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The Most Cited Articles and Authors Published in Pubmed Central on the Topic of Opioid Use Disorders Since 2000

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Abstract

Background: *Many regions are experiencing an epidemic of drug overdose (poisoning) deaths involving opioids (opioid pain relievers and heroin). A total of 47,055 drug overdose deaths occurred in the United States, representing a 1-year increase of 6.5%, from 13.8 per 100,000 persons in 2013 to 14.7 per 100,000 persons in 2014. Numerous author collaborations have been made to publish articles using cause-of-death mortality data to examine current trends and characteristics of drug overdose deaths and opioid use disorders (OUD). Which articles and authors on OUD were most cited in the past years is unknown. Whether article types on OUD are different in cited metrics is required to study.*

Methods: *By searching the PubMed database (Pubmed.com), we used the keyword "opioid use disorders" and downloaded 371 articles published since 2000. A total of 1,868 articles were citedin Pubmed Central. The Medical Subject Headings (MeSHterms) were applied to cluster the journal types using social network analysisto compare the differences in the bibliometric indices, i.e., h, g, L, χ, and the author impact factor (AIF). The authorship-weighted scheme was used for quantifying coauthor contributions in an article byline. Kendall's coefficient of concordance (W) was performed to verify the differences in impact factors among MeSHclusters. A visual dashboard for the most-cited authors was shown on Google Maps.*

Results: *We observed that Kendall's W is 0.74(χ^2=17.68, df=6, p<0.001), congruent with the internal consistency on metrics across the article types. The top three mortality, epidemiology, and adverse effects relatively higher impact factors than the others. The author Rose A Rudd(the US) ranks the highest (i.e., χ=12.69, AIF=378.49, L=243.72, Ag=160.98) with one paper (PMID: 26720857, 2016) cited 250 times. The χ-indexes for opioid use disorders, the U.S., and the UK are 17.26, 16.77, and 3.91, respectively.*

Conclusions: *The article types might affect the journal impact factor. Both classifying the article types and quantifying the coauthor contributions incorporated with the bibliometric indices can be accommodated to scientific disciplinesin the future.*

Keywords: *Pubmed Central, authorship-weighted scheme, Medical Subject Headings, social network analysis, Google Maps, article type.*

Background

The United States is experiencing an epidemic of drug overdose (poisoning) deaths. The rate of deaths from drug overdoses has increased 137% since 2000, including a 200% increase in the rate of overdose deaths involving opioid use disorder (OUD)[1] (e.g., fentanyl, heroin, oxycodone) that leads to clinically significant impairment [2]. A total of 47,055 drug overdose deaths occurred in the United States with a 1-year increase of 6.5%, from 13.8 per 100,000 persons in 2013 to 14.7 per 100,000 persons in 2014 [1].

OUD diagnoses have risen substantially over the last decade, and treatment services have struggled to meet the demand [2]. Treatment for OUD is important because of the negative health, societal and economic consequences of illicit opioid use, but treatment adherence can be a challenge[3]. Fatal drug poisonings have already surpassed firearm injuries as the leading cause of injury deaths. Mortality from drug overdoses and opioid poisonings in the US were 50 and 70 % higher than comparable national rates in 2012–2014, respectively [4].

Despite the excess mortality from drug-related poisonings has been linked to a higher opioid prescribing rate when compared with prescribing patterns [5], an opioid overdose prevention policy that strengthens prescription drug and monitors programs use and physician education programs, and expanding access to naloxone, is an opioid antagonist for reversing opioid overdose in out-of-hospital settings [6].

Further,numerous author collaborations on a specific topic have been made to publish articles in recent years[7-9]. The studies[10-14],using cause-of-death mortality data to examine current trends and characteristics of drug overdose deathsand OUD, have been reported in the literature. Which articles and authors on OUD were most cited in the past years is unknown. Whetherarticle types on OUD are different in cited metrics is required to study.

In this study, we attempt to (1) identifythe most cited articles,and authors on the OUD topic; (2) classify the type of articles to predict the bibliometric indices; (3) demonstrate a visual dashboard for the most-cited authors shown on Google Maps.

