Trend and prediction of citations on the topic of neuromuscular junctions in 100 top-cited articles since 2001 using a temporal bar graph
A bibliometric analysis

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Abstract

Background: A neuromuscular junction (NMJ) (or myoneural junction) is a chemical synapse between a motor neuron (MN) and a muscle fiber. Although numerous articles have been published, no such analyses on trend or prediction of citations in NMJ were characterized using the temporal bar graph (TBG). This study is to identify the most dominant entities in the 100 top-cited articles in NMJ (T100MNJ for short) since 2001; to verify the improved TBG that is viable for trend analysis; and to investigate whether medical subject headings (MeSH terms) can be used to predict article citations.

Methods: We downloaded T100MNJ from the PubMed database by searching the string ("NMJ" [MeSH Major Topic] AND ("2001" [Date - Modification]: "2021" [Date - Modification])) and matching citations to each article. Cluster analysis of citations was performed to select the most cited entities (e.g., authors, research institutes, affiliated countries, journals, and MeSH terms) in T100MNJ using social network analysis. The trend analysis was displayed using TBG with two major features of burst spot and trend development. Next, we examined the MeSH prediction effect on article citations using its correlation coefficients (CC) when the mean citations in MeSH terms were collected in 100 top-cited articles related to NMJ (T100NMJs).

Results: The most dominant entities (i.e., country, journal, MesH term, and article in T100NMJ) in citations were the US (with impact factor [IF] = 142.2 = 10237/72), neuron (with IF = 151.3 = 3630/24), metabolism (with IF = 133.02), and article authored by Wagh et al from Germany in 2006 (with 342 citing articles). The improved TBG was demonstrated to highlight the citation evolution using burst spots, trend development, and line-chart plots. MeSH terms were evident in the prediction power on the number of article citations (CC = 0.40, t = 4.34).

Conclusion: Two major breakthroughs were made by developing the improved TBG applied to bibliographical studies and the prediction of article citations using the impact factor of MeSH terms in T100NMJ. These visualizations of improved TBG and scatter plots in trend, and prediction analyses are recommended for future academic pursuits and applications in other disciplines.

Abbreviations: AWS = author-weighted scheme, BS = burst spot/burst strength, CC = correlation coefficient, IF = impact factors, IP = inflection point, NMJ = neuromuscular junction, MNs = motor neurons, MeSH = medical subject headings, TBG = temporal bar graph, T100NMJ = 100 top-cited articles related to NMJ.

Keywords: bibliometric study, Google Maps, MeSH term, neuromuscular junction, prediction, social network analysis, temporal bar graph

1. Introduction

The neuromuscular junction (NMJ) is a highly specialized synapse between a motor neuron (MN) nerve terminal and its muscle fiber that is responsible for converting electrical impulses generated by the MN into electrical activity in the muscle fibers.[1] The NMJ is at the crossroads between the nervous system (NS) and the muscle. Following neurotransmitter release from MNs, muscle contraction occurs, and movement is generated.[1,2] The NMJ synapse formed between a lower MN

Highlights

- The main features of this study are focused on TBG and scatter plots in trend and prediction analyses that were demonstrated:
- The trends of topical entities in NMJ were displayed using the improved TBG, which is novel and innovative in bibliographical studies and not mentioned for clarity and computation in Citespace software.
- Based on the proportional publications or citations in articles, the bubbles are sized based on cluster analysis using social network analysis, which has never been done in professional biblimetric software (e.g., VOS Viewer and CiteSpace).
- Visual dashboards on Google Maps that can be manipulated by readers on their own to examine details about further information in topical entities.

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and skeletal muscle fiber represents a major focus of both basic neuroscience research and clinical neuroscience research. NMJs are known to play an important role in many neurodegenerative conditions affecting humans. Nonetheless, recent findings have merely demonstrated major differences between the cellular anatomy and molecular anatomy of humans,[3] although the NMJ is thought to play a crucial role, as it demonstrates distinct age-related deterioration involving both neural and muscular aspects.[4] The trend and prediction of citations on NMJ are required for investigations using bibliometric analysis

1.1. Bibliometric analysis is required to explore more knowledge for readers

Much more knowledge[5] is required from publications for readers to understand the features of articles or data accumulated at a high velocity, resulting in datasets that are too large in traditional data-processing systems.[6,7] In practice, data in health care need to incorporate visual representations with increasingly sophisticated and analytical features in ways that make the data meaningful and useful to humans in our lives.[8] Understanding the trend and prediction of citations on NMJ motivates us to conduct the current study comparing topical entities through techniques (e.g., bibliometrics) in dealing with these so-called big data in 100 top-cited articles (100 top-cited articles related to NMJ [T100NMJ] for short).

Bibliometrics is a form of research that combines the traditional bibliographic research of analyzing the information obtained from published materials with a technical method to quantitatively calculate the impact of the publications,[9] assess the quality of the studies, analyze the key areas of research, and predict the direction of future studies.[10] Meanwhile, such bibliometric analysis can characterize and predict the development of a specific field (e.g., NMJ) to compare contributions across countries, institutions, and/or journals.[11]

During the past few decades, there have been many reviews about the prediction of NMJ, but no such in-depth scientometric analysis (or bibliometric analysis) of publications on NMJ has been provided in publications until now.

1.2. Quality as a bibliographic study

Many manuscripts are erroneously labeled bibliographic studies, as they do not use bibliometric (= statistical) methods and only provide lists of important and impactful topical entities (e.g., authors, journals, topics, articles, and affiliated institutes/countries) because compiling and providing such lists is an essential first step but does not qualify the study as a bibliographic

study.[12] As such, a description and summary of "simple" bibliographic metadata (i.e., topical entities mentioned above) are too superficial to derive specific answers to particular research questions. Conversely, bibliographic studies are particularly useful to describe the development of topical entities over time.[12] That is, a good bibliographic study provides a chronological view of the field (e.g., how has the number of studies evolved, how have the topics evolved, how have the outlets evolved) and provides an overview of the most influential entities, such as the temporal bar graph (TBG),[13,14] to interpret the evolution of entities.

A bibliographic study should not stop at this stage using TBG, which plays a critical role in any bibliographic study. Instead, TBG can be a starting point to dig deeper into bibliographic data using bibliometric methods, such as the prediction of citations in future articles. That is, a bibliographic study should rely on more sophisticated, multivariate statistical analyses (e.g., cocitation analysis) to derive results instead of those simple article and citation counts in Tables, as we saw in those 100 top-cited studies.[15-18] Good examples of articles following this approach are those[19-24] to identify a relevant and interesting "story" that is supported by their bibliographic data and bibliometric analyses.

1.3. The improved TBG is required in bibliometrics

Traditionally, TBG[13,14,25] has several drawbacks that should be overcome, including no such information about the determination of burst spot and burst strength provided for readers by merely performing the TBG tool of Sci2[26] and the trend stages (e.g., increasing, ready to rise, decreasing, and slowdown) when observing the end of time points. The improved TBG is thus proposed in this study.

