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Bibliometric Survey on "GIS and Public Health (Physical Activity and Walking)

Yoshita Shah [1], Preeti Mulay [2], Abha Arya [3]
[1,2,3]Symbiosis Institute of Health Sciences, Symbiosis Institute of Technology, Symbiosis International (Deemed University), Pune, India
Email: [2]preeti.mulay@sitpune.edu.in

Abstract

GIS in public health is a restively new technology but it has been widely used in research and implantation studies in healthcare. The sole purpose of the bibliometric analysis is to understand the current research pattern on GIS and Public health (Physical activity and Walking). The analysis evaluated the importance, impact and research gaps of the published articles on the same. This paper considers the publication database of Scopus for retrieving and extracting the electronic data published on the concerned topic. The data was shortlisted using combination of specific keywords and analysed on the aspects of author, source, country, etc. of the publication. A set of 135 articles was selected and analysed thoroughly to identify the research gaps and opportunities for further research in the given paper.
Keywords: GIS, Public health, Geographic Information System, Geographical Information Systems, Physical Activity, Walking.

Introduction

The paper deals with two segments, GIS (Geographic Information system) and Public Health. GIS refers to computer based tools which are used to store, visualize, analyse and interpret geographic data. The data could be in any form which can be marked on the globe or visualised on a map (Ershad, Ali, 2020). On the other hand, Remote Sensing refers to the phenomenon collection of data regarding a subject without any physical contact with the said subject (Berhane & Dessalegn Ejigu, 2016).

Similarly, public health can be defined as the science of prevention and improvement of health of the community as a whole rather than of an individual (Park, 2015). The core principles of public health are promotion and prevention of health as well as early detection of diseases. It is primarily concerned with changing behaviour of community in order to improve their lifestyle and health.

John Snow had identified the water source which was responsible for an outbreak of cholera in London. He identified the location of those affected and marked them on a map in a form of spot map (Park, 2015). This helped in identification of source of infected water. This serves as a classic example of how mapping can be used in epidemiological research. The use of GIS in epidemiological studies has seen a rise in the recent times. Agencies can easily track the source of disease and also track the movement of contagions (Musa et al, 2013). By doing this, they can respond in better ways and outbreaks can be tackled more effectively by identifying the high risk populations and targeting interventions accordingly to suit that population (Park, 2015).

Moreover, it has observed multiple times in the literature of epidemiology and public health that the rising incidences of obesity can be understood by the spatial patterning influenced by built environment which includes "urban design, land use, and transportation system" (Handy et al, 2002; Handy et al, 2010). A range of spatial information in form of data from multiple sources can be integrated into a single framework with the help of GIS which helps in "developing precise measures of the built environment" (Thornton et al, 2011).

Taking a deeper look, GIS also has tools which can help identify different geographic measures which include road distances between different locations, important landmarks like health facility, road networks and quality of services in the neighbourhood, etc. (Saelens el at, 2003; Owen et al, 2004). For instance, GIS in current times is tracking COVID-19 spread by identifying disease hotspots and containment zones; identification of areas with high disease density to set up testing clinics, nearest healthcare facilities like hospitals and testing centres; as well as migration and movement of people by the application of remote sensing. Along with the spatial attributes, the descriptive data allows identifying associated attributes like population, age groups, high risk population in a particular geographical area, the bed capacity of hospitals, number of ventilators available, quantity of oxygen cylinders, testing statistics, etc. (Franch-Pardo et al, 2020; Mollalo et al, 2020).

A similar example can be seen in managing non-communicable health issues like road accident surveillance. The areas where the higher number of road accidents were observed can be tracked using GIS. The data can be analysed to identify the problems and formulate required interventions to decrease mortality and morbidity due to road accidents. Furthermore, GIS can also be used to track the physical activity and movement pattern (walking) (Cerin et al, 2007). This is important from the perspective of public health as physical inactivity is one of the leading cause of Non-Communicable diseases. It can be used to analyse the causes and develop relevant and required intervention to improve the health of community.

Therefore, GIS and remote sensing are useful in various ways and above-mentioned literature points out its importance in maintaining public health. This paper intends to understand the research pattern in physical activity and GIS. Physical activity is chosen as a topic because of its increasing importance in today's life and rising cases of physical and mental illnesses due to its restriction. The restraint is caused by urban planning and changing built environment which is realized by several authors like Perdue et al (2003). Nevertheless, any bodily movement which is produced with the help of skeletal muscles that require energy expenditure is known as physical activity that may include cycling, walking, sports and recreation etc. These can be done at any level of skill and also for enjoyment. Regular and adequate level of physical activity is necessary for better functioning of cardiac and respiratory system, improved functional health, reducing lifestyle diseases, maintaining strength of body, physical and mental health of the individual.

