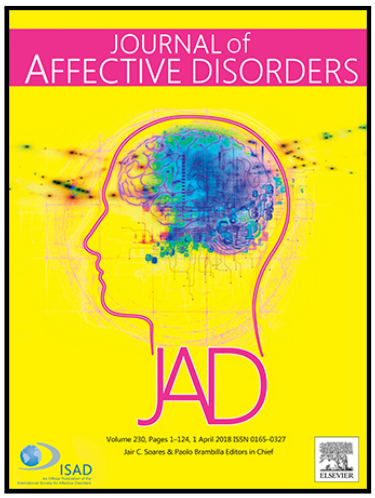

A Scientometric Analysis of Suicide Research: 1990-2018

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Highlights

- publications related to suicide research have been increasing significantly from 1990 to 2018.
- There is significant imbalance in the amount of research effort especially in the regions with high suicide rates.
- The quantity and quality of publications do not transpire in the reduction of suicide rates in the higher socioeconomic level regions.
- A better connection between the fundamental and practical research on suicide should be built especially in the higher socioeconomic level regions.
- More resources should be focused on the lower socioeconomic level regions with higher suicide risks.

A Scientometric Analysis of Suicide Research: 1990-2018

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Abstract

Background: Increasing knowledge on suicide prevention has been shown to be important for suicide prevention. This paper exams the accomplishment of research on suicide and examine how those research activities contribute to the change of suicide rates.

Methods: Data of the publications relating to suicide from 1990 to 2018 were retrieved from the Web of Science and Scopus. Bibliographic information was analyzed and the relationships between suicide rates with the number of publications per million population and the average article citations per year were examined.

Results: From 1990 to 2018, globally, publications on suicide have increased significantly. The United States ("USA") had the greatest number of publications. Research collaborations among different countries/regions have been flourishing and multinational centers have become more common than ever. Nonetheless, in some countries/regions with high rates of suicide, suicide research was scarce. It was found that the number of publications per million population and the average article citations per year were negatively correlated with the suicide rates at the global level ($r = -0.96$, $p < 0.001$; $r = -0.91$, $p < 0.001$, respectively), but not in the higher SDI regions ($r = -0.05$, $p = 0.81$; $r = 0.02$, $p = 0.91$, respectively). Furthermore, research focusing on suicide intervention was also relatively limited.

Limitation: The origins of the publications were only based on the corresponding authors' regions.

Conclusions: There is significant imbalance in the amount of research effort especially in the regions with high suicide rates. In the higher socioeconomic level regions, the quantity and quality of publications sometimes do not transpire in the reduction of suicide rates. A better connection between the fundamental and practical

suicide research should be established. More resources should be made available to the low- and middle-income countries/regions with higher suicide risks, then the effect of suicide prevention might be much more significant.

Keywords: Suicide research; Scientometric analysis; Suicide prevention

1. Introduction

Suicide is a serious global burden of disease. According to the report of the World Health Organization("WHO"), more than 800,000 people died from suicide every year, and, alarmingly, it was the second leading cause of death in young people aged 15-29 (World Health Organization, 2018). Furthermore, 79% suicides occurred in the low- and middle-income countries where mental health resources are often scarce (World Health Organization, 2018; Yip, 2012). Even though globally, from 1990 to 2016, the age-standardized mortality rate for suicide has decreased by 32.7%, this decline was not witnessed in central Latin America, high income Asia Pacific, western sub-Saharan Africa, and eastern Europe (Naghavi, 2019).

Reducing the rates of suicide has become one of the 17 sustainable development goals proposed by the United Nations ("Sustainable Development Goals"). Valuable human capital to society has been lost in suicide and it has also created a non-insignificant impact on life expectancy (Law et al., 2010). Its negative impact has also spread to family members, friends, acquaintances, healthcare professionals, and local communities, thus, the impact of suicide is devastating and far-reaching (Cerel et al., 2019; Pitman et al., 2014). Improving and enhancing the understanding of suicidal behavior is of great importance and relevance to reduce the suicide rate worldwide. At present, there is a serious mismatch of the availability of resources at a country and global level on suicide prevention.

The book by Durkheim (1879) in 19th century has laid the foundation for suicide research, however, not much has been done until the last three decades. The WHO has given high priority to suicide prevention, resulting in many countries placing suicide prevention on their public health and political agendas, consequently, more resources on suicide prevention and also numerous related research have surfaced (World Health Organization, 2013, 2018). The research focused on multiple facets of suicide, including the neural, epidemiological, psychological, clinical and social environment perspectives. Previous studies have shown that suicide is a result of the interplay between biological, psychological and social factors (World Health Organization, 2014). Risk and protective factors of suicidality have also well been recognized. For example, mental health disorder and substance abuse increase the risks of suicide (Chesney et al., 2014). Psychological factors such as feeling of hopelessness, thwarted belongingness, perceived burdensome, cognitive rigidity are all positively associated to suicide (Ellis and Rutherford, 2008; Van Orden et al., 2010). Socioeconomic support, social integration, good coping skills have also been identified as protective factors (Chang et al., 2017, 2019; Kaslow et al., 2002; McMahon et al., 2013; Šedivy et al., 2017). Improving the recognition on physicians and the response to suicide risks, restriction of access to suicide means and gatekeeper education, are further promising interventions on suicide (Krysinska et al., 2016; Mann et al., 2005; Yip et al., 2012). Furthermore, excessive media reporting has been shown to be related to copycat suicides especially relating to the celebrities (Yip et al., 2006, Chen et al., 2014; Niederkrotenthaler et al., 2016). Although knowledge on the risks and protective factors of suicide has grown enormously, nonetheless, little is known on the effectiveness and relevancy of these research in contributing to suicide prevention

worldwide. What impact these research activities has in the change of suicide rates is thus an important aspect, especially in evaluating the effectiveness of the research.