1.4. Study aims

This study aims to identify the most dominant entities in T100NMJ since 2001; to verify the improved TBG that is viable for trend analysis; and to investigate whether medical subject headings (MeSH terms) can be used to predict article citations.

2. Methods

2.1. Data sources

We programmed Microsoft Excel's Visual Basic for Applications (VBA) modules to extract the downloaded abstracts published on NMJ within the article title since 2001. The search terms were defined as (((NMJ [MeSH Major Topic]) or (NMJ [Title]))) AND (("2001" [Date - Publication]: "3000" [Date - Publication])).

A total of 3831 abstracts were retrieved from the PubMed database. Only those articles labeled journal articles were included. Others, such as those marked as "Published Erratum, Editorial, or conference proceedings," were excluded. Article citations were extracted and matched to compare journal research achievements. All those T100NMJs are listed in reference.[27] No ethical approval was needed as all data were collected from a publicly available database.

2.2. Data arrangement to fit the SNA requirement

Before visualizing our results using social network analysis (SNA),[28] we organized the data in compliance with the format and guidelines defined by Pajek software.[29] Microsoft Excel's VBA routines were used to perform data fitting to SNA requirements; see the MP4 video.[30]

2.2.1. Bubbles sized by degree centrality. The number of connections for a specific MeSH term[31] in an article was computed. The equal weight (Wi) shown in Equation (1) was used to calculate the weighted degree centrality (DC), where L denotes the number of MeSH terms in an article, and j represents the location in an article byline. In SNA, each MeSH term defined as a note earns the DC Equation (2), where n denotes the sample size, and the DC for a given MeSH term is determined by using the summed weights in all articles.

$$W_i = \frac{1}{L},$$

$$\text{WDCk} \quad \text{in} \quad \text{an} \quad \text{article} = \left(\sum_{i=1}^{L-1} \sum_{j=i+1}^{L} (W_i + W_j)\right) \div (L-1)$$

$$= 2 \times W_i \times \frac{L \times (L-1)}{2} \div (L-1)$$

$$= 2 \times \frac{1}{L} \times \frac{L \times (L-1)}{2} \div (L-1) = 1,$$

where L is the number of cooccurring entities (e.g., authors or MeSH terms) in an article byline. Wi is the equal weight for an entity in an article byline; see Equation (1). WDC is thus the weighted DC. In Equation (4), Wi equals Wj based on Equation (1). The sum of WDC for all entities in an article equals 1.0. The total WDC is equal to the number of articles (e.g., in Equation (3)), different from the traditional SNA ignoring the WDC equal to the number of articles using Equation (4) to sum the connections of elements (=L) in an article.

$$\text{Total WDC} = \sum_{k=1}^{n} WDC_k,$$

$$WDC_i = L - 1,$$

where n = article number. The WDC is thus sized by a bubble in SNA.

2.2.2. All weights equal article number. Traditionally, DC is primarily denoted by the number of cooccurring entities in an article (see Eq.). The sum of DC across all entities in all articles might not be equal to the number of articles in the study data (e.g., using Equations (3) and (4)). As such, a particular adjustment is required to make the total WDC (in Equation (3)) equal the number of articles via Equations (1) to (3) before performing the Pajek software.[28]

For instance, there are two MeSH terms A and B in an article. The WDC = $2 \times \frac{1}{2} \times \frac{2 \times (2-1)}{2} \div (2-1) = 1$. Similarly, WDC equals 1 if L is greater than 2. The WDC for a specific MeSH term (or other entity) k is the summation of Wi in all articles in Equation (5).

2.2.3. All citation weights equal article number multiplied by citations. If article citations (denoted by the symbol IF) were taken into account, the weights of a specific entity (e.g., WDC in Equation (4)) are combined with IF to compute the $IFWDC_k$ via Equations (5) and (6).

$$\text{IFWDC in an article} = IF \times \left(\sum_{i=1}^{L-1} \sum_{L=i+1}^{L} (W_i + W_L)\right) \div (L-1)$$

$$= IF \times 2 \times W_i \times \frac{L \times (L-1)}{2} \div (L-1)$$

$$= IF \times 2 \times \frac{1}{L} \times \frac{L \times (L-1)}{2} \div (L-1) = IF,$$

$$IFWCD_k = \left(\sum_{j=1}^{n} \text{IFWDC}_j\right) \div \quad WDC_k,$$

$$\text{Citations} = \sum_{k=1}^{n} IFWCD_k,$$

where $IFWCD_k$ is the mean IF of entity k. All citations in articles are composed of individual $IFWCD_k$ in Equation (7). Accordingly, the bubble can be sized by $IFWCD_k$ for each entity if citations are applied to the topical entities.

It is worth noting that the computation of IFWDC for individual authors in articles could be applied using the unequal author-weighted scheme (AWS)[32,33] instead of the equal credit in Equation (4). As such, the first author earns the most credit (approximately 63%), followed by others (e.g., the corresponding author (assumed as the last author) with approximately 12% credit and other middle authors obtain the remaining portions in descending order).

In this study, the weights in an article are assumed to be equal using Equation (1) (called equal AWS) because only the first authors and their corresponding affiliated institutes/counties are involved in SNA. For instance, the entities in SNA include article identity number, first author/institute/country, journal, publication year, and MeSH terms in the respective article.

2.3. Citation analysis in T100NMJ

The publications over the years for countries and journals were separately displayed using Tables. The top five most cited entities were selected by performing SNA via Equation (7) using the data in T100NMJ.[27] The relatively high density (i.e., the weighted citations in Equation (7)) was used to represent the dominant role in the respective cluster using the Alluvial plot[34] to display(see how to draw the Alluvial in Supplemental Digital Content 1, http://links.lww.com/MD/H365). Only citations for dominant entities were considered for the following analyses (e.g., trend and prediction).

Task 1: Comparisons of Non-AWS and AWS Approach in SNA

We verified the AWS-based SNA by comparing the results in Equation (4) using the traditional SNA. A four-quadrant diagram was applied to interpret the differences and commonalities between the two approaches (i.e., AWS and non-AWS) in three scenarios using Pajek software.[29] The three scenarios include non-AWS as Equation (4), equal AWS, and unequal AWS.[32,33]

Quadrant I (without single authors in articles and weight = 1 in an article):

Quadrant II (without single authors in articles and weight > 1 in an article):

Quadrant III (with single authors in articles and weight = 1 in an article):

Quadrant IV (with single authors in articles and weight > 1 in an article):

Four articles with different author-affiliated countries were included, such as countries in order: {US, US}, {US, China}, {China, UK, India}, {China, UK, US, India}. Only the first involves a single author (i.e., the US) in the article.