Dasso (2018) argues that physical activity is an umbrella term and cannot be used interchangeably with exercise. She emphasizes that the later is the "subcategory of physical activity" whereby exercise is a deliberate attempt to either maintain or reduce body weight

and physical activity is the energy expenditure by different means (Dasso, 2018: 1). The author and WHO page on NCD prevention mention that physical inactivity is the leading cause of NCD and the associated deaths due to expanding risks "of cancer, heart diseases, stroke and diabetes by 20-30% and shortens the lifespan by 3-5 years" . This has manifold impact on socio-economic spheres of an individual due to increasing medical cost and reducing competitiveness and work productivity. Declining physical activity is the main reason behind diabetes and cardiovascular diseases and associated deaths in both the high income countries as well as low and middle income countries (WHO, 2009).

Lee et al (2012) argue boosting physical activity shall cause an improvement in the health globally. The authors categorically mention that "it would remove between 6% and 10% of the major NCDs of CHD, type 2 diabetes and breast and colon cancers, and increase life expectancy". This will also help in the improvement of what WHO mentions, "globally, around 31% of adults aged 15 and over were insufficiently active in 2008 (men 28% and women 34%). Approximately 3.2 million deaths each year are caused due to insufficient physical activity".

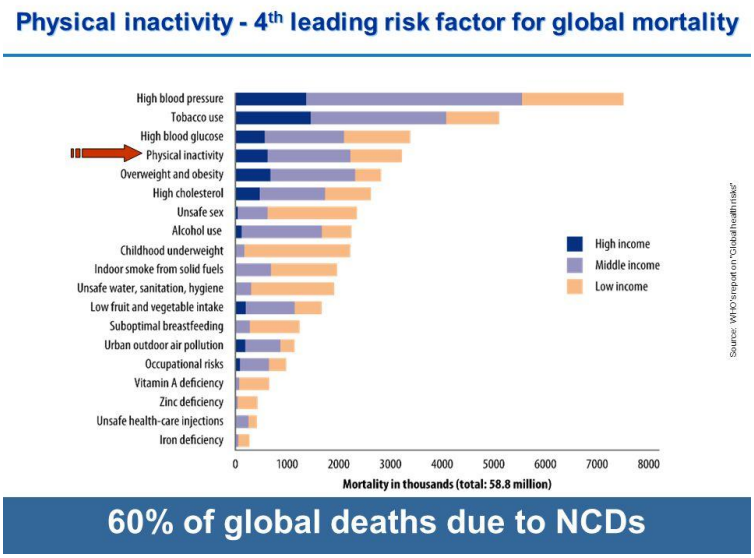

Figure 1 Deaths due to Physical Inactivity

Source: Global health risks: Mortality and burden of disease attributable to selected major risks. Geneva: World Health Organization; 2009.

To fight the physical inactivity, WHO has formulated 9 voluntary global targets where one of the targets specifically focuses on 'insufficient physical activity' (WHO, 2013). The report further defines this target as "Prevalence of insufficiently physically active adolescents, defined as less than 60 minutes of moderate to vigorous intensity activity daily". For the individuals above 18 years shall remain physically active above 150 minutes per week.

In Sustainable Development Goals, reducing physical activity is included in the achievements of 8 SDGs and 18 targets. This can be better understood in the pictorial representation below in Figure 2.

Figure 2 Physical Activity and SDGs

Source: Global health risks: Mortality and burden of disease attributable to selected major risks. Geneva: World Health Organization; 2009.

In the above discussion, the importance of physical activity and walking and the role of GIS in tracking physical inactivity among a specific population and improving the same by analysing and interpreting the data to formulate an intervention can be seen. To get a broader scenario about GIS with its intersections in the field of public health (in terms of Physical activity and walking) research area, there is a need of bibliometric survey in this field.

The paper presents a bibliometric survey study of 'GIS and Public health (physical activity and walking)' where the present section has given a brief introduction of the topic and also mentioned its rationale. Further, section 3 highlights methodology and data collection; section 4 gives a complete bibliometric analysis, section 5 and 6 of the paper discuss the implication of the study in research and limitations of the current studies available, respectively. Section 7 of the paper gives concluding remarks followed by references.

Methodology and data collection

"Research databases are organized collections of computerized information or data such as periodical articles, books, graphics and multimedia that can be searched to retrieve information".

Publication databases are better than website databases, as the former has credible information from experts in the fields and the facts are peer reviewed and checked for the published work. It is easy to cite, narrow topics using set of keywords, easy to exclude unrequired documents, and is frequently updated with the dates of publication and citation information.