To the best of the authors' knowledge, only one study analyzed the worldwide publications on depression and suicide from 1990 to 2007, however, that study only compared the total amount of publications with the suicide rates in 1999 among the G8 countries and, with the change of time, was insufficient to display the correlations between the research activities and suicide rates (Vogelzang et al., 2011). In the present study, the long-term development of suicide research activities and their impact on the changes in suicide rates were explored. Since the publications are part of scientific discourse and considered as an important indicator of the science of productivity (Larsen and Von Ins, 2010), the present study investigates into the global publications on suicide over time as well as the geographical distributions and international collaborations. The associations between the quantity and quality of publications and suicide rates were examined to evaluate their impact on the reduction of suicide rates. A better understanding and timely scientometric analyses on suicide research would help to focus on priorities and deployment of resources in reducing suicide rates effectively and efficiently.

2. Methods

2.1. Data source

Data were retrieved from the Web of Science ("WoS") and Scopus databases which provided well access bibliometric indicators of the published items for quantitative analyses. Data on the suicide rates and the Socio-demographic Index ("SDI") were obtained from the database of the Global Burden of Disease where suicide was defined as a death caused by self-harm ("GBD Results Tool"). SDI, a

composite measure of income per capita, average educational attainment, and fertility rates, is used to identify where the countries/regions stand on the spectrum of development (Institute for Health Metrics and Evaluation, 2019).

2.2. Search strategy

In order to approximate the overall number of publications on suicide, articles containing "suicid*" (e.g., suicide, suicidality, suicidal) in their titles, keywords, abstracts were identified as suicide relevant research. In the search, the terms "title = suicid*" and "abstract = suicid*" were used in the WoS. Subsequently, the identified records that contained "suicid*" in their keywords were extracted. In Scopus, the word "suicid*" was used to search in the titles, keywords and abstract section, and then they were combined by using the Boolean operator "AND". The analyzed time span was restricted to the period from 1900 to 2018. The data were accessed on May 30th, 2019. After combining the records from the two databases and removing the duplicates, the titles and abstracts were read manually, and all the irrelative articles which did not target human suicide behaviors (e.g., cell suicides, gene suicide therapies) were removed. The detailed search strategy and data cleaning process can be found in Figure 1. The final dataset contained 25, 687 articles.

2.3. Data analyses and visualization

After retrieval of the metadata on all the selected publications, the bibliographic information of the selected publication was converted and analyzed automatically by using the bibliometric package in R environment (Aria and Cuccurullo, 2017). Considering the differences in the population sizes among the countries may impact on productivity, the number of publications divided by its population size was employed as an indicator to measure the quantity of publications. In addition, the average article citations per year is used to quantify the impact of a publication. As

the number of publications and the year the paper was published may influence the total number of citations in a certain region, the average article citations per year, which was calculated by dividing the average number of citations per article by the number of years the author has been publishing papers, has been adopted to indicate the research impact. The authorship of the publication was assigned to the corresponding author's country. Descriptive analyses were performed. Line graph was used to display annual scientific production (Figure 2). Bar chat was used to display the number of publications in the top 30 productive countries/regions (Figure 3). The migration flow circle plots developed by Sander et al. (2014) were used to better visualise the collaborations among different countries/regions (Figure 4). In the circle plots, the thickness of the linkages indicates the intensity of the collaborations. The color of the linkages presents the authorship of the collaborative publications (the countries of the corresponding authors). World maps were used to demonstrate the geographic distributions of the research production from 1990 to 2018 and the global variations of suicide rates in 2017 (Figure 5). Dogging bar chat was used to compare the percentages of suicide research and suicidal deaths (Figure 6). Double-line graphs were adopted to display the trend of suicide publications and suicide rates over time for the period 1990-2018 (Figure 7). Moreover, spearman correlation was conducted to examine the associations between the quantity and quality of publications and suicide rates by the socioeconomic conditions of the countries under study using the SDI. Finally, in order to examine the profile of the practical studies which had significant influence on suicide prevention, keywords of "risk factors" and "intervention" were used to compare the number of publications on these two subject areas in suicide research (Figure 8).

3. Results

3.1. Number of Scientific Productions

From 1990 to 2018, 25,687 articles were published with a reference to suicide (Figure 2). A rapid rate of increase in the number of publications was observed from 278 in 1990 to 2,070 in 2018. After 2008, more than 1,000 papers on suicide were published every single year. The average annual growth rate of suicide publications from 1990 to 1999 was 6.62%, and increased to 9.48% from 2000 to 2009, and has remained at 7.40% in the period of 2010-2018.

3.2. Geographical Distributions

Figure 3 shows that a small number of countries/regions were dominant in the majority of the research output. The top 30 countries/regions published 81.70% of the total amount of publications. The USA produced an overwhelming number of publications (n= 7,659; 29.82%). The second highest output country was the United Kingdom (n=1,365; 5.31%), followed by Canada (n=1186; 4.62%), Australia (n=1,054; 4.10%), Germany (n=943; 3.67%), Sweden (n=659; 2.57%), France (n=649; 2.53%), Korea (n=606; 2.36%), Italy (n=554; 2.16%), and Japan (n=509; 1.98%).

3.3. International collaboration patterns

Figure 4 shows the collaborations among the regions with at least 10 publications. From 1990 to 1999, only the USA, Canada and Sweden were on the list. The USA and Canada published 20 papers together, where the corresponding authors of 11 papers were from Canada. The USA cooperated with Sweden on 12 papers and the authorship of 6 papers was also located in the USA. In the next 10-year period, the collaborations have expanded to 25 countries/regions; 24 among the 25 countries/regions had joint publications with the USA. Cooperation between the USA and Canada was most common (n = 88), followed by between the USA and Italy (n =

84). Subsequently, many European countries started to get involved in the collaboration network. From 2010 to 2018, international cooperation became more intense. Besides the connections between the high-income countries/regions, more low- and middle-income countries/regions have also participated in the collaboration.