Methods

Data Source

By searching the PubMed database (Pubmed.org), we used the keywords“opioid use disorders” on October 7, 2018, and downloaded 371articles published since 2000. An author-made Microsoft Excel visual basic for application modulewas used to analyze thedata. All the downloaded abstractswerebased on the type of journal article. All the data used in this study were downloaded from PubmedCentral (PMC), which means that the studyrequired no ethical approvalaccording to the regulation promulgated by the TaiwanMinistry of Health and Welfare.

Approaches for Displaying Research Results

Author-Based Perspective

The authorship-weighted scheme (AWS) was proposedfor quantifying theauthorcontributions [9]. The sum of authorships equals 1 for each paperreferred. More importance is given to the first (primary) andthe last (corresponding or supervisory) authors [15], whereas the others (middle authors)are assumed to have made smaller contributions [16, 17]. Similarly, the smallest portion) is assigned to the last second author with the odds=1 as the basic reference [9, 18].

The author impact factor (AIF) [19,20] can be definedin Eq.1:

$$AIF = \frac{\sum Cited.papers.based.on.\times W_j.in.a.given.year.and.the.proceeding.years}{Citable.papers.\times W_j.in.a.year}), (1)$$

The other author bibliometric indices, such as x[21], h[22], g[23], and L[24], were calculated and defined as x= $\sqrt{\max_i (i \times c_i)}$, h($\geq c_i$), g($\leq \sum_{i=1}^{g} c_i$ /g) and L(= $(\sum_{i=1}^{n} c_i \times W_i)$), where all the number of cited papers(denoted by ci) are based on cited publications until2018. The mean of core articles on g denoted by Ag (defined by $\sum_{i=1}^{g} c_i / g$) improves the discrimination of individual research achievements [25].

The most highly-cited authors can be plotted with a dashboard on Google Maps [9, 18]. The authors' x-indexes are located on the Y-axis, AIF on the X-axis, bubble-sized by cited publications, and colored by Ag-index.

Paper-Based Perspective

Social network analysis (SNA) was applied to classify the majorMedical Subject Headings (MeSHterms) of articles on OUD. In alignment with the Pajekguidelines [26], using SNA, we defined a MeSH term [i.e., a major topic with an asterisk (*) in the downloaded MeSHlabels] as a node (or an actor) that is connected to another counterpart nodethrough the edge of a line. Usually, another weight is defined by the number of connections between two nodes. The algorithm of community partition was performed to identify and separate the clusters. The betweennesscentrality [27] was applied to identify the influential strength in the network.

Each article was, in turn, identified to a specific MeSH cluster through the maximum likelihood estimation[i.e., selecting the highest weighted summation score from allthe possible clusters (k), whereas in the weighted summation score for MeSH(i) in a given cluster(k)=$\sum_{i \in k}^{n} W_i$, Wi is the degree centrality of MeSH(i) in the journal network]. As a result, the unique MeSH cluster for an articleis determined by selecting the maximum summation score across all possible clustersthroughthe articleMeSH terms and the degree centralities.

The bibliometric indices for each MeSH cluster can be obtained. The Kendall's coefficient of concordance (W)[28] was computed to examine the internal consistency (IC) of the data (i.e., the four indices) related to MeSH clusters. If the agreement is accepted by the statistical alpha level (<0.05)[29], the following one-way analysis of variance (ANOVA) for inspecting the difference in the means of indices is meaningful.

Author Affiliation Perspective based on Country

After ranking all the author-cited weights on each article in descending order, we can compute the x-indexes on the OUD topicforeach country/area using the formula $(=\sqrt{\max_i (i \times c_i \times W_{ij})})$, where Wij denotes the author (j) weight on a specific article (i). We can anticipate that the discrimination power is low if the h-index (=1) is appliedasnumerousauthors only published one paper in a given year regardless ofthe number of citations on a citable paper.