Some of the popular publication databases recommended are Scopus, Web of science, Pub Med, ERIC, Science Direct, DOAJ, JSTOR, Mendeley, Google scholar and Research Gate, etc.

For this paper, data is retrieved and extracted using Scopus database applying specific set of keywords. The electronically available data was shortlisted to 135 articles and further analysed from the aspect of author, source journal, geographic location, document type, affiliation, subject area, etc. The articles were also reviewed on the basis of citation given over the years.

Significant keywords

The keywords to be used for the study were divided into Primary, Secondary and Tertiary Keywords. For this research, the keywords used in combinations using Boolean operators are as mentioned in the table 1.

Table 1 Combinations of Keywords

Primary Keywords	**"GIS" AND "Public" AND "Health"**
Secondary Keywords **(AND)**	"Physical activity" OR "Walking"
Tertiary Keywords **(AND)**	"GIS" OR "Geographic information system" OR "Geographic information systems" OR "Public health" OR "Epidemiology" OR "Demography" OR "Information systems" OR "Spatial Analysis" OR "Geographic Distribution" OR "Geographic mapping" OR "Spatial distribution" OR "Remote sensing"

Initial search results

A combination of specific keywords was used to generate 135 publications in the Scopus database of all languages as mentioned in table 2 below.

Table 2 Language trend for Publications in Scopus

Sr. No.	**Publishing Language**	**Publications Count**
1	English	132
2	French	2
3	Spanish	1
Total		**135**

Source: https://www.scopus.com/ (Accessed on 07/07/2020)

The documents retrieved from Scopus database on GIS and Public Health (Physical activity and Walking) were of following types as shown in table 3.

Table 3 Types of Published Document for GIS and Physical Activity/Walking

Document Type	Number
Article	135
Review	10
Conference Paper	3
Editorial	1

Source: https://www.scopus.com/ (Accessed on 07/07/2020)

Preliminary data highlights

The documents on GIS and Public health (Physical Activity and walking) retrieved and extracted from Scopus database from 2005 to 2020. The publication trends over the span of these years are shown in table 4.

Table 4 Trends of Publication by year

Year	Publication Count
2005	1
2006	4
2007	8
2008	6
2009	6
2010	4
2011	7
2012	8
2013	6
2014	12
2015	9
2016	14

2017	13
2018	15
2019	14
2020	8
Total	**135**

Source: https://www.scopus.com/ (Accessed on 07/07/2020)

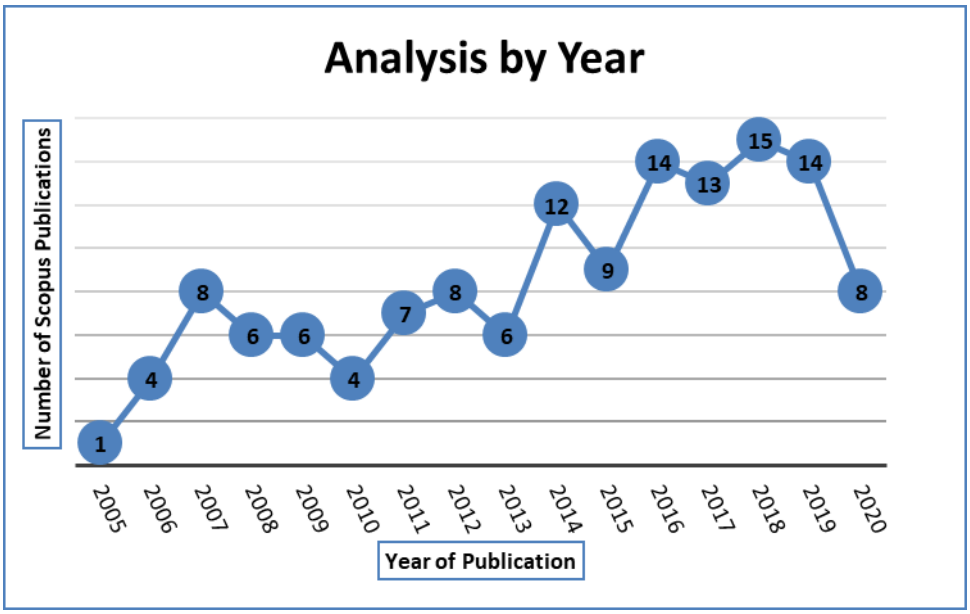

Figure 3 Analysis of publications by year

Source: https://www.scopus.com/ (Accessed on 07/07/2020

Data investigation

Furthermore, a detailed bibliometric analysis is done in the paper in the following section. The analysis gives a thorough idea about the various aspects of the publications such as geographical origin of the publication authors, source journals, affiliations, author characteristics, statistics of citation were considered as a basis of analysis.