3.4. Relationships of research publications and suicide rates

During the period from 1990 to 2018, a total of 117 countries/regions contributed to the literature on suicide. Despite higher suicide rates, there was paucity of suicide research in some countries/regions. For example, in Lithuania, the suicide rate was 36.27 per 100,000 in 2017, while only 22 related articles were published in the given research time frame; also, in Ukraine and Russia, with the suicide rates of 30.61 and 30.03, respectively, only 21 and 189 publications were found. On the contrary, among the top 5 most productive countries with publications on suicide research, their suicide rates were 15.02 in the USA, 8.67 in the United Kingdom, 12.83 in Canada, 12.76 in Australia and 14.66 in Germany. It thus seems that the worldwide distribution of suicide research did not align with the distribution of the suicide rates (see Figure 5). Looking at the percentages of suicide research and deaths from suicide globally (see Figure 6), India was responsible for the largest proportion of suicide deaths, however, its publications on suicide research were limited, only taking up 1.54% of all the publications. Similarly, China and Russia accounted for 16.20% and 5.53%, respectively in the global suicide, but only 1.38% and 0.74%, respectively were observed in their suicide research. In contrast, the USA shared 29.82% in the total global research, while their people who died from suicide accounted for 6.15% of the global suicide deaths. Hence, there is a significant imbalance of suicide research efforts in those countries/regions with high suicide rates.

Figure 7 shows the correlations between the number of publications per million population on suicide research and suicide rates in different GBD regions for the period 1990-2017. In the high-income regions, the number of publications per million population increased dramatically, however, the suicide rate did not change much throughout the same period, remaining at around 15 per 100,000 people ($r = 0.01$, $p = 0.95$). In Central Europe, Eastern Europe and Central Asia, even though the suicide rates went up rapidly, nonetheless, few papers were published before 1994. After 2007, an upward trend of the number of publications per million population was witnessed, and correspondingly, the suicide rate experienced a significant drop but still remained at high levels ($r = -0.55$, $p < 0.01$). In regard to Southeast Asia, East Asia and Oceania, South Asia and Sub-Saharan Africa, the number of publications per million population increased, and in general, the suicide rates decreased ($r = -0.97$, $p < 0.001$; $r = -0.83$, $p < 0.001$; $r = -0.74$, $p < 0.001$, respectively). However, these negative relationships were not significant in North Africa and Middle East ($r = -0.23$, $p = 0.24$). Interestingly, in Latin America and the Caribbean region, the suicide rates increased as the number of research publications went up ($r = 0.88$, $p < 0.001$).

Table 1 presents the correlations between the quantity and quality of publications and suicide rates after controlling the level of SDI. Globally, as the number of publications per million population increased, the suicide rates had a gradual decrease ($r = -0.96$, $p < 0.001$). The average article citations per year were also negatively correlated with the suicide rates ($r = -0.91$, $p < 0.001$) at the global level. However, these relationships were not observed in the higher SDI regions ($r = -0.05$, $p = 0.81$; $r = 0.02$, $p = 0.91$, respectively). In the lower SDI regions, the increased number of publications per million population was significantly related to lower suicide rates ($r = -0.96$, $p < 0.001$).

3.5 Risk factors and intervention related publications in suicide research

In Figure 8, it can be observed that over time, more and more papers related to risk factors and intervention were published. However, it is worth noted that the number of suicide intervention research was still limited. From 1990 to 2018, studies on risk factors were 8 times more than the intervention studies. Specifically, in the higher SDI countries, studies on risk factors were 7 times more than the intervention studies; while in the lower SDI countries, very few *intervention-related publications* were published.

4. Discussion

During the period from 1990 to 2018, the number of publications related to suicide research has been increasing significantly. From 2000 onward, the significant growth of the overall scientific output on the subject of suicide not only attributed to the facilitation of retrieving publications with the advance of the Internet, but it can also be explained by the increasing scientific attention to mental health, especially to suicide. Nevertheless, most productive countries/regions are high-income countries/regions. Publications from the USA contributed to most of the publications, but its suicide rate has risen by around 30% in the past two decades (Hedegaard et al., 2018). It should also be noted that international collaborations among different countries /regions have become more and more intense. The USA, Canada, the United Kingdom and Italy played key roles in fostering international cooperation. It is suggested that the increasing collaboration was driven by the resources available and the competitive research funding environment. Also, globalization of research activities has removed some geographical barriers which were congenial to the increase in research collaborations (Iglič et al., 2017). The increase of global

cooperation is also beneficial to enrich multidimensional understanding of suicide as well as good practice sharing in different countries/regions (Larsen and Von Ins, 2010).

Nevertheless, the discrepancies between the number of publications and their suicide rates in different countries/regions should be a genuine concern. It is observed that there is a serious mismatch in the resources available and the severity of the problem. Even though some countries/regions had high suicide rates, nonetheless, publications on suicide were rare, and this is commonly found in the low - and middle- income countries/regions. In India, people who died from suicide were 4 times higher than in the USA, while at the same time, it had 10 times fewer publications. This can be linked to the insufficient resources of the middle- and low-income countries/regions. It can also be related to the scarcity of resources and/or the stigmatization of suicide. To date, in some countries/regions, suicide is still a taboo to openly discuss it. The deep-rooted stigma of suicide in some cultures has turned it into a problem that hindered suicide research and research funding (Batterham et al., 2013; Khan, 2005). Previous studies suggested that the drivers of suicide mortality varied by regions and nations, thus the implementation of prevention strategies also varies in different contexts (Naghavi, 2019; World Health Organization, 2010). Due to the relatively deprived medical and health resources, evidence has revealed that early identification and treatment of depression in the high-income countries might not be applicable to the middle- and low-income countries (Mann et al., 2005). In view of the most recent publications from high-income countries, it is discovered that research in the middle- and low-income regions is urgently needed to build evidence-based intervention sensitive policies to cater for different patterns of suicide in the local context.

Research taking some psychosocial approaches into consideration such as the role of religiosity, mindfulness and community-based work could be more relevant to intervention practice in different cultural contexts (Colucci and Martin, 2008; Sisask et al., 2010). Globalization of suicide research is also needed, i.e., a global challenge but requires local solutions.

