A comparison of publication to TBI burden ratio of low- and middle-income countries versus high-income countries: how can we improve worldwide care of TBI?

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OBJECTIVE Traumatic brain injury (TBI) is a global public health problem and more than 70% of trauma-related deaths are estimated to occur in low- and middle-income countries (LMICs). Nevertheless, there is a consistent lack of data from these countries. The aim of this work is to estimate the capacity of different and heterogeneous areas of the world to report and publish data on TBI. In addition, we wanted to estimate the countries with the highest and lowest number of publications when taking into account the relative TBI burden.

METHODS First, a bibliometric analysis of all the publications about TBI available in the PubMed database from January 1, 2008, to December 31, 2018, was performed. These data were tabulated by country and grouped according to each geographical region as indicated by the WHO: African Region (AFR), Region of the Americas (PAH), South-East Asia Region (SEAR), European Region (EUR), Eastern Mediterranean Region (EMR), and Western Pacific Region (WPR). In this analysis, PAH was further subdivided into Latin America (AMR-L) and North America (AMR-US/Can). Then a “publication to TBI volume ratio” was derived to estimate the research interest in TBI with respect to the frequency of this pathology.

RESULTS Between 2008 and 2018 a total of 8144 articles were published and indexed in the PubMed database about TBI. Leading WHO regions in terms of contributions were AMR-US/Can with 4183 articles (51.36%), followed by EUR with 2003 articles (24.60%), WPR with 1507 (18.50%), AMR-L with 141 articles (1.73%), EMR with 135 (1.66%), AFR with 91 articles (1.12%), and SEAR with 84 articles (1.03%). The highest publication to TBI volume ratios were found for AMR-US/Can (90.93) and EUR (21.54), followed by WPR (8.71) and AMR-L (2.43). Almost 90 times lower than the ratio of AMR-US/Can were the ratios for AFR (1.15) and SEAR (0.46).

CONCLUSIONS An important disparity currently exists between countries with a high burden of TBI and those in which most of the research is conducted. A call for improvement of data collection and research outputs along with an increase in international collaboration could quantitatively and qualitatively improve the ability of LMICs to ameliorate TBI care and develop clinical practice guidelines.

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KEYWORDS global neurosurgery; traumatic brain injury; publication; LMICs; research

TRAUMATIC brain injury (TBI) is a major public health problem globally, as it is the most severe injury type among trauma-related accidents²² and therefore affects approximately 69 million people every year.¹⁰ Epidemiological data from different geographical regions and

countries are hampered by several factors. For example, mild TBI cases, which usually comprise 80%–90% of all TBI cases, are often not reported or are underreported because very few of them require hospitalization.⁵ Furthermore, there is a lack of consistent data capture due

ABBREVIATIONS AFR = African Region; AMR-L = Latin America; AMR-US/Can = North America; EMR = Eastern Mediterranean Region; EUR = European Region; HIC = high-income country; ICP = intracranial pressure; LMICs = low- and middle-income countries; PAH = Region of the Americas; SEAR = South-East Asia Region; TBI = traumatic brain injury; WPR = Western Pacific Region.

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TABLE 1. Publication output according to region, along with main contributor country

Region	No. of Publications			Main Contributor	No. of Publications
	10 Yrs (%)	Average	2018 Only (%)		
AMR-US/Can	4183 (51.36)	418.3	759 (41.91)	US	3427
EUR	2003 (24.60)	200.3	507 (28.00)	United Kingdom	451
WPR	1507 (18.50)	150.7	392 (21.65)	Australia	532
AMR-L	141 (1.73)	14.1	56 (3.09)	Brazil	50
EMR	135 (1.66)	13.5	47 (2.60)	Iran	47
AFR	91 (1.12)	9.1	25 (1.38)	South Africa	57
SEAR	84 (1.03)	8.4	25 (1.38)	India	66
Total	8144	814.4	1811		

The average value was obtained by dividing the number of publications (productivity) over 10 years by the number 10. The “main contributor” is the country with the most publications in that region along with its respective number of publications.

to poor injury surveillance/reporting systems in many low- and middle-income countries (LMICs) but also in some high-income countries (HICs).²¹ LMICs face the greatest burden of trauma, as more than 70% of trauma-related deaths are estimated to occur there.¹⁰ Differences between LMICs and HICs exist in terms of infrastructure, resources, availability of staff,²⁴ and epidemiology, as patients tend to be younger and road traffic accidents are the most prevalent injury mechanism in LMICs.¹⁵ Because of these discrepancies, the development of relevant context-specific clinical practice guidelines useful for LMICs requires the publication of research and other TBI-related papers from these countries. Previous bibliometric studies have already highlighted the contribution of different countries in the worldwide neurosurgical literature,^{12,16,25} but none of them have taken into account the respective incidence of disease for each region. We conducted a bibliometric analysis of TBI-related papers published in the last 10 years and in 2018, and after collecting volumes of the pathology for each geographical region, we estimated the capacity of different and heterogeneous areas of the world to report and publish data on TBI. In addition, we wanted to estimate countries with the highest and lowest number of publications when taking into account the relative TBI burden.