Bibliometric analysis

The bibliometric analysis for GIS and Public health (physical activity and walking) as conducted by application of geographical characteristics analysis and statistical analysis of attributes like keywords, citations, author information and so on. It gives an insight into the distinctiveness of the available research in the area of GIS and public health (physical activity and walking).

Analysis By Geographical Region

The geographical attributes of the published articles is marked in the following mp using imapbuilder.net. The concentration indicates the region with most research conducted on GIS and Public health (physical activity and walking) as shown in figure 4.

Figure 4 Geographical attributes of the publications

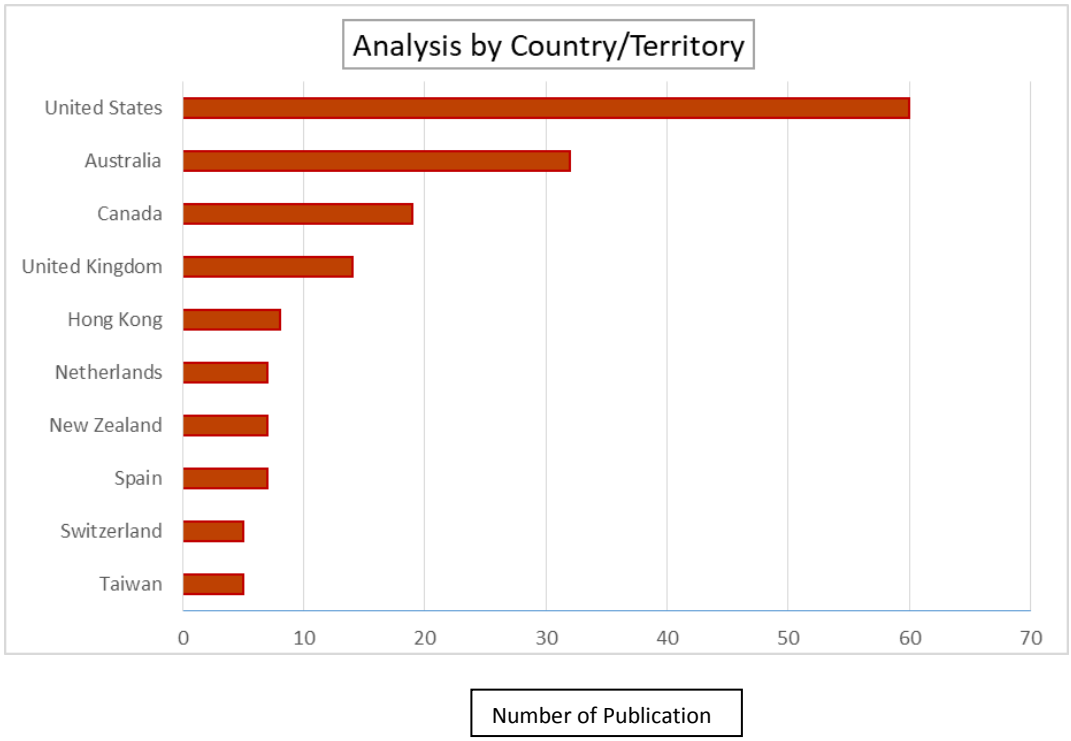

Figure 5 Analysis of Scopus publication by geographical territory

Source: https://www.scopus.com/ (Accessed on 07/07/2020)

Analysis of keywords

The use of specific and direct keywords in different combinations yield different results. The correct combination will give more accurate results. The primary and secondary keywords and number of publications using those are shown in table below.

Table 5 Primary and secondary keywords in GIS and Public health (physical activity and walking)

Keywords	Number of publications
GIS	41
Public Health	11
Geographic Information System	28
Geographic Information Systems	17
Physical Activity	54
Walking	19

Source: https://www.scopus.com/ (Accessed on 07/07/2020)

Network analysis

Network analysis is a combination of techniques used to analyse the links between different statistical entities to yield a graphical network. The parameters are depicted as nodes and their relations are denoted as lines or edges. To generate a network analysis of various parameters we have used "Gephi" which is an open source and free software. Gephi is used for exploratory data analysis, social network analysis, biological network analysis, link analysis, to mention a few.

Figure 6 shows a cluster of number of publication, subject area. The figure consists of 11 nodes and 18 edges.