It is expected that improving knowledge on suicide can bring change and better prevention strategies. This claim was supported by the present results at the global level. More high quality research indeed could to some extent lead to the reduction of suicide rates. However, this might not be the case in higher SDI regions. Despite abundant research efforts made in the higher SDI regions, the suicide rates had not experienced a significant decrease. Current literature has been repetitively engaged in studies on risk factors (see Figure 8), many of which showed similar results without much added value to the knowledge on suicide prevention. Moreover, the worrying trend is the inflation of publications indoctrinated in the academic sector or research institutions where "publish or perish" is the major concern (Rawat and Meena, 2014). Emphasis on the quantity of publications rather than on any relevance and/or impact on suicide prevention has undermined the particle value of research, as the researchers might scramble to find anything that could be published. There are cases where an excellent research on suicide might be able to fill a knowledge gap, but yields no impact whatsoever on suicide prevention. It is high time that what was publishable or useful to suicide prevention be reexamined. Also, there is some biological-genetic research on suicide where its impact has also yet to be materialized. Furthermore, there is not enough research on implementation science. Some recent important publications nonetheless have revealed that increasing belongingness and interpersonal contact, and limitation of access to the means of suicide had powerful

effect in reducing suicides (e.g., Joiner et al., 2009; Yip et al., 2012). Future suicide research effort should thus move away from the unilateral focus on "risk factors" and head toward a stronger focus on "intervention".

There are some limitations in the present study though. Firstly, the analyses were based on the data collected from the Web of Science and Scopus. The actual number of papers published on suicide might have been underestimated. Employment of other databases may yield slightly different results. Besides, the analyses of the origins of the publications were only based on the corresponding authors' regions. Future studies to consider the weighting factor of the co-authors' regions will provide a more comprehensive picture of the research effort on suicide. Finally, as only the bibliometric indicators of suicide research were looked at, analyses of the themes and contents were not included in the current study. Future studies could examine how particular types of research are related to suicide rates.

5. Conclusion

The current study represents a concise analysis of global suicide research from 1990 to 2018 as indexed in the Web of Science and Scopus databases. The study focuses on various aspects of performance of the accomplishment of the research on suicide, including growth of the publications, productivity of the countries, collaborations of the countries, worldwide publications and the associated suicide rates. Despite the ongoing expansion of suicide literature, global imbalance in suicide research was found. High suicide rates in the middle- and low- income counties necessitate more attention to this issue and localized research is imminent. As research that aligns with service needs is an important pathway to achieve suicide

prevention, to establish a research environment embedded in service delivery is also essential.

Contributors

ZY Cai: study design, data collection, data analyses, figures, data interpretation, writing of the first draft, revising the first draft, finalizing the manuscript.

QS Chang: study design, data collection, data analyses, figures, data interpretation, writing of the first draft, revising the first draft, finalizing the manuscript.

PSF Yip: study design, data interpretation, critically revised the first draft, finalized the manuscript, supervised the entire study.

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Conflict of interest

None

Ethics approval

The data used in this study are publicly available. No ethics approval is needed.

Author Statement

Contributors

ZY Cai: study design, data collection, data analyses, figures, data interpretation, writing of the first draft, revising the first draft, finalizing the manuscript.

QS Chang: study design, data collection, data analyses, figures, data interpretation, writing of the first draft, revising the first draft, finalizing the manuscript.

PSF Yip: study design, data interpretation, critically revised the first draft, finalized the manuscript, supervised the entire study.

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Table1 Correlations between the Quantity and Quality of Publications and Suicide rates

	Number of Publications per Million Population		Average Article Citations per Year	
	r	P-value	r	P-value
All	-0.96***	< 0.001	-0.91***	<0.001
High SDI	-0.05	0.81	0.02	0.91
Low SDI	-0.96***	<0.001	-0.33	0.08