Task 2: Trend Analysis in T100NMJ Using the Improved TBG

The improved TBGs combined with burst spot and trend stage (e.g., increasing, ready to rise, decreasing, or slowdown) were applied to display their trend evolution of selected entities in SNA, different from the traditional TBG[13,14,25] merely with the former (i.e., burst spot) only in TBG; see the two panels in Figure 1.

In the current study, the improved TBG is a transition from the selected entities to the line-chart plot. There are five major components (combined with the inflection point (IP), the heatmap,
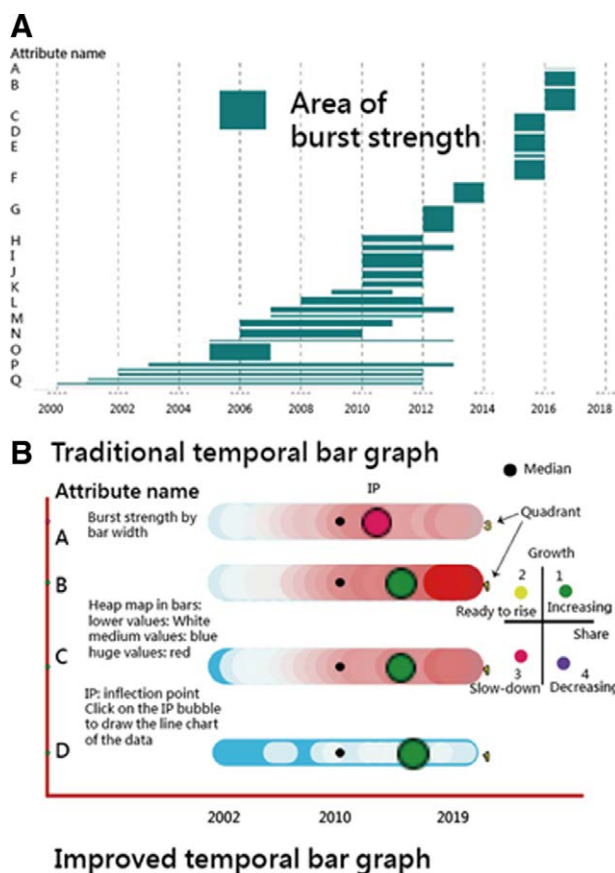
Figure 1. The improved TBG that can release more information (e.g., burst spot, data trend, increasing type, and heatmap) on the bar graph. TBG = temporal bar graph.

the data pattern using two bubbles to explain the trend, and the burst strength) described in the next section.

2.3.1. The IP on an ogive curve. The IP (IP as the location of the burst spot in the data) can be obtained through the Newton–Raphson Iteration Method[35–38]; see the two examples in Figure 2.

Seven cumulative observed data points (named item responses) are illustrated in Figure 3. The IPs on ogive curves for each score with the respective category probability decrease as the items become more difficult across the ordered item responses[39,40] shown in Figure 3. We can see that the IP (or the burst spot) is located on the point at item difficulty[41,42] based on the item response theory feature.[35,36]

2.3.2. Heatmap. Geospatial visualizations often use heatmaps since they quickly help identify "hot spots" or regions of high concentrations of a given variable.[43] Compared to the traditional TBG,[13,14,25] the improved TBG (in the lower panel of Fig. 1) is composed of four colors made for data values: Q1 in blue, Q2 in white, Q3 in light red, and Q4 in dart red using the function of the interior.color index in MS Excel (e.g., the color values (X) are separated by the formula ($= \frac{X - Min.}{Max. - Min.} \div 256$), where X from 0 (blue), 1 to 90 (white), 91 to 180 (light red), to 181 to 256 (dark red).

2.3.3. The data pattern using two bubbles to explain. In the bottom panel of Figure 1, three data patterns (including left skewness, right skewness, and normal distribution) are identified by the two bubbles: median and IP point.

2.3.4. The trend using the growth/share matrix. Four stages (i.e., ready to rise, increasing, decreasing, and slowdown) are

divided into four quadrants based on the end-point stage (e.g., in the latest four endpoints). The 4-quadrant matrix is derived from previous studies[44,45] using the growth/share matrix coined by the Boston Consulting Group (BCG) in 1970 to classify the evolution of a specific product in features (i.e., growth on the Y-axis and share on the X-axis).[45,46] The two axes are represented by the two indicators (i.e., share in the x-axis and growth on the y-axis); see the right-bottom corner in Figure 1.

$$\text{Growth} = \left(\frac{X_n}{X_{n-3}} \div \left(1 + \frac{X_n}{X_{n-3}} \right) - 0.5 \right) \times 2,$$

where Xn is the observed value at the endpoint and Xn-3 is the value at the latest four-time points. The growth rate ranged between –1.0 and 1.0.

$$\text{Share} = \left(\prod_{i=n-3}^{n-1} \frac{X_{i+1}}{X_i} \right)^{1/3} - 1 = \left(\frac{x_n}{x_{n-3}} \right)^{\frac{1}{3}} - 1$$

where × denotes the cumulative count at the last (Xn) and the start point (Xn-3) time points, and n stands for the sequential days observed. The Share is in a range between –∞ and ∞ with the median at 0.

2.3.5. The burst strength sized by the IP bubble in TBG. The burst strength (BS) was proposed to denote the critical spot[25,26] in Equation (10), based on the two factors of intensity (or momentum) and the increasing slope in the important part (burst spot) and recent part, respectively, in the time-series data.[40,41]

$$\text{BS} = \ln \left(\sqrt{Nip \times a} \right),$$

where Nip is defined as the number at IP, and the parameter a denotes the item slope parameter in item response theory.[35,36] A steeper ogive curve (or a higher Nip) leads to a stronger BS, as denoted by the bar on the TGB.

2.4. Using line-chart plot to verify the features in TBG

The line charts of observed citations annually and the cumulative data together appear on the website once the black bubble of the median is clicked on the TBG.

2.5. Prediction analysis of article citations in T100NMG

2.5.1. Calculation of weighted MeSH terms. Mean citations per MeSH term were computed via Equation (6) by performing the SNA.

2.5.2. Prediction power between MeSH terms and citation counts. The correlation coefficient (CC) was used to determine the prediction power between the weighted MeSH terms and the original article citations. The *t* value of CC was calculated by the formula $= \left(\frac{cc}{\sqrt{\frac{1 - CC^2}{n-2}}} \right)$, and displayed on a scatter plot[22] (see how to draw the scatter chart in Supplemental Digital Content 1, http://links.lww.com/MD/H365). A prediction equation was produced by using simple regression analysis in MedCalc 9.5.0.0 for Windows (MedCalc Software).