Results

Task 1. The Most Cited Authors Shown Google Maps

The author Rose A Rudd (the US) ranks the highest (i.e., χ=12.69, AIF=378.49, L=243.72, Ag=160.98) with one paper (PMID: 26720857, 2016 [1]) cited250 times. Another author Holly C Wilcox (the US) gained a total citation of 111 times on a single article (PMID: 15555812, 2004 [12]). Interested authors are suggested to scan the QR-code in Figure 1 to examine the author's publication outputs in PMC by clicking the specific author bobble.

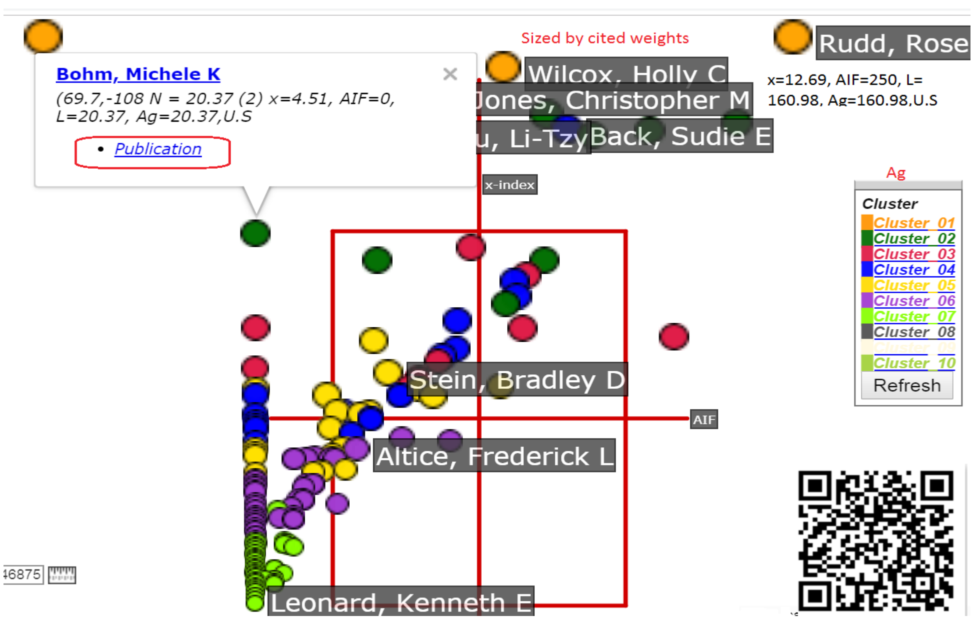

Figure 1. *The most cited authors shown on Google Maps*

Task 2. Clusters of MeSH Terms

The top sevenMeSH clusters were separated as shownin Figure 2. The representative terms with the most degree ofbetweennesscentralityare shown for each cluster. The interested readers are recommended to scan the QR-coed in Figure 2 to see the detailed information in PMC by clicking the word of publication when the specific MeSH bubble is selected.