***p< 0.001.

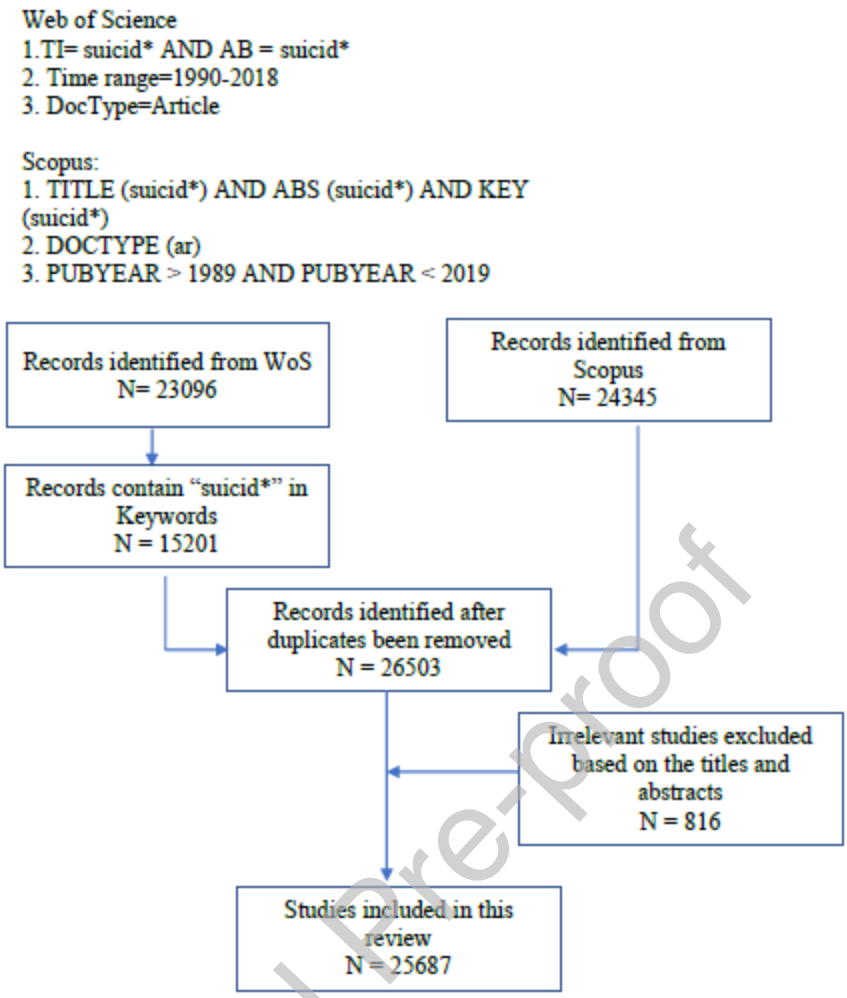


Figure 1: Search Strategy and Data Screening Process

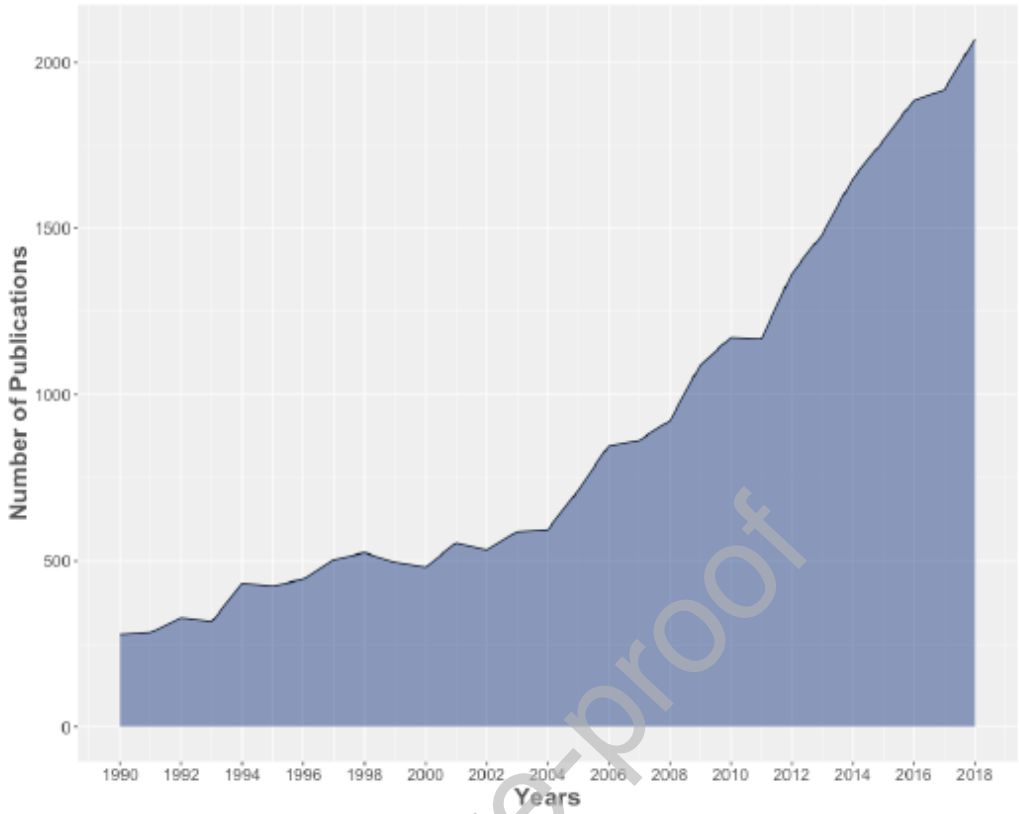


Figure 2: Annual Scientific Production

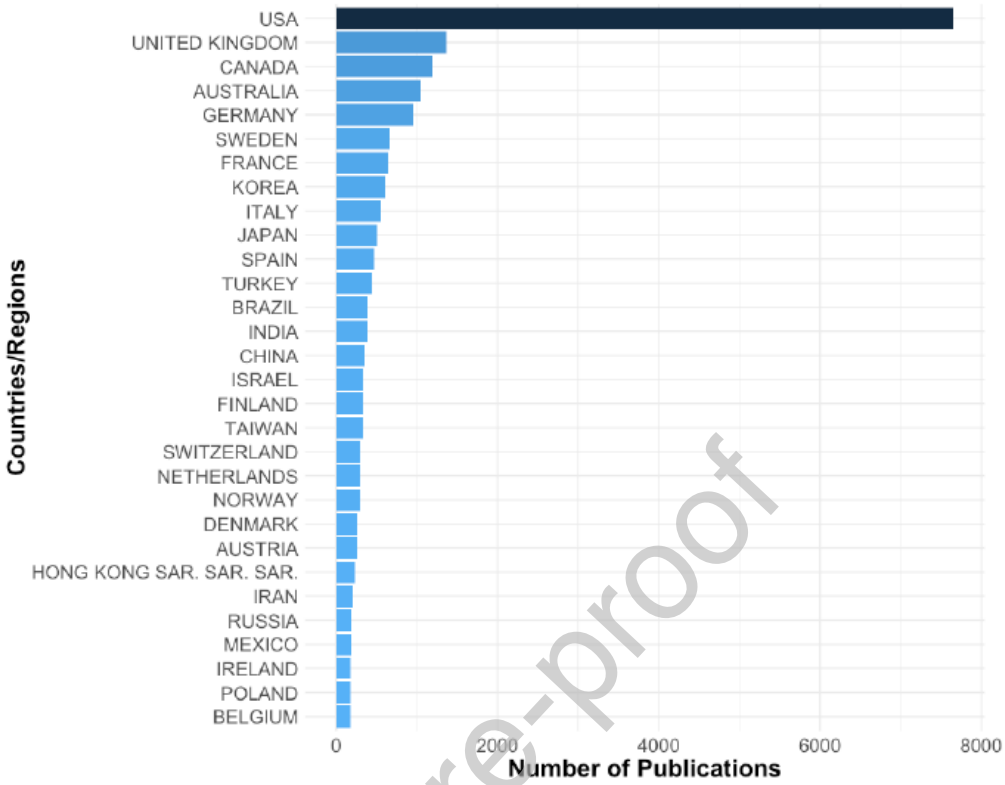


Figure 3: The top 30 Most Productive Countries/Regions in the period 1990 -2018