2.6. Creating dashboards on Google Maps

We applied the author-made modules in Microsoft Excel and the SNA in Pajek to obtain the CD of each topical entity. The pages of Hypertext Markup Language (HTML) used for Google Maps were created. All relevant information was linked to the
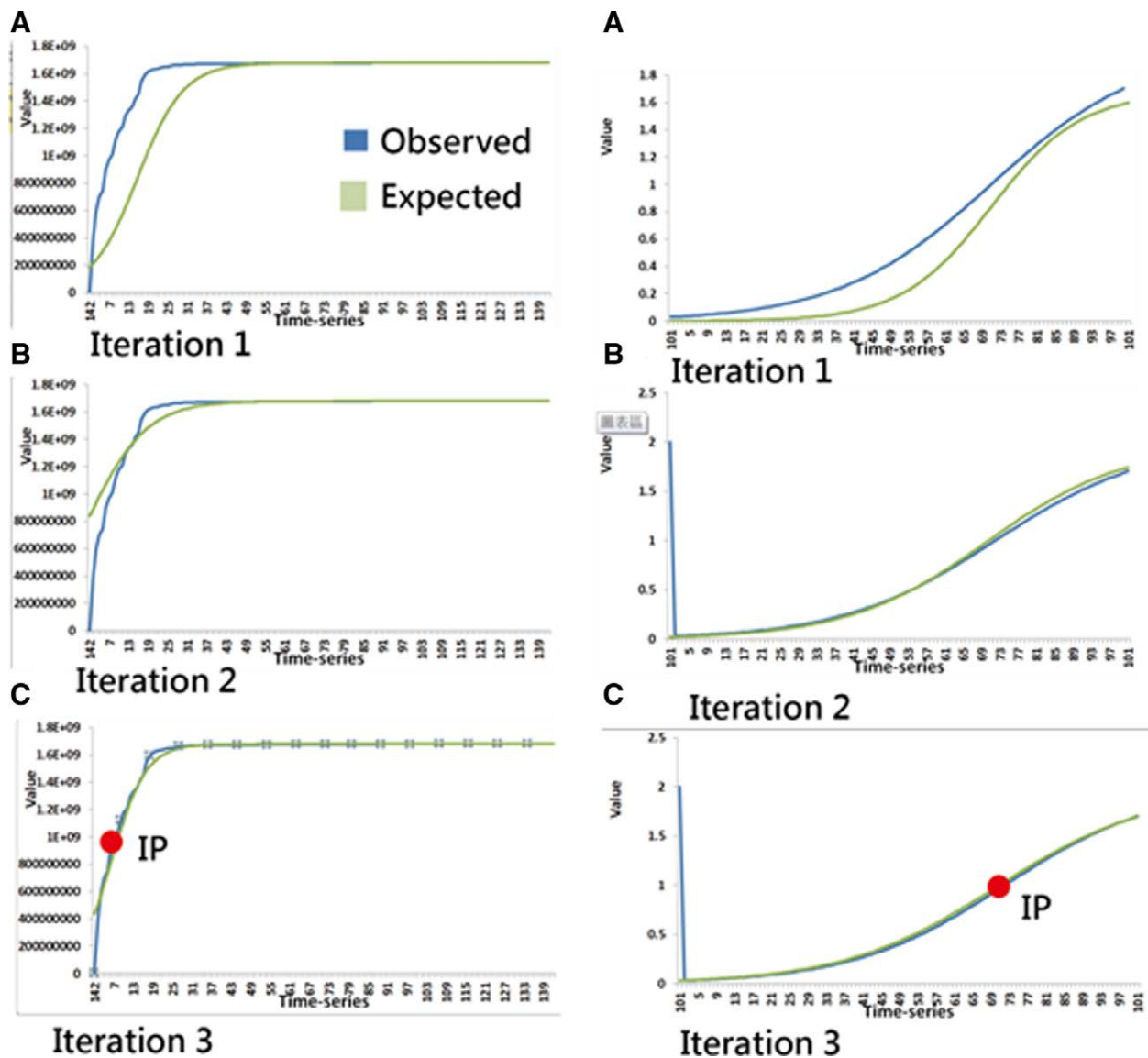
Figure 2. The IP determined on an ogive curve using the Newton-Raphson Iteration Method(NRIM)[35-38] approach from top to bottom as model-data-fit curves with the number of iterations in process. IP = inflection point.

dashboards on Google Maps. The study flowchart is shown in Figure 4.

3. Results

3.1. The AWS-SNA approach in comparison to the traditional SNA

The total DCs in the three scenarios were distinctly different in the four quadrants (Fig. 5):

Quadrant I (without single authors in articles and weight = 1 in an article): 9, 3, 3

Quadrant II (without single authors in articles and weight > 1 in an article): 10, 6, 6

Quadrant III (with single authors in articles and weight = 1 in an article): 7, 7

Quadrant IV (with single authors in articles and weight > 1 in an article): 4, 4 (equal to the number of articles = 4)

Accordingly, the AWS-SNA approach is superior to the traditional SNA without the adjustment in Equations (2) and (5). An equal AWS was applied to this study to achieve total citations
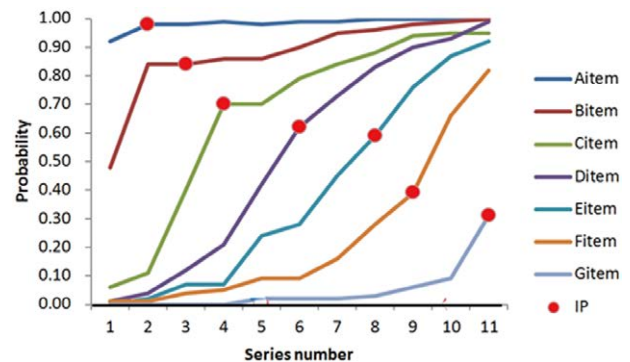
Figure 3. An illustrative example of IPs determined on seven output curves (Note. The IPs on the locations of item difficulties form the easy (left) to the hard (right)). IP = inflection point.

equal to the summation of weighted citations in individual entities via Equation (3).

Figure 4. The study flowchart (Note. Trend and prediction using visualizations and weighted MeSH terms to predict the article citations).

3.2. Distribution of publications and citations in countries and journals

Publications and citations over the years in T100NMJ since 2001 are shown in Tables 1 and 2 for affiliated counties and journals, respectively. The most highly cited entities are the US and the journal Neuron, with IF = 142,2 and 151.3, respectively.

