.99, 1.99, 1.28, and 0.17) was computed by the formula ($=1.99$ due to h-core at one paper) in years of 2015 and 2016. We demonstrated the AWS-based h-index displaying all authors on Google Maps in comparison (Fig. 4). Readers are suggested to click any bubble of interest and see the author's publications in PMC, see the hyperlink at the reference (Chien, 2018d).

4. Discussion

The trend of author collaboration on schizophrenia research is increasing with more authors contributing to each article ($=0.89$, $p < .001$). The number of authors per article has increased from 4.5 in 2008 to 6.4 in 2017. It is higher than that in PubMed from 1.9 in 1975 to 5.67 in 2016 (US National Library of Medicine, 2017). However, it is less than the three leading general medical journals (JAMA, The Lancet, and New England Journal of Medicine) (from a range of 8–11 in 2005 to 11–18 in 2015) in 2005, 2010, and 2015 (Muth and Golub, 2017). The correlation coefficient ($=0.90$) between the number of nations for the first authors on schizophrenia and the GDP in 2016, indicating the research climate on the topic of schizophrenia is related to the national GDP.

The proportion of articles decreased for North America from 46.7% in 2008 to 32.3% in 2017, whereas in Asia the article proportion increased from 14.5% in 2008 to 23.9% in 2017. The nations with the greatest increase in schizophrenia research publications are China (corr. = 0.98)

Table 2

The representative in each cluster for their respective network indicators.

Author	Density	D_Weight	E-I index	Count	Link	L_Weight
Green, Michael F(U.S.)	0.01	0.08	0.57	543	1272	12,233
Kane, John M(U.S.)	0.00	0.02	0.75	502	536	2145
Lieberman, Jeffrey A(U.S.)	0.00	0.02	0.80	471	470	2677
Andreassen, Ole A (Norway)	0.02	0.07	0.44	469	1769	7528
He, Lin(China)	0.01	0.06	0.65	452	1262	6234
Kahn, Rene S (Netherlands)	0.01	0.02	0.69	452	519	2509
Weinberger, Daniel R (U.S.)	0.00	0.02	0.82	416	405	1774
Iwata, Nakao(Japan)	0.01	0.08	0.60	413	1207	6845
Calhoun, Vince D(U.S.)	0.01	0.08	0.53	374	1016	5496
Keshavan, Matcheri S (U.S.)	0.01	0.03	0.77	322	265	1383

Note. Density: the ratio between the number without duplicated connections and the maximal possible connections($=n(n-1)/2$); D_Weight: Density with the number of repeated connections; E-I index: the difference between the External and internal contacts divided by the total number of connections, the less means, the higher convergent centrality; Count: the number of members($=n$); Link: the number of non-duplicated connections; L_Weight: the number of duplicated connections.

and India (corr. = 0.94), indicating the trend of the dominant countries has been moved from the United States and Europe to Asia.

The top three MESH terms are physiopathology, schizophrenic psychology, and complications. This is in contrast to research that identifies genetic research as the main collaborative field (Wu and Duan, 2015). However, in line with previous research the keyword “genetic research” is shown to be one of the top six principal clusters in this study (see Fig. 3).

Much previous research has investigated coauthor collaboration using the SNA (Liu et al., 2005; Osareh et al., 2014; Sadoughi et al., 2016; Wu and Duan, 2015). This research is markedly different as we employ unique visual representations produced on Google Maps. The application of this visual allows journal authorship and collaboration to be easily compared, and links between nations easily identified. Such a network can be defined as a collaboration pattern. If the entity bubble (ego) is clicked, the nations connected with the specific ego will be highlighted on the map. This animated dashboard has applications in other scientific fields to demonstrate entity relations in a network.