Methods

Publication Capacity Across WHO Regions

We conducted a bibliometric analysis of all the publications available in the PubMed database from January 1, 2008, to December 31, 2018. Related publications were identified by searching for the MeSH term “TBI traumatic brain injury.” As previously described in the literature,²³ we used the Boolean operators (AND, OR, and NOT) in our search string to collect the number of publications for each country. For example, to obtain TBI-related publications in Italy, we searched for “(TBI traumatic brain injury[MeSH Terms]) AND Italy.” Moreover, an additional search was conducted with the publication date filter set only to the year 2018. The data were then tabulated for country and grouped according to each geographical region as indicated by the WHO (https://www.who.int/choice/demography/by_country/en/): African Region (AFR), Region of the Americas (PAH), South-East Asia Region (SEAR), European Region (EUR), Eastern Mediterranean Region (EMR), and Western Pacific Region (WPR). PAH was further subdivided as previously described by Dewan et al.¹⁰ into North America (AMR-US/Can) and Latin America (AMR-L).

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Publication Ratio

In the second part of our study we derived a “publication ratio” for each WHO region by dividing the average number of published articles in that region (numerator, obtained by dividing the documents produced in 10 years by the number 10) by the volume of TBI in the population inhabiting that region (denominator). A similar publication ratio has already been described in the literature by Al-Shahi et al.² As previously performed by Corley et al.,⁹ the volume of TBI was obtained from the estimation conducted by Dewan et al.¹⁰ (number of million new TBI cases/year). We subdivided the PAH into North America (AMR-US/Can) and Latin America (AMR-L) to have comparable data. Data were analyzed using Microsoft Excel.

Results

Publication Output Worldwide

Between 2008 and 2018 a total of 8144 articles were published and indexed in the PubMed database about TBI. Leading WHO regions in terms of contributions were AMR-US/Can with 4183 articles (51.36%), followed by EUR with 2003 articles (24.60%), WPR with 1507 (18.50%), AMR-L with 141 articles (1.73%), EMR with 135 (1.66%), AFR with 91 articles (1.12%), and SEAR with 84 articles (1.03%; Table 1). These percentages are represented graphically in Fig. 1. The main contributors in each WHO region were the US for AMR-US/CAN (81.9% of publications from this region), the United Kingdom for EUR (22.52% of publications), Australia for WPR (35.30%), Brazil for AMR-L (35.46%), Iran for EMR (34.82%), South Africa for AFR (62.64%), and India for SEAR (78.57%). Additionally, in Table 1 we report the number of published papers only for the year 2018. Comparing 2018 with the entire decade, one can see that

FIG. 1. Proportional contribution of TBI publications over a 10-year period for each geographic region.

there is a decrease in papers from AMR-US/Can and an increase in papers from all other areas. We subsequently divided all countries into 4 groups according to the number of publications: > 500 articles, 100–500 articles, 50–100, and 10–50. For the papers published in 2018 we used a different scale: > 100 papers, 50–100, 10–50, 5–10, and 1–5 papers (Table 2).

Publication to TBI Volume Ratio

By dividing the average number of publications per year by the volume of new cases of TBI indicated in million cases per year we obtained a “publication to TBI volume ratio” highlighting a huge heterogeneity among regions. The highest ratios were found for AMR-US/Can (90.93) and EUR (21.54), followed by WPR (8.71) and AMR-L (2.43). Almost 90 times lower than the ratio of the AMR-US/Can region were the ratios for AFR (1.15) and SEAR (0.46; Table 3). This disparity can be appreciated in Fig. 2, showing the different contributions in percentages in terms of worldwide publication productivity and of TBI cases for each region, and in Fig. 3, reporting the variation of the publication to TBI volume ratio across the globe.