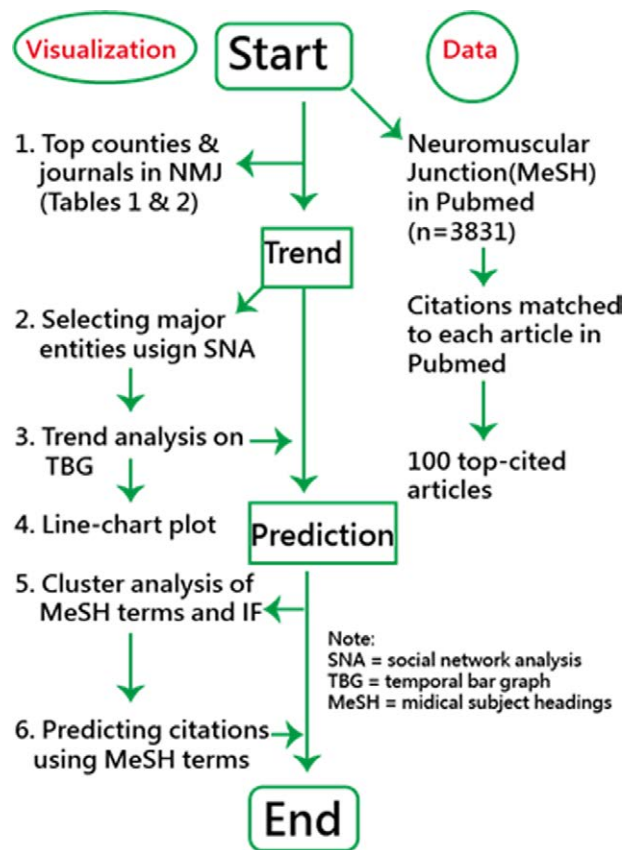### 3.3. Degree centrality by citation for each entity in SNa

Figure 6 shows the most frequently cited entities in the six clusters. There are five top members of each cluster (by column): 2006 (665 citations), the US (2656), J Neurosci (332), Physiology (2957), Research Support (4215), and PMID = 20331995 (203) in terms of years, countries, journals, MeSH terms, document types, and articles. In Figure 6, having a larger block implies that there are more citations in T100NMJ. As compared to their counterparts, the red curves indicate the most flow vertically.

3.4. Trend analysis in TBGs and line-chart plots

In addition to the top three entities in 10 clusters, we collected the three top-cited articles and the annual counts in publications in TBGs (Fig. 7). The larger bubble of the burst spot is from the US shown at the top TBG. All data in the selected entities are tailed to the left, but the bottom (annual publications) has an identical location in the burst and median points.

Most entities present a slowdown trend (i.e., with the red burst bubble or symbol 3 in the last column in TBS). The line-chart plot immediately appears on the website once the black median bubble of interest is clicked. In Figure 7, we can see that

the trends with a slowdown are in the US, annual publications, and the article with PMID = 16543132 based on the last four time points. On the other hand, the trend of the MeSH term of physiopathology is increasing.

3.5. Prediction analysis in citation in T100NMJ

3.5.1. MeSH clusters and MeSH weights. For citation analysis, six clusters with MeSH terms are shown in Figure 9. The top three most cited MeSH terms are physiopathology (=184), physiology (=179.63), and innervation (=162.21). In addition, other MeSH IFs are presented as red numbers, as demonstrated in Figure 9.

3.5.2. Prediction model using MeSH terms. To utilize the MeSH weights (represented by weight denoted by IF) to predict article citations, according to our results, MeSH terms were evident in prediction power on the number of article citations (CC = 0.40, t = 4.34) (Fig. 10). The regression equation is defined as Article citation (y) = 20.55 + 0.7169 × Weight (x) of the MeSH term. The slope coefficient was statistically significant (F = 18.83, t = 4.34, P < .001). The majority of articles fall within the 95% confidence interval curves. When the QR-code in Figure 10 is clicked, the article appears immediately on the Pubmed website. The reader is encouraged to practice the dashboard on his or her own.

3.6. Creating dashboards on Google Maps

Figures 2–4 are provided with links to the references.[47-51] Readers are invited to see the detailed information on the dashboard laid on Google Maps.

## 4. Discussion

4.1. Principal findings

Since the concept of bibliometrics has been introduced in the literature, the IF for NMJ is required for discussions about the journals of interest. Bibliometric analysis has proven the important role played in the formulation of policies and clinical guidelines, making it attractive as an analytical method.[11]

Based on the results of this study, the principal findings include the following: The most dominant entities (i.e., country, journal, MesH term, and article in T100NMJ) in citations were the US (with IF = 142.2 = 10237/72), neuron (with IF = 151.3 = 3630/24), metabolism (with IF = 133.02), and article authored by Wagh et al from Germany in 2006 (with 342 citing articles), respectively; the improved TBG was demonstrated to highlight the citation evolution using burst spot, trend development, and line-chart plot; and MeSH terms were evident in prediction power on the number of article citations (CC = 0.40, t = 4.34).

4.2. The features of citation analysis in bibliometrics

Authors can easily identify the impact factors (IF) related to MeSH terms that are associated with their submitted articles to the target journal through a visual display of major MeSH terms (Fig. 9). This study provides Google Maps and SNA to display all associated entities (e.g., countries and MeSH terms) on dashboards and is a major breakthrough made for future similar studies. Such a network yielded by the bibliometric analysis can be defined as a type of co-occurrence pattern, which is a phenomenon search, similar to previous studies.[52-54]