A total of 57,964 abstracts were identified when searching titles for the keyword “schizophrenia” in PMC on February 20th, 2018. Only seven papers incorporated MESH into their studies (Chien, 2018e). None of the previous literature utilizes SNA to present relevant knowledge to readers, nor do they dynamically apply Google Maps as we did in the current study. Scientific publication is one of the objective measurements to evaluate the achievements of a medical specialty or discipline (Chang et al., 2017). It is worth combining the SNA and Google Maps to disclose knowledge and information to the readership of journals in the future.

Many algorithms and measures have been developed using SNA to graphically explore data (Sadoughi et al., 2016). We identify the interested target, i.e., author, keyword or journal, as the core subject that can be analyzed using the centrality measure yielded by the SNA (Liu et al., 2005; Osareh et al., 2014).

One strength of this study is the sophisticated use of Google Maps and in-text links for each topic (Chien, 2018a, 2018b, 2018c, 2018d). Readers can manipulate the links independently to better understand author collaboration, the keyword relationship, or the author IRA. The depiction of distribution by the nation is a useful feature to understand international coauthor collaborations on schizophrenia research. As it is said, “a picture is worth a thousand words,” so we hope following studies can report other types of information using the Google API (application programming interface) to readers in the future.

The most worth-noting feature is the authorship-weighted scheme (AWS) fully congruent with the category probability theory based on the Rasch rating scale model (RSM) (Andrich, 1978). We can adjust the parameters (i.e., the base and the power) to accommodate many types of situations or scenarios in practice. Hence, Vavryčuk's combined weighted scheme (Vavryčuk, 2018) [for the harmonic credits (Hagen, 2008)] is a special case of the general AWS in Eq. (2).

We particularly provided several MP4 videos for interested readers to understand the process and main contents of this study. The hyperlinks are provided by scanning the QR-code on each Figure. The approaches used in this study are suitable for use in many kinds of long-term researches (Ayasa-Arriola et al., 2017; Cuesta et al., 2017; Eack, 2018; Kugathanan et al., 2018; Li et al., 2018).

There are several limitations to this study. Firstly, Caution should be taken when interpreting and generalizing findings beyond this type of research as data were extracted exclusively from Medline.

Secondly, although the data were extracted from Medline and were carefully handled, the original download may have included errors which may affect the resulting reports in this study.

Thirdly, there are many algorithms used for SNA. We applied community cluster, and density with weighted degrees, any changes made to this algorithm will present a different pattern and show distinct inference making.