Discussion

The aim of our study was to compare the worldwide volume of TBI with the published papers on TBI as reported by PubMed. We tabulated all clinical papers published from 2008 to 2018 addressing TBI, subdivided according to the country of origin. In the literature, several articles described the burden of TBI at a continental level. Overall, 295 per 100,000 people per year are affected worldwide by brain trauma according to a meta-analysis by Nguyen et al.¹⁹ This burden is, however, heterogeneously distributed across the continents. In fact, the incidence of TBI varies from higher numbers in Europe and the US (287.2/100,000 hospital admissions/year in Europe¹⁸ and 787.1/100,000 emergency department visits/year in the US²⁷) to lower numbers in the Middle East Region

TABLE 2. Results by country

No. of Publications	Countries
Overall	
>500	US, Canada, Australia, China
100–500	United Kingdom, Germany, Italy, Sweden, Netherlands, France, New Zealand, Japan
50–100	Switzerland, Israel, South Korea, Taiwan, Ireland, Belgium, Spain, India, South Africa, Finland, Denmark, Russia, Norway, Brazil
10–50	Iran, Poland, Singapore, Austria, Jordan, Argentina, Turkey, Greece, Colombia, Saudi Arabia, Chile, Hungary, Portugal, Qatar, Mexico, Lebanon, Malaysia, Pakistan
2018 only	
>100	US, China, Canada, United Kingdom, Australia
50–100	—
10–50	Germany, Italy, Sweden, Netherlands, France, Japan, Switzerland, New Zealand, South Korea, Ireland, Taiwan, Iran, Israel, Belgium, India, Spain, Russia, Brazil, Denmark, Norway, Finland, South Africa
5–10	Poland, Austria, Argentina, Chile, Egypt, Mexico, Singapore, Colombia, Hungary, Romania
1–5	Jordan, Turkey, Saudi Arabia, Pakistan, Hong Kong, Uganda, Portugal, Qatar, Lebanon, Tanzania, Uruguay, Thailand, Cuba, Ecuador, Greece, Malaysia, Vietnam, Nigeria, Czech Republic, El Salvador, Grenada, Bolivia, Lithuania, Slovak Republic, Nepal, Jamaica, Iceland, Tunisia, Benin, Indonesia, Sri Lanka, Albania, Kuwait, United Arab Emirates, Cambodia, Chad, Kenya, Niger, Senegal, Maldives, Kazakhstan, Morocco

Countries grouped according to their publication output for the 10-year period and 2018 only, indicated as ranges of the number of publications.

(45/100,000 hospital admissions).¹¹ Furthermore, in Europe patients are older (with a mean age around 50 years) and the most common mechanism of injury is falls.^{7,21} The volume of TBI is described as specifically afflicting LMICs,¹⁵ but the literature from these areas reports mostly data from single-center studies. For example, a study by

TABLE 3. Publication to volume ratio by region

Region	TBI Volume (million cases/yr)*	Mean No. of Publications/Yr	Ratio
AMR-US/Can	4.6	418.3	90.93
EUR	9.3	200.3	21.54
WPR	17.3	150.7	8.71
AMR-L	5.8	14.1	2.43
EMR	5.8	13.5	2.33
AFR	7.9	9.1	1.15
SEAR	18.3	8.4	0.46

* TBI volume for each region as reported by Dewan et al.¹⁰

FIG. 2. Comparison of the percentages of total publications and TBI case volumes for each geographic region.

Peeters et al.²⁰ described 1200 admitted patients with TBI in a major government hospital in Cambodia. A study by Tran et al.²⁸ reported an incidence of 89/100,000 admitted cases/year of severe TBI that was deduced from a retrospective collection of patients with GCS scores < 8 admitted to a single national referral hospital in Uganda. To have reliable and comparable data across regions in our study, we decided to utilize the volume of cases reported in the article by Dewan et al.,¹⁰ as previously performed in the literature with other objectives.⁹ In fact, Dewan et al.¹⁰ es-

timated the incidence through a sequence of mathematical steps with data obtained through a systematic review of the literature. Using a methodology previously described in the literature,² the aim of our bibliometric analysis was to relate the epidemiology of a WHO region to the number of published papers on TBI in order to form an estimate of the publishing capacity of each region. As detailed in Table 1 and Fig. 1, the largest number of publications were from US/Canada, Europe, and the Western Pacific Region, with Africa and Southeast Asia together responsible for

FIG. 3. Map showing the heterogeneity in the publication to TBI volume ratio across the globe.

only less than 3% of all published papers. These regions have a population of 3.5 billion people, representing 46% of the total worldwide population. If we then examine single countries, the US, Canada, China, and Australia are the most productive countries, with an important increase in Chinese papers in the last few years. The second “line” was formed in the last 10 years by European countries (the United Kingdom, Germany, Italy, the Netherlands, France, and Sweden) with the addition of Japan and New Zealand. In 2018 many other countries entered into this group (Table 2) but India was the only one from the LMICs.