As age advances, the nervous system begins to suffer a slow and continued reduction in its functions. NMJs are one of the structures of changes in the aging process and the physical link
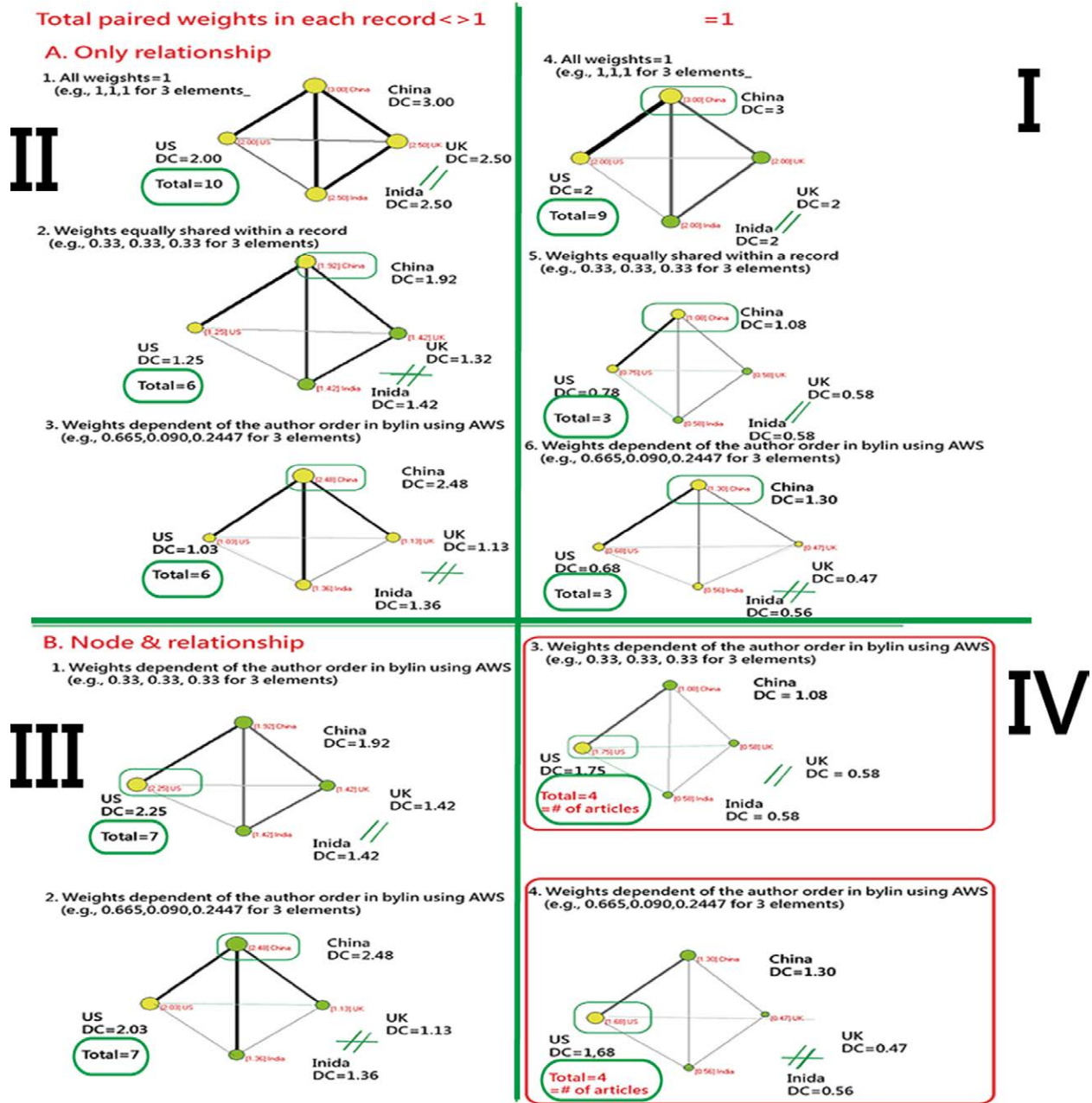
Figure 5. The comparison of three scenarios between the non-AWS and AWS approaches (Note. Only the scenario IV that can make the weighted DC equal counts of publications or citations in articles through a series of adjustments in Equations (1)–(7)). AWS = author-weighted scheme.

between neurons and muscle cells and play a central role in the communication between these two cell types.[55,56] T100NMJ[22] can be considered influential articles on NMJ, with citation numbers and publications in journals with high IF serving as indicators of an article's quality.

Classically, it is not expected for the articles published in recent years to be cited as much as the older ones. There are many factors determining whether an article will be cited in high numbers or not.[57] Therefore, the current study merely provides a timely broad understanding of NMJ for readers as future research directions.

4.3. Three most-cited articles

The top-ranked article was titled "Bruchpilot, a protein with homology to ELKS/CAST, is required for structural integrity and function of active synaptic zones in Drosophila" by Wagh

et al[58] The article was cited 432 times. Adults show loss of T bars at active zones, absence of synaptic components in elect-roretinograms, locomotor inactivity, and unstable flight (hence the term "bruchpilot"-crash pilot). According to the authors, Bruchpilot protein (BRP) is necessary for intact AZ structure as well as normal-evoked neurotransmitter release at chemical synapses in Drosophila. As a result, the articles were frequently cited in numerous studies.

The second-ranked article was authored by Sanes and Lichtman[59] and titled "Induction, assembly, maturation, and maintenance of a postsynaptic apparatus". The article was cited 379 times. This article discusses the fact that embryonic NMJs are very different from adult NMJs. An oval plaque changes into a pretzel-like set of branches, and the junctional membrane changes from a flat sheet to an invaginated surface with gut-ters and folds. Currently, the mechanisms underpinning each of these transformations are only beginning to be understood.

Table 1

Article distribution for countries in T100NMJ over the years.

Country	2001	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	n	Ci	IF*
U.S.	6	8	4	7	7	5	8	6	2	5	1	6	2		1	1	1	2	72	10237	142.2
Germany	1	2			1	1		1						1					7	1264	180.6
U.K.	1		1	1		1	1	1											6	688	114.7
Canada			1				1	1		1	1								5	652	130.4
France			1						2										3	277	92.3
Switzerland										1					1				2	228	114
Australia											1								1	83	83
Belgium												1							1	172	172
China												1							1	91	91
Italy														1					1	139	139
Japan						1													1	148	148
Total	8	10	7	8	8	8	10	9	4	7	3	8	2	2	2	1	1	2	100	13979	139.8

IF = impact factors, T100NMJ = 100 top-cited articles related to NMJ.

*IF = Ci/n.

Table 2

Article distribution for journals in T100NMJ over the years.

Journal	2001	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	2018	n	Ci	IF*
Neuron	1	7	2	3	2	2	1	3		1		1					1		24	3630	151.3
Cell	1	1		1			2	2				1							8	1321	165.1
J Neurosci			2	2	2	1			1										8	953	119.1
Hum Mol Genet			1	1				2		1		1							6	834	139
Nat Neurosci	1						3	1											5	675	135
Science				1	1	2			1										5	790	158
Nature	2											2							4	510	127.5
PLoS One									1	1	1	1							4	381	95.3
Development					1	1				1									3	550	183.3
Curr Biol					1	1													2	182	91
Curr Opin Neurobiol						1	1												2	259	129.5
J Appl Physiol (1985)							1							1					2	185	92.5
Lancet Neurol															1			1	2	285	142.5
Proc Natl Acad Sci U S A					1					1									2	321	160.5
Others	3	2	2				2	1	1	2	2	2	2	1	1	1	0	1	23	3103	134.9
Total	8	10	7	8	8	8	10	9	4	7	3	8	2	2	2	1	1	2	100	13979	139.8

IF = impact factors, T100NMJ = 100 top-cited articles related to NMJ.

*IF = Ci/n.

With the use of microscopic and genetic approaches, the molecular and cellular mechanisms that govern each of these stages are now being clarified, allowing the NMJ to serve as a model for smaller and less accessible central synapses. This is the reason why this article has been cited in a number of studies.

Verstreken et al[60] published an article titled "Synaptic mitochondria are critical for mobilization of reserve pool vesicles at Drosophila NMJs", which ranked third. The article was cited 374 times. Mutations in dynamin-related protein (DRP1) were identified by the authors. During intense stimulation, mutants are unable to maintain normal neurotransmission. However, FM1-43 labeling indicates that reserve pool vesicles cannot be mobilized, despite normal exo- and endocytosis. They suggest that mitochondria play a specific role in regulating synaptic strength. A large number of citations in the past have been attributed to this article, providing a deeper understanding of NMJ.