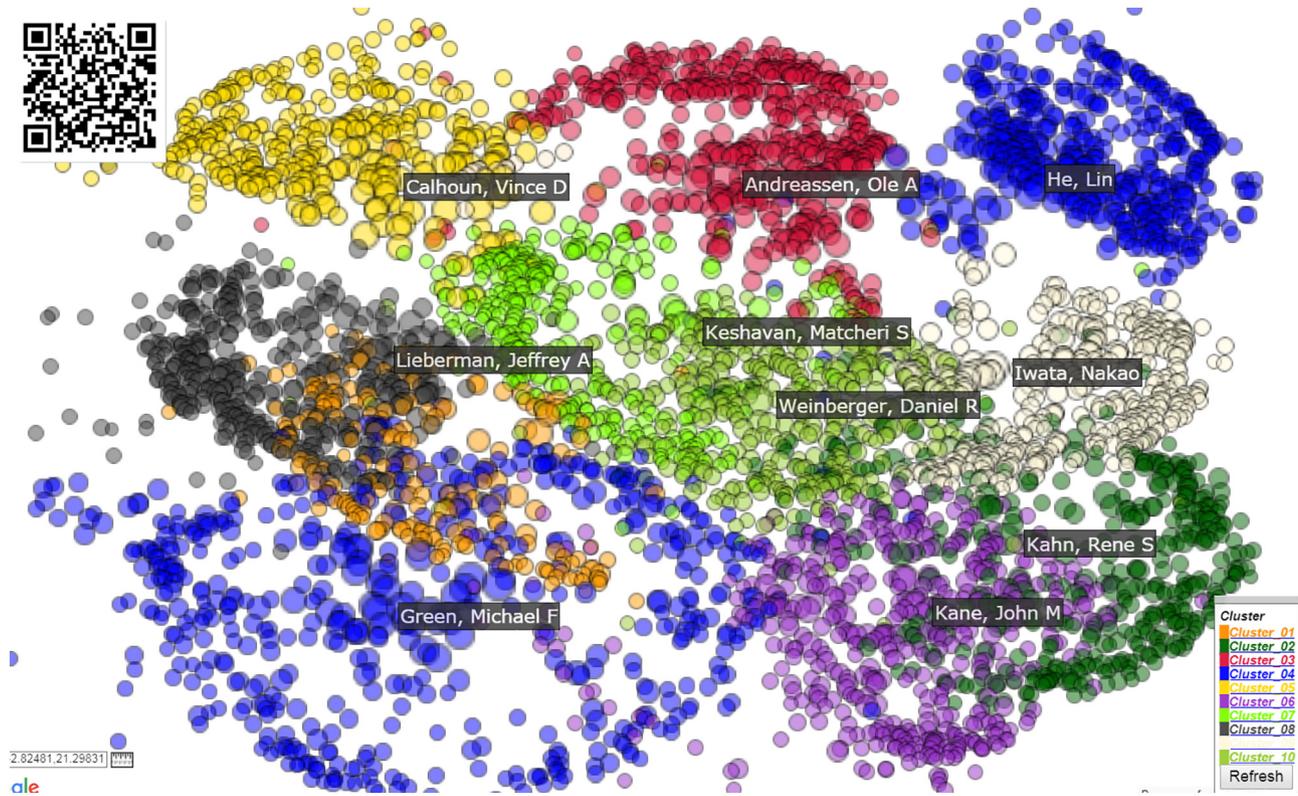


Fig. 2. Productive authors in clusters of the Schizophrenia network.

Fourthly, the role of Internet technology has been played earlier in influencing greater academic accessibility and facilitating more collaboration on the topic of schizophrenia and other disciplines. The cutting point we set at 2008 in Table 1 for defining the trend in recent ten years due to the space limitations is another limitation. Future studies are encouraged applying more years ahead for emphasizing the Internet contribution to author collaborations in academics.

Finally, SNA is not specific to the Pajeck software we used in this study, other software such as Ucinet (Borgatti et al., 2002) and Gephi (Bastian et al., 2009) are also viable packages for researchers to use.

In conclusion, this study offers an objective picture of the representativeness and evolution of international research on schizophrenia by employing Google Maps to present results. We chose visualization technology to analyze collaborative author relationships and the individual researchers' achievements in schizophrenia research. As a result, researchers will be able to produce effective research diagrams on Google Maps, improve the efficiency of research work, and provide wide and deep insight into the relationships among nations and coauthors. The results can provide readers with insight into the evolution of schizophrenic research across years and countries.

Table 3

The most number of published papers across the cluster author representatives among journals and MESH terms on Schizophrenia.

Journal's name	Authors represented in their clusters										Total	%	
	A	B	C	D	E	F	G	H	I	J			
Journal(Impact factor)													
Schizophr Res(3.986)	12	76	23	26	14	25	25	44	20	64	329	35.26	
Schizophr Bull(7.575)	11	36	3	4	15	16	7	18	7	14	131	14.04	
Biol Psychiatry(11.412)	7	11	5	9	10	5	7	18	21	11	104	11.15	
Am J Psychiatry(14.176)		12		1	1	19	22	6	14	7	82	8.79	
J Clin Psychiatry(5.291)	2	5	2			38	13	7	1	1	69	7.40	
Psychiatry Res(2.528)	7	4	6	7	5	3	4	6	4	13	59	6.32	
Am J Med Genet B Neuropsychiatr Genet(3.253)	14		2	16	2		3	8			45	4.82	
Neuroimage(5.835)		1			26			5		6	38	4.07	
Neuropsychopharmacology(6.403)		4		3	1	6	12	2	8	2	38	4.07	
PLoS One(2.806)	5	5	3	6	6		1	5	3	4	38	4.07	
Mesh Term													
Genetics	158	34	419	350	49	61	73	94	204	35	1477	31.78	
Physiopathology	33	112	3	8	130	12	32	65	79	84	558	12.01	
Therapeutic use	2	24	24	45		159	135	42	20	22	473	10.18	
Pathology	53	1	3	11	95	16	34	106	33	83	435	9.36	
Drug therapy	8	27	14	24		120	117	44	16	18	388	8.35	
Physiology	27	113	13	7	36	9	16	51	43	42	357	7.68	
Schizophrenic psychology	26	103	3	7	10	38	42	41	31	47	348	7.49	
Diagnosis	21	86	2	2	25	24	17	31	11	40	259	5.57	
Metabolism	21	1	15	13	4	5	33	27	53	19	191	4.11	
Methods	4	28	7	5	62	18	3	12	13	10	162	3.49	