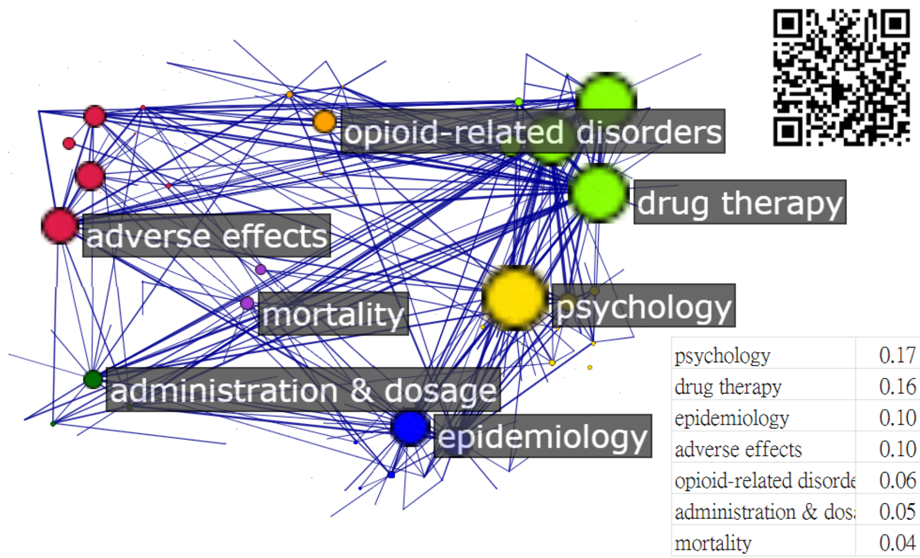

Figure 2. *The cluster analysis of MeSH terms on the OUD topic*

Task 3. Analysis of Kendall's W

Table 1shows the counts of citable and cited articles across the MeSH clusters,including other bibliometric indices since 2000. We noted that Kendall's W is 0.74 (χ =17.68, df=6, p<0.001) including indices of h, g, x, and L only, indicating astrong IC (at the bottom in Table 1) and the strongcorrelation coefficients. All the indicesbut the AIF and Agexhibited high correlations between indices

Table 1. *Citation analysis of MeSH clusters for this study*

A.MeSH cluster	Citable	Cited	IF	h	g	Ag	x	L
opioid-related disorders	7	11	1.57	1	1	5.5	2.83	3.32
administration & dosage	8	13	1.63	2	3	3	3.16	3.61
adverse effects	28	215	7.68	8	14	14.71	9.54	14.66
epidemiology	40	545	13.63	11	22	23.5	14.14	23.35
psychology	40	173	4.33	7	12	12.75	8.12	13.15
mortality	4	267	66.75	1	1	133.5	15.81	16.34
drug therapy	116	644	5.55	13	21	21.62	15.1	25.38
Mean	34.71	266.86	14.45	6.14	10.57	30.65	9.81	14.26
B.Correlation								
IF			1.00					
h			-0.34	1.00				
g			-0.33	0.99	1.00			
Ag			1.00	-0.31	-0.32	1.00		
x			0.60	0.55	0.54	0.62	1.00	
L			0.24	0.83	0.82	0.27	0.92	1.00
C.Kendall's W			All	Including h, g, x, and L only				
W			0.69	0.74				
x^2			24.71	17.68				
df			6	6				
p			<0.001	<0.001				
Cronbach alpha			0.59	0.91				

Note. One way ANOVA shows significantly different among MeSH clusters with statistics of F(6,246)=8.069, p<0.001, on impact factors(IF).

One-way ANOVA showed that the means of metrics for MeSH clusters are statistically distinct ($F(6,246)=8.069$, $p<0.001$). TheMeSH clusters represented by mortality, epidemiology, and adverse effects displayedhigher impact factors than others.

Table 2 displays the top ten journals published articles on OUD in the past years. The journals of Drug Alcohol Depend, SubstAbus, and J Subst Abuse Treat rank as the top three with the most publication outputs.

Table 2. *The top ten journals published articles on OUD in the past years*

Journal	<-2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Total	%
Drug Alcohol Depend	1		2	1	3	2	7	3	11	5	35	9.43
SubstAbus	0				1	1	3	8	8	9	30	8.09
J Subst Abuse Treat	0						3	7	4	7	21	5.66
Addict Behav	2		1		1	2	1		1	9	17	4.58
Am J Addict	0			1	1		1	3	5	5	16	4.31
J Addict Med	0		2	1			2	3	4	4	16	4.31
Addiction	1	1	1					2	2	1	8	2.16
Am J Drug Alcohol Abuse	0		1		1	1				2	5	1.35
ContempClin Trials	0				1		1	2		1	5	1.35
Front Psychiatry	0							1		4	5	1.35
Others	10	6	4	7	2	14	22	28	59	61	213	57.41
Total	14	7	11	10	10	20	40	57	94	108	371	100

Task 4. X-Index Based on Journal and Authors' Countries/Areas

Theχ-indexes for opioid use disorders, the U.S., and the UK are 17.26, 16.77, and 3.91, respectively. The results in Table 3 show that the number of publications might yield high citations andχ-indexes (i.e., a highcorrelation of 0.98 between χ-indexes and outputs). The U.S. (195,83.69%) and Canada (8,3.43%) rank as the top two published papers on *OUD* since 2000.The authors' affiliation areas according tooutputs on OUD are dispersed on Google Maps, see Figure 3. The bigger sizes on flags mean, thenumber of author collaborations on OUD.