4.4. The strength of this study

Three major strengths are illustrated in this study:

1. A particular adjustment was made for SNA using the AWS approach to make sense of bubble size equal to the weighted DC, based on the requirement of Pajek software. Otherwise, the weighted DC in SNA would be biased to the meaning of bubble size when referring to Equation (3).
2. The improved TBG is superior to the traditional TBG,[13,14] which lacks an explanation of how to determine the burst spot and burst strength as well as display the trend type in TBG. For instance, multiple studies[61-63] have reported cluster analysis and keywords with the strongest citation bursts using VOS viewer[64] and CiteSpace.[65] There is no correlation between bubble size and the number of publications or citations, as indicated in Equations (1) to (7). The citation analyses of keywords (or referenced articles) with the strongest citation bursts are not provided for the sake of clarity and computation, as we provided in Equations (8) to (10) and Figures 7 and 8.
3. A bibliographic study should dig deeper insight into data using statistical methods, such as the prediction of citations in future articles.
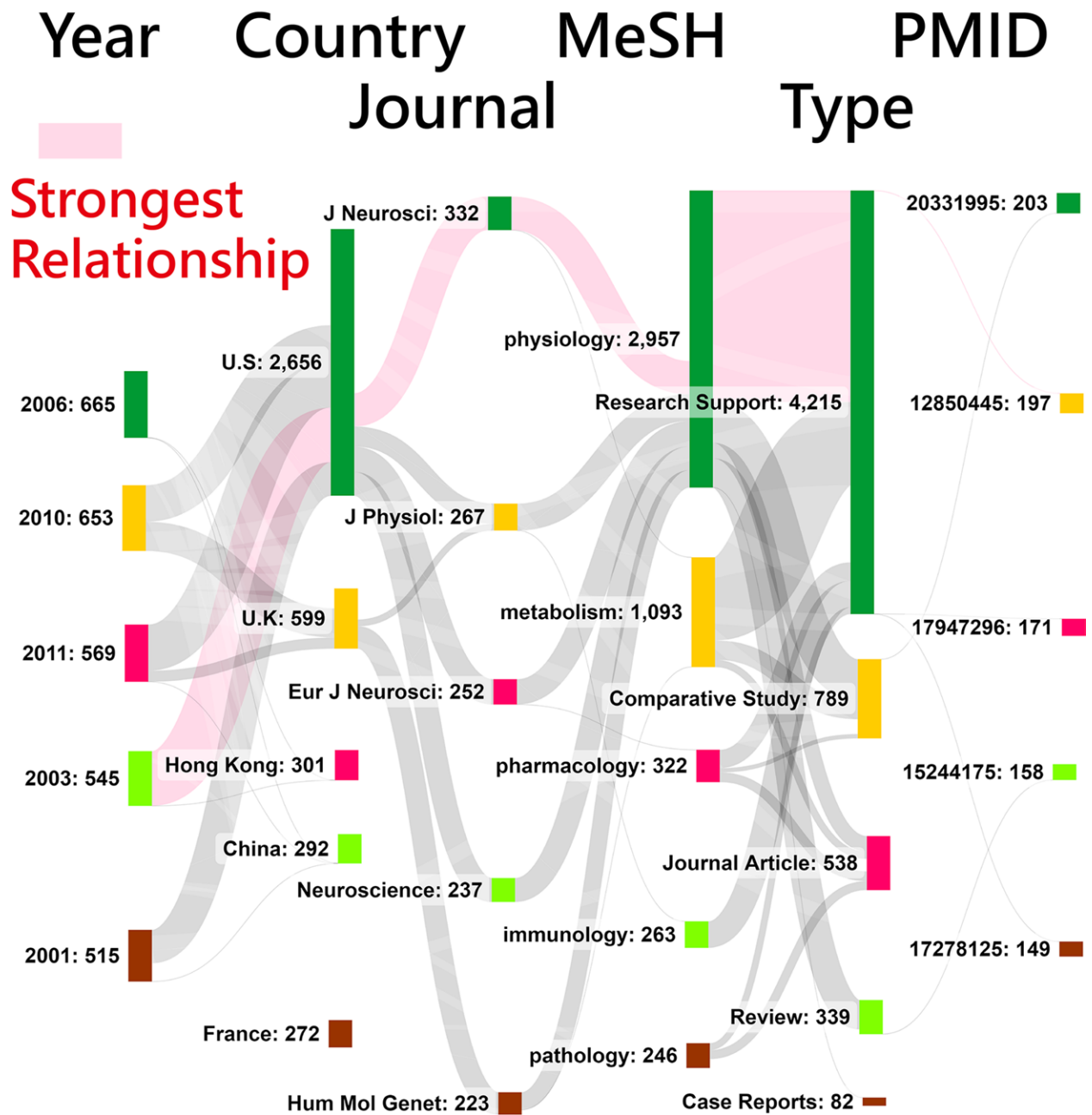
These articles[19-24] have followed a relevant and interesting "story" that is supported by their bibliographic data and bibliometric analyses.

4.5. Limitations and suggestions

Although the findings were based on the aforementioned analysis, our study also has several limitations. First, articles with

Figure 6. The selection of top 5 topical entities (Note. All entities are analyzed together using SNA and shown on the Alluvial diagram). SNA = social network analysis.

more publication years may receive more citations[66,67] than those articles in the earlier ten years. The number of citations in the latter publication years might have increased in recent years. The change in T100NMJ might be exhibited over time.

Second, citation counts do not directly reflect the quality of an article but enable a quantitative evaluation of the scientific impact of an article in a specific discipline. The advanced hotspot would be dependent on the number of citing articles on an article in the future.

Third, only articles with MeSH terms were included in this study to predict the number of article citations. Others without MeSH terms were excluded from this study. This might be biased by omitting a large number of article citations outside the T100NMJ.

Fourth, although our cluster analysis using SNA is unique and useful, it is still challenging for the authors to include all relevant entities on a board without mess and confusion to readers. The results should be improved further to make it clearer and easier to understand than the one we provided in this study, such as clusters separated by an entity (e.g., author, journal, country, institute, MeSH, etc.) instead of closed actors, as we did in Figure 9, to highlight the top ones in citations.

Finally, article citations have many associated factors, such as the number of references and the number of authors. As such,

the finding of MeSH terms associated with article citations is not the only factor influencing article citations. Further studies are encouraged to investigate the factors predicting the number of citations in the future.