Note. A. Andreassen, B. Green, C. He, D. Iwata, E. Calhoun, F. Kane, G. Lieberman, H. Kahn, I. Weinberger, J.Keshavan; SCI IF: <http://www.bioxbio.com/ifa/html/BIOL-PSYCHIAT.html>

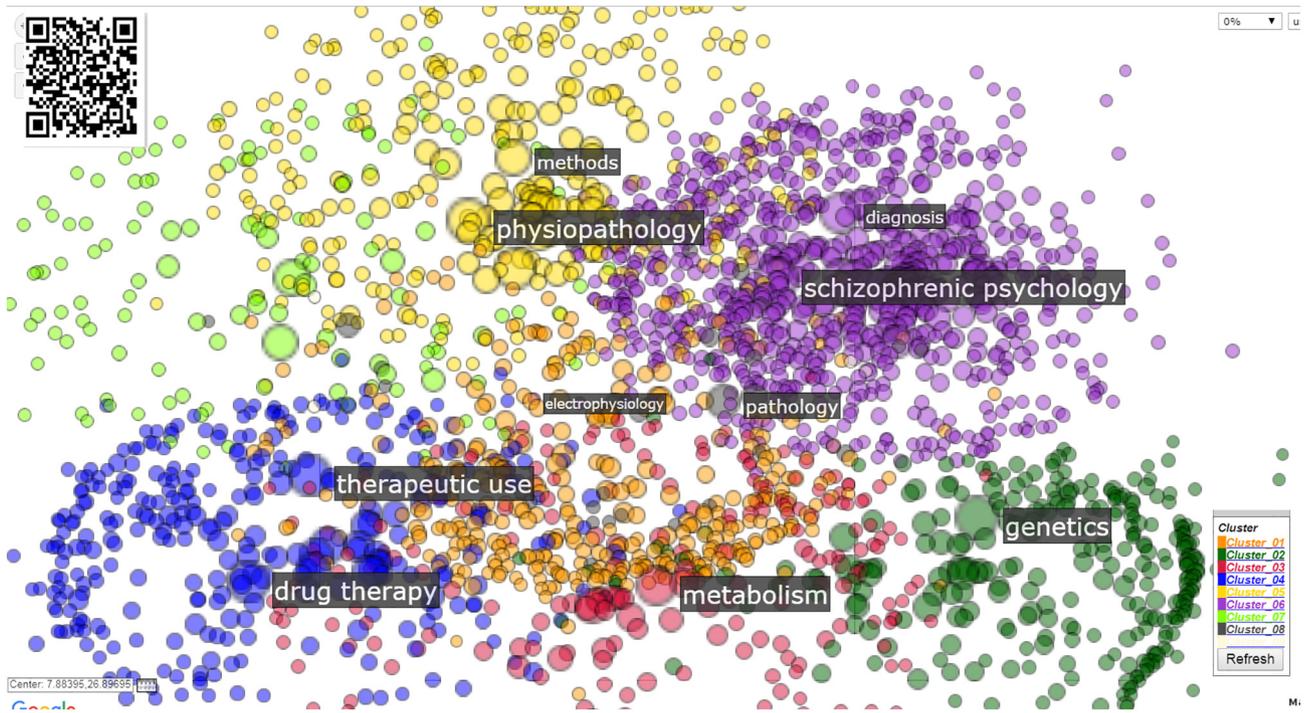


Fig. 3. The representatives of MESH term in principal clusters in Schizophrenia.