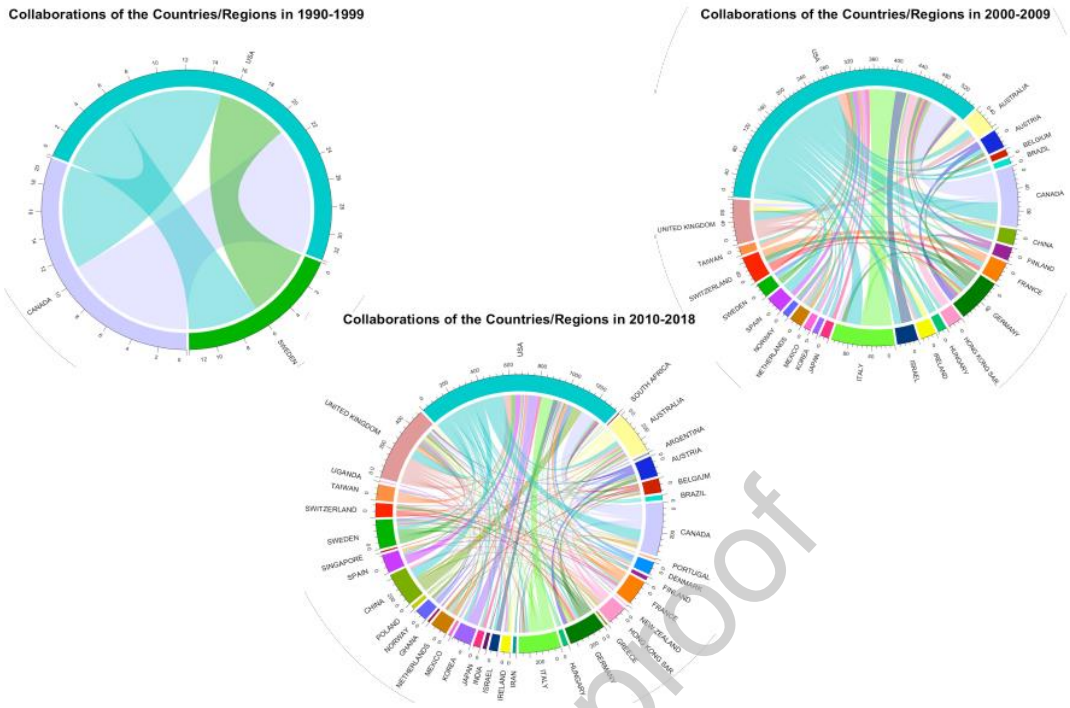


Figure 4: Evolution of Collaborations of the Countries/Regions from 1990 to 2018

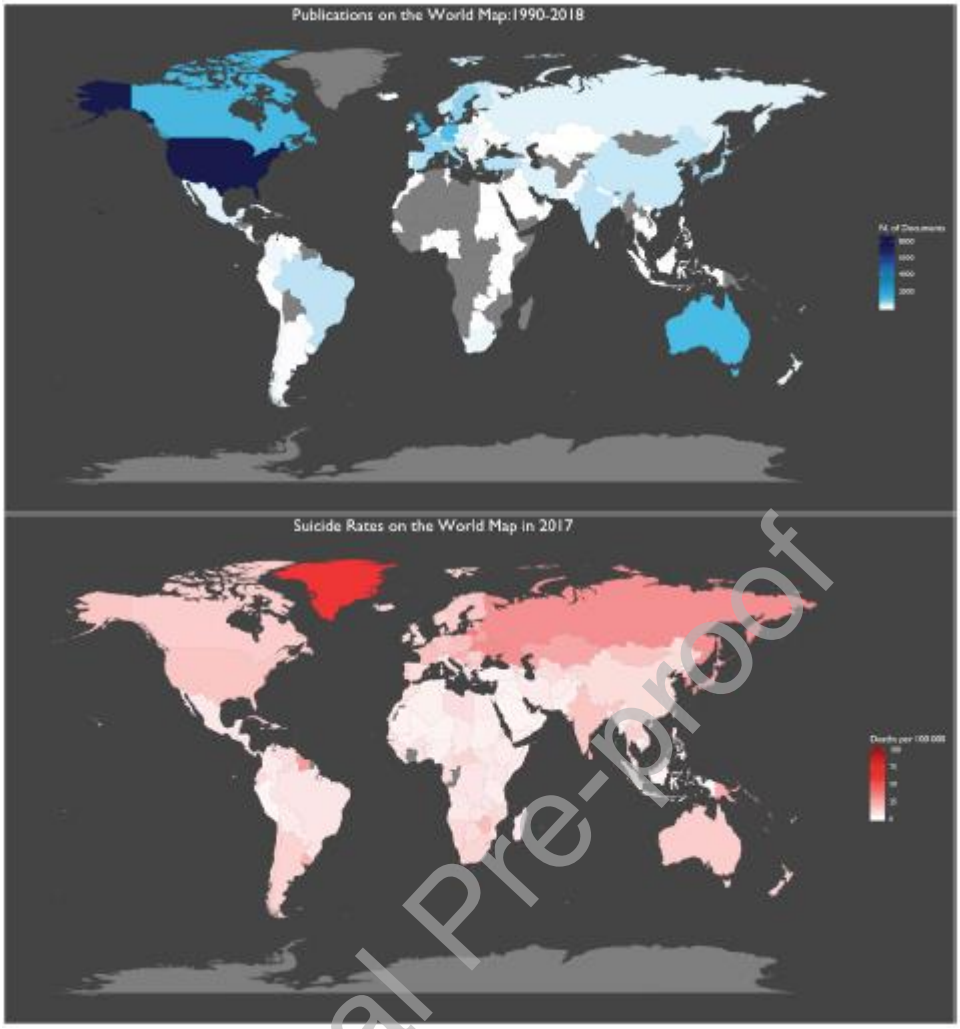


Figure 5: Worldwide Suicide Research Activities and Suicide Rates from 1990 to 2018