Table 3. *Author affiliation areas via outputs on OUD distributed over the years*

Region (since 2002)	<-2009	2010	2011	2012	2013	2014	2015	2016	2017	Total	%	x-index
AFRICA								1		1	0.43	
Egypt								1		1	0.43	
ASIA	1			1		1	3	3	4	13	5.58	
India	1			1			1		2	5	2.15	1.6
Iran						1	1	1	1	4	1.72	2.25
Lebanon								1		1	0.43	1.12
China							1			1	0.43	1.12
Israel									1	1	0.43	
Saudi Arabia								1		1	0.43	
EUROPE	2		4					2	4	12	5.15	
U.K.	1		1						2	4	1.72	3.91
Denmark			1							1	0.43	3.31
Bulgaria								1		1	0.43	
Cyprus								1		1	0.43	1.59
Germany			1							1	0.43	3.28
Greece	1									1	0.43	2.1
Italy			1							1	0.43	2.39
Spain									1	1	0.43	
Ukraine									1	1	0.43	0.03
N. AMERICA	9	5	7	9	9	16	30	47	71	203	87.12	

U.S.	9	5	7	9	9	15	28	45	68	195	83.69	16.77
Canada						1	2	2	3	8	3.43	2.75
OCEANIA		1			1		2			4	1.72	
Australia		1			1		2			4	1.72	3.09
Total	12	6	11	10	10	17	35	53	79	233	100	17.26

Note. Correlation coefficients between counts and x-indexes is 0.98

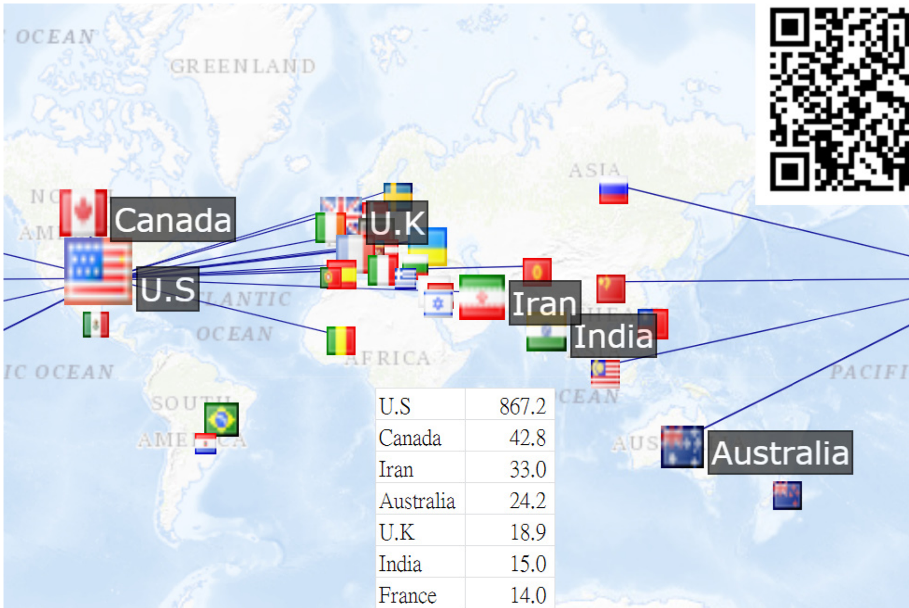

Figure 3. *The authors' affiliation areas dispersed on Google Maps according outputs on OUD*

Discussions

Principal Findings

We observed that the MeSHclusters showed significantly different metrics among the article features (F(6,246)=8.069, p<0.001). The results are similar to a 2002 study [30], which reported that the published papers, which are commonly used measures of study methodology and design, can predict the frequency of citations.

Compared with the previous studies [31-33] addressing that (1) a higher IF is associated with the publication of reviews and original articles instead of case reports, (2) rigorous systematic reviews receive more citations than other narrative reviews, and (3) case reports with low IFs due to rarely cited by articles. The MeSH clusters are a new approach to verify the article types with different numbers of cited papers in a journal or scientific discipline.

Study Features

The first feature is to objectivelyidentify the type of articles byapplyingthe SNA [9, 18, 34, 35] to the MeSH terms, particularly matching each article to the corresponding cluster (feature) and linking the bibliometric indices to the clustersforcomparison (Fig. 2). The latent clusters can be characterized by a pattern of conditional probabilities that indicate the chance that articles are classified to a specific concept or characteristic, similar tothelatent class model [36] in statisticsused for featuring the type of articles [37].

The second feature is to develop the AWS for quantifying the coauthor contributions in computing bibliometric indices, particularly using the proportional decimal numbers of the weighted author credits. As such, (1)both integral h and g indices,which are muted to rank the achievements, can be improvedby using the sophisticatedindices [25], and (2) the Vavryčuk's combined weighted scheme [7] (or the harmonic credits[38]) is also a special case of the AWS that we developed in previous articles [9, 18]..

The χ-index and AIF are used on two axes in Fig.1as both indices are independent (Table 1). The χ-index proposed in 2018 is also newly modified and developed later than the h-index and other indices. The AIF is sensitive to the number of citable papers[e.g., AIF for mortality=66.75 higher than others in Table 1 due to a smaller citable sample size=4 and AIF=160.98 and 73.84 forboth authorsRose A Rudd and author Holly C Wilcoxwith a single citable paper.

The other bibliometric indices, such as R-index (= $\sqrt{\sum_{i=1}^{h} c_i} = \sqrt{Ah}$, where $A = \sum_{i=1}^{h} c_i / h$) [39] and Euclideanindex(= $\sqrt{\sum_{i=1}^{h} c_i^2}$)[40], are available. Each contains its features and limitations. The third feature in this study is the demonstration ofthe combination of various indices on a dashboard using Google Maps fordisplay;suchdemonstrationis rarely seenin the literature.

The fourth feature is the PMC citations used in this study. In tradition, over 100 papers were found with the search of "most-cited articles" [Title] in PubMed library on October 10, 2018. Most of them applied academicdatabases,suchastheScientificCitationIndex (Thomson Reuters, New York, NY, the United States), Scopus (Elsevier, Amsterdam, the Netherlands), and Google Scholar[41, 42], to investigate the mostcited articles in a specific discipline. None was found using the PubMed library to retrieve the cited articles and calculating individual research achievements (Fig.1)/

Limitations

Although the findings are based on the above analysis, several potential limitations may still encourage further research efforts. First, this study only focuses on one target journal which can be generalized to other fields or areas, particularly with different characteristics and science categories.

Second, biases may occur in the author identification given the presence ofseveral authors with the same name or abbreviation and who are affiliated to different institutions.

Third, using the Mesh terms to define the article type is arbitrary. The concept should be inducted from all or at least two or three main elements instead of the principal one. For example,thMeSH term of psychology is related to health knowledge, attitudes, practiceand rehabilitation (Fig.2). Interested readers are suggested to scan the QR-code in Figure 2 to examine the more relevant MeSH in a cluster to define the true concept for the latent cluster.

Finally, although our cluster analysis and the AWSformula are useful approaches for verifyingthe association of MeSH terms and the number of weighted cited papers for individual authors, the results may be affected by the accuracy of the MeSH terms and real author contributions instead of the last author name as the true corresponding author. We used a variety of methods to clean and identify the data in this research, but typos and errorsstill exist, which will affect the cluster results to a certain extent.

Conclusions

By the above results and discussion, the valuable results for the OUD topic were obtained, including the article types associated with the number of cited metrics. The results suggest that thearticle types might affect the journal IF. Both the classification of the article types and quantificationthe coauthor contributions incorporated with the χ-index and other indices can be accommodated to scientific disciplinesin the future.

List of Abbreviations

AIF: author impact factor

AWS: authorship-weighted scheme

BC: Betweenness centrality

IC: internal consistency

IF:impact factors

MESH: medical subject headings

PMC: PubMed Central

SNA:Social network analysis

VBA: visual basic for application

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