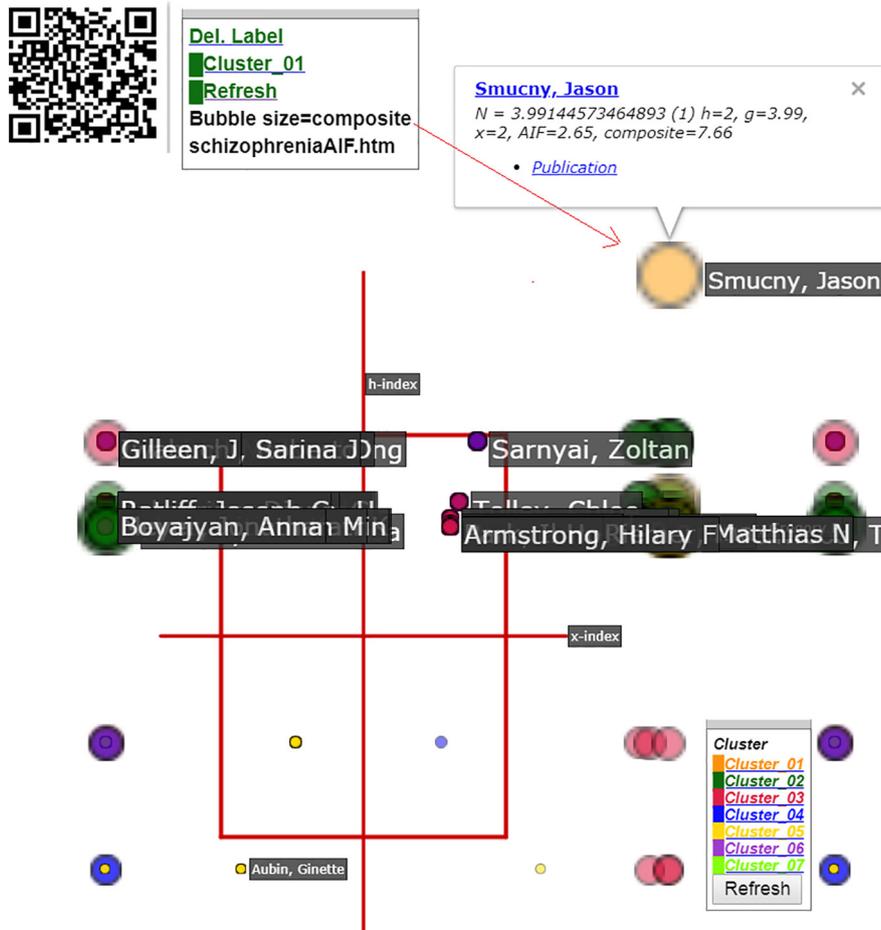


Fig. 4. Distribution of h-index and x-index for authors of schizophrenia in both years of 2015 and 2016 using PMC publications to the calculation.

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.schres.2018.09.015>.

Abbreviations

GDP	gross domestic product
IRA	individual researchers' achievements
MESH	medical subject headings
PCA	principle component analysis
SNA	social network analysis
VBA	Visual Basic for Applications

Ethics approval and consent to participate

Not applicable.
All data were downloaded from MEDLINE database at pubmed.com.

Consent to publish

Not applicable.

Availability of data and materials

All data used in this study is available in Multimedia files.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

TW conceived and designed the study, YC interpreted the data, and WC monitored the process and the manuscript. TW drafted the manuscript. All authors read the manuscript and approved the final manuscript.

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