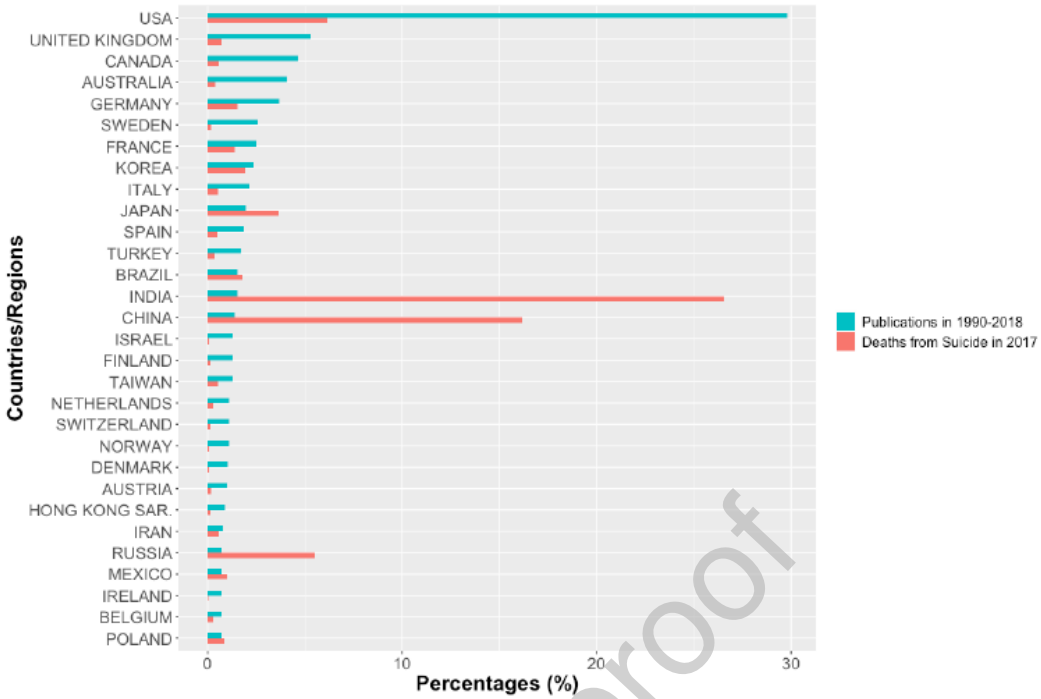
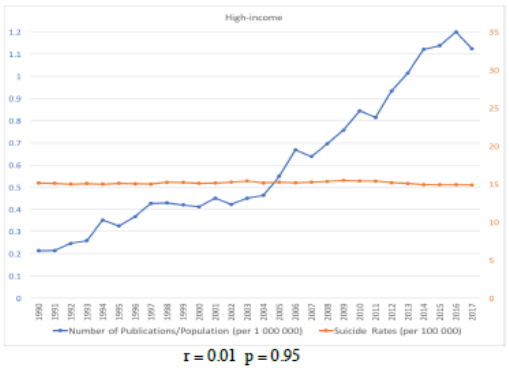
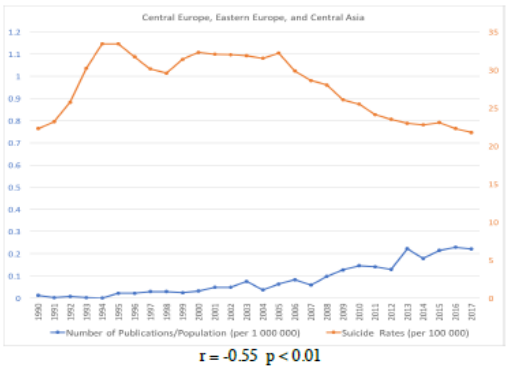


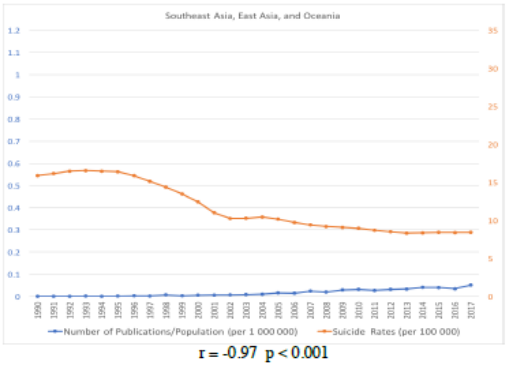
Figure 6: Publications and Deaths from Suicide in the Top 30 Productive Countries/Regions