The relationship between the number of publications and the burden of TBI becomes even more clear using the publication to volume ratio, ranging from a ratio of 91 in the US and Canada, to a ratio of 22 in Europe, to a low of 1 in Africa and 0.5 in Southeast Asia (Table 3, Fig. 3). This trend is confirmed by recent data on randomized clinical trials (Hutchinson PJ, Kolias A, et al., unpublished data, 2019) where only 35 trials (8.8%) were conducted in LMICs. As an example, all patients included in the decompressive “DECRA” study⁸ are from HICs as well as 91% of the patients included in the “RESCUEicp” (Randomised Evaluation of Surgery with Craniectomy for Uncontrollable Elevation of ICP) study.¹⁴ Furthermore, if we investigate the most cited papers in TBI, 67 of 100 are published in the US and the rest in Europe.¹⁶ The guidelines recently published on TBI management are the result of this disparity.⁴ Evidence-based medicine is produced by high-quality papers that are, in large part, originated from HICs where TBI is less than 30% of worldwide volume. Therefore, it is difficult to apply such guidelines in settings in which the resources, infrastructure, and staffing levels are completely different.²⁶ There have been a series of appreciable suggestions from Western countries about how to address this issue. One example is the substitution of intracranial pressure (ICP) monitoring when it is not available with a series of CT scans to monitor for mass effect.^{3,6} Unfortunately, repeat CT is not possible because this would necessitate out-of-pocket expenses; therefore patient management must be based on this reality.¹ This example shows how important it is to include papers from LMICs even if not scored as level of evidence class I or II, if we wish to produce worldwide applicable guidelines.

What Can We Do to Reduce This Disparity?

The production of suggestions on TBI management based on consensus conferences is a good way to include neurosurgeons from all over the world both in the discussion and in publications.¹³ Their views on indications are different from neurosurgeons in HICs and must be taken into account, such as the use of decompression as a “preventive” measure to avoid subsequent intracranial hypertension. The inclusion of some LMICs in large international databases of TBI¹⁷ is a good example of how to compare data from these areas with American and European patients. Another way is the establishment of simple prospective studies with a form and registries that can be electronically filled out all over the world (<https://globalneurotrauma.com>). Some specialized selected centers from LMICs have been recently included in high-level clinical randomized trials. In the RESCUE-ASDH trial

(Randomised Evaluation of Surgery with Craniectomy for patients Undergoing Evacuation of Acute SubDural Haematoma) some sites from LMICs have actively participated and enrolled several patients (<http://www.rescueasdh.org/home>).

A recurring theme is the need to support the building of research capacity in LMICs. For most neurosurgeons working in the developing world, conducting research is a luxury. Research collaborations between surgeons from HICs and LMICs can lead to a sustainable increase in local research capacity but requires a long-term strategy and commitment as well as an ethical framework. Additionally, the root causes of the paucity of epidemiological data and papers²¹ from LMICs need to be addressed. Unless national surveillance and data collection capacity is strengthened, the true burden of TBI and other high-burden conditions will never be known or tracked. Here, the World Federation of Neurosurgical Societies can advocate through the WHO to include TBI data elements in national injury surveillance and trauma registries. One aspect of the publication process that has not been mentioned is the cost of publications and the paywall for accessing the articles. Solutions are needed that remove the financial barriers for authors from LMICs for publishing their research, as well as the economic possibility to access and read articles, for example, with free open access resources.

Conclusions

Our bibliometric analysis detected an important disparity that currently exists between countries with a high burden of TBI and those in which most of the research is conducted. Improving the care of patients with TBI on a worldwide perspective also means to better treat patients wherever they are. It will take substantial effort, time, and funds to conduct high-volume and quality sophisticated research originating from LMICs, but we need to encourage investigators from HICs to collaborate with colleagues from LMICs to improve their research capacity and guideline production.

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Disclosures

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author Contributions

Conception and design: Spaggiari, Tropeano, Ileyasoff. Acquisition of data: Spaggiari, Tropeano, Ileyasoff. Analysis and interpretation of data: Spaggiari, Tropeano, Ileyasoff. Drafting the article: Spaggiari, Tropeano, Ileyasoff, Kolias. Critically revising the article: Spaggiari, Park, Kolias, Hutchinson, Servadei. Reviewed submitted version of manuscript: Park, Kolias, Hutchinson, Servadei. Study supervision: Hutchinson, Servadei.

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