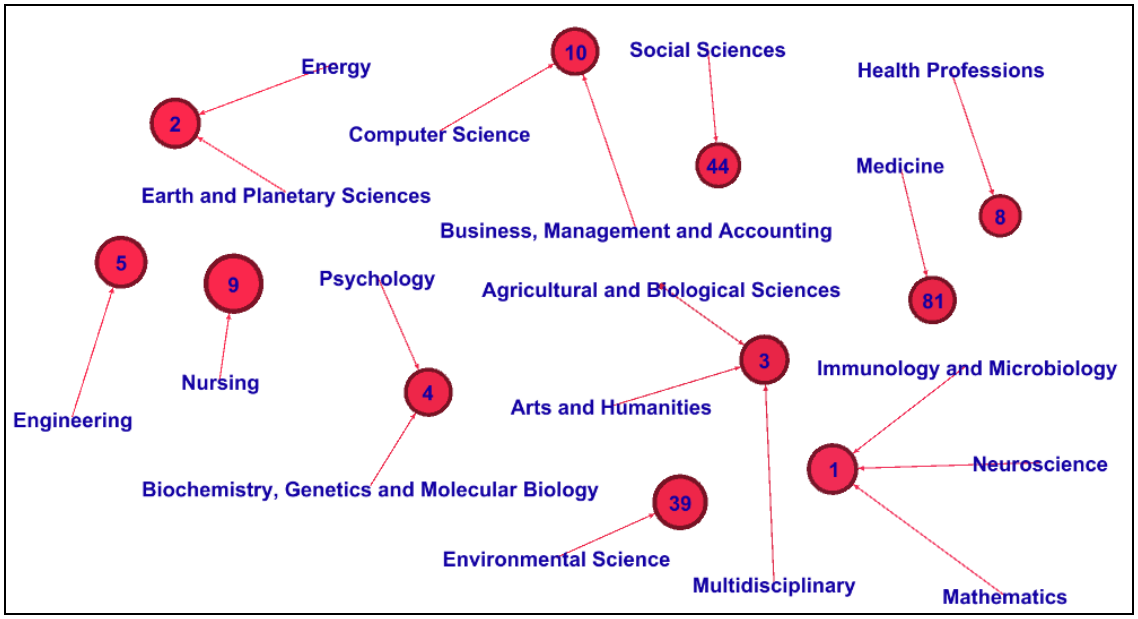

Figure 6 Cluster of Number of Publication and Subject area

A cluster of number of publications and the geographical region/country is depicted in figure 7. The figure includes 11 nodes and 26 edges.

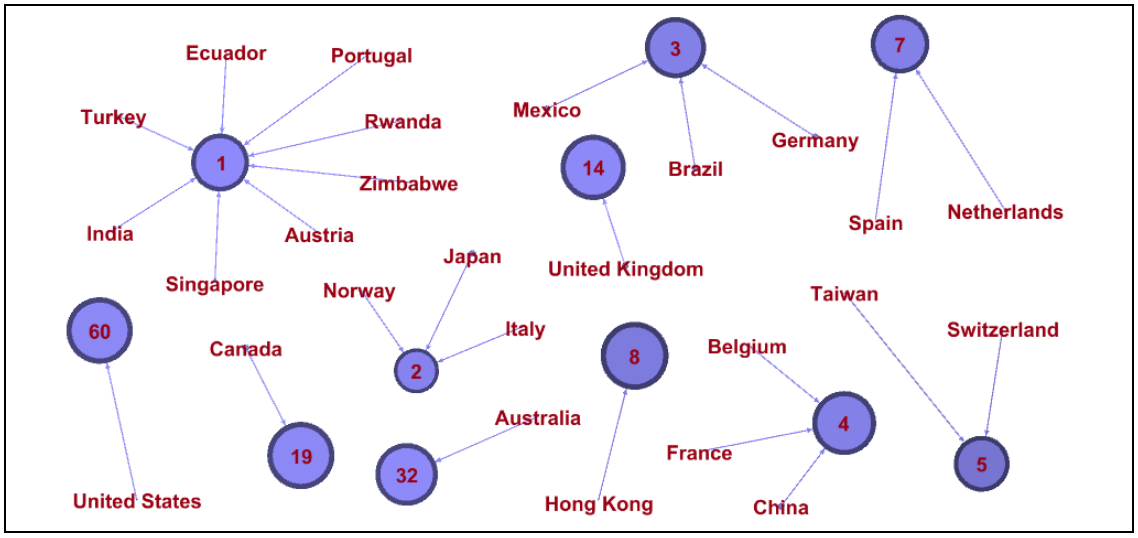

Figure 7 Cluster of Number of Publication and Geographic Region/Country

Analysis by subject areas

The pie diagram in figure 8 shows the analysis of subject areas in which