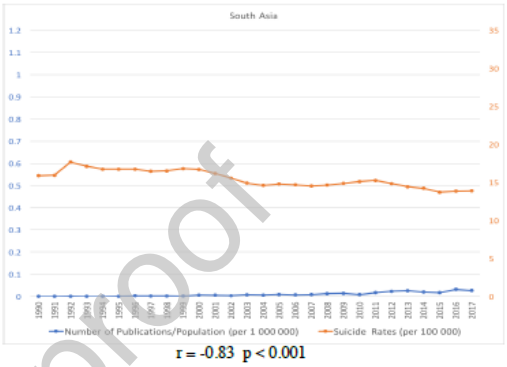
r = 0.01 p = 0.95



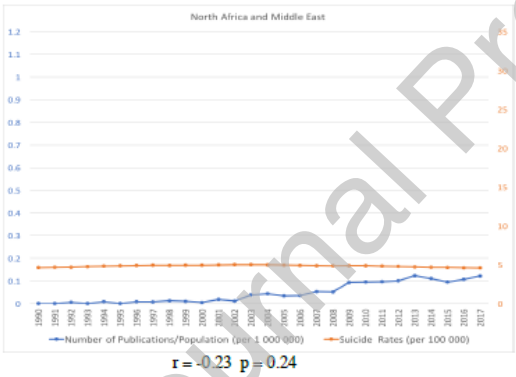
r = -0.55 p < 0.01



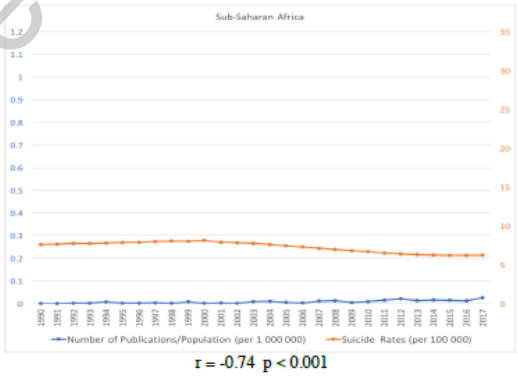
r = -0.97 p < 0.001



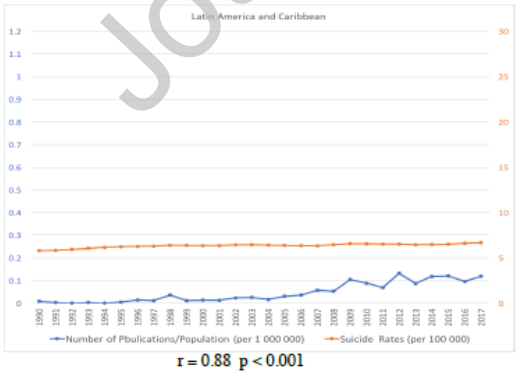
r = -0.83 p < 0.001



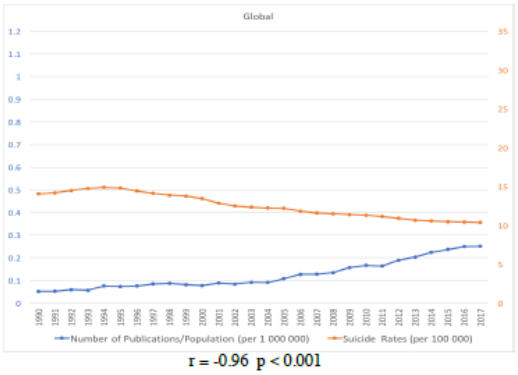
r = -0.23 p = 0.24



r = -0.74 p < 0.001



r = 0.88 p < 0.001



r = -0.96 p < 0.001

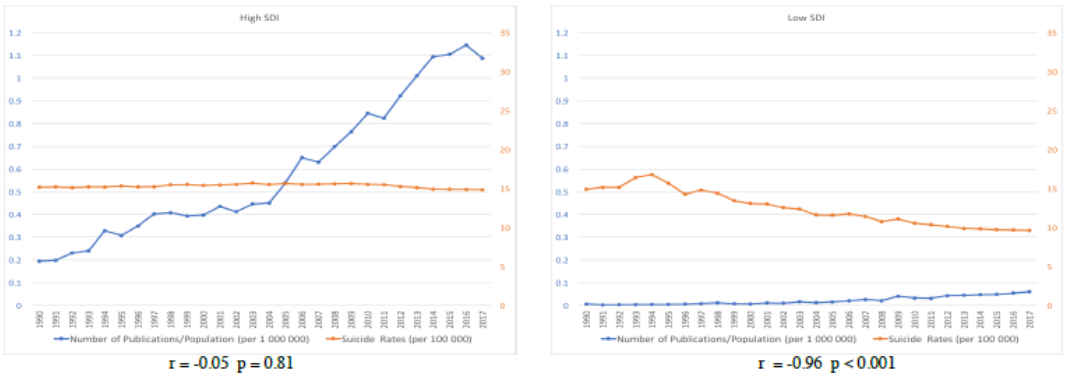


Figure 7: Number of Publications per Million Population and Suicide Rates in the period 1990 - 2018

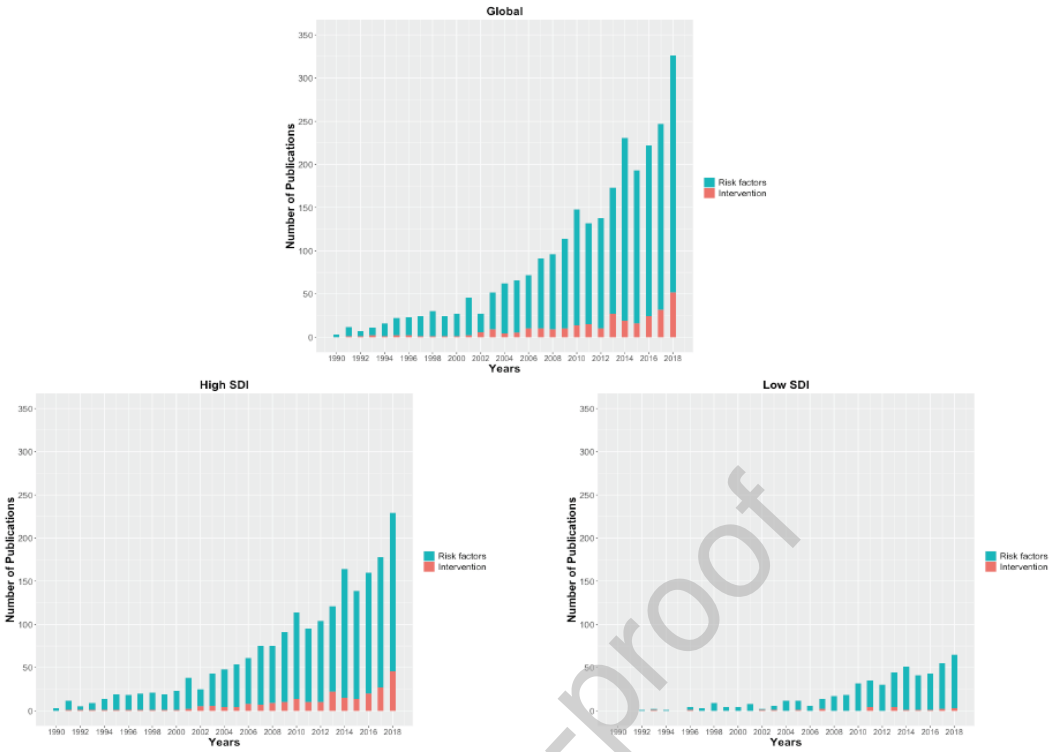


Figure 8: Publications on Risk Factors and Intervention in the period 1990 - 2018