5. Conclusion

This study is the first to report T100NMJ in bibliographical studies. Two major breakthroughs were made by developing the improved TBG applied to bibliographical studies and the prediction of article citations using the IF of MeSH terms in T100NMJ. These visualizations of improved TBG and scatter plots in trend, and prediction analyses are recommended for future academic pursuits and applications in other disciplines.
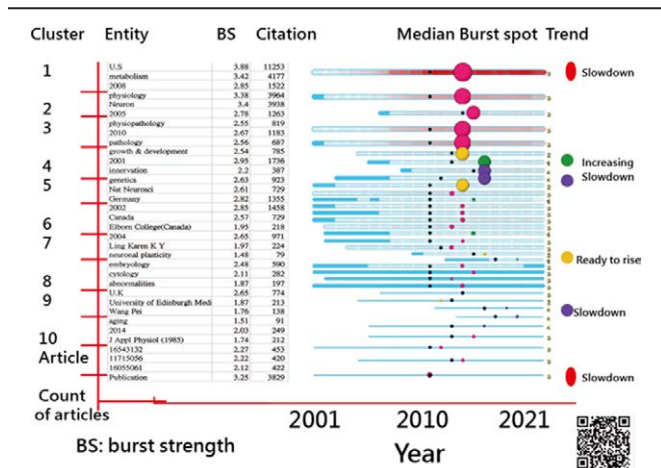
Figure 7. Citation trend of major topical entities shown on TBG (Note. The first feather of this study is to develop the enhanced TBG used for bubliometrics). TBG = temporal bar graph.
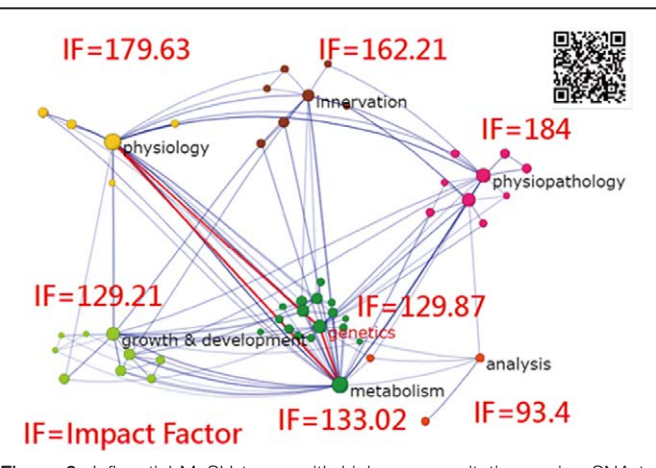

Figure 9. Influential MeSH terms with higher mean citations using SNA to display the IF (i.e., the mean citations based on T100NMJ) on Google Maps. IF = impact factors. MeSH = medical subject headings, T100NMJ = 100 top-cited articles related to NMJ.
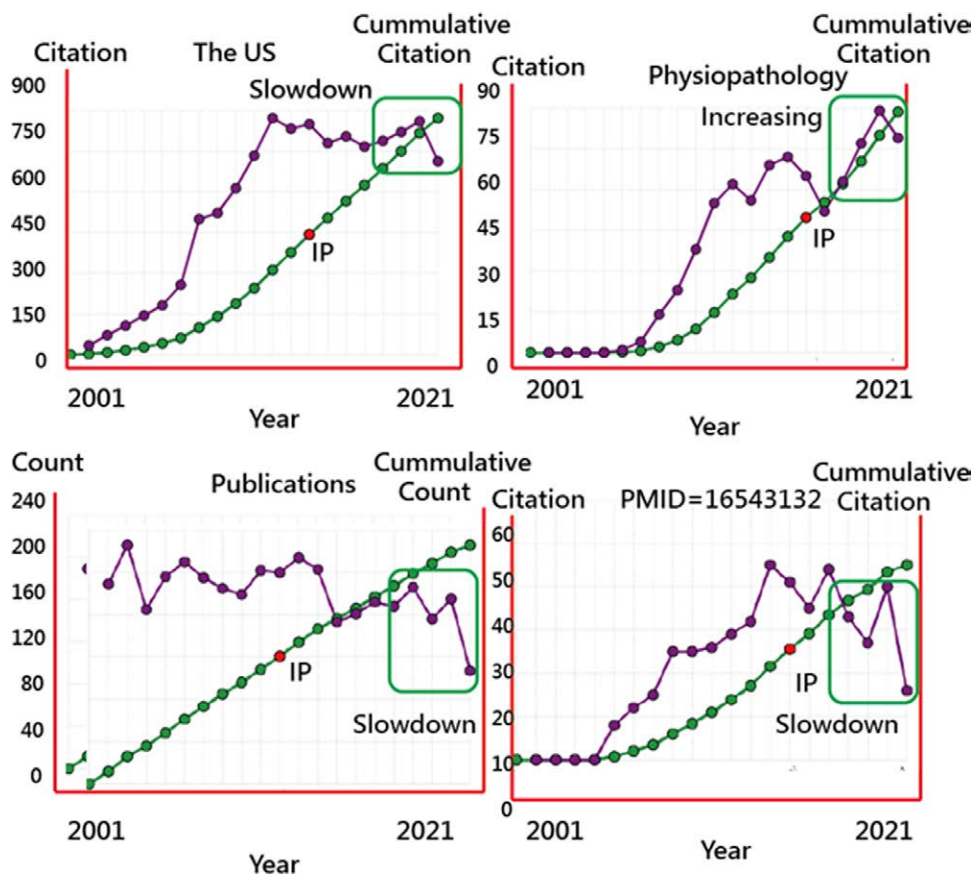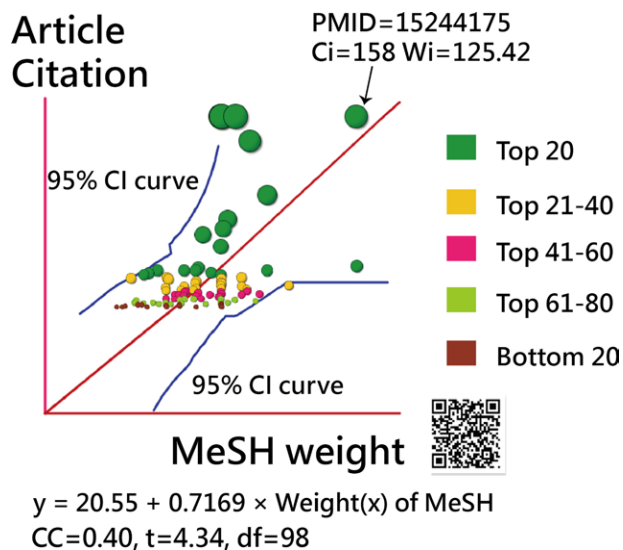

Figure 8. Citation trend and burst spot for the targeted entity using a line-chart plot (Note. Once the bubble of interest in TBG is clicked, the line chart appears immediately). TBG = temporal bar graph.

$$y = 20.55 + 0.7169 \times Weight(x)\ of\ MeSH$$
$$CC = 0.40,\ t = 4.34,\ df = 98$$

Figure 10. Predicting the number of articles in T100NMJ using the weighted DC of MeSH terms in Equations (1) to (7) (Note. Bubbles are sized and colored by article citations). MeSH = medical subject headings, T100NMJ = 100 top-cited articles related to NMJ.

Author contributions

JW and YH initiated the research, collected data, TWC conducted the analysis, and wrote the manuscript. TWC contributed to the design of the study and provided critical reviews of the manuscript, and YH contributed to the interpretation of the results. WC monitored the study as a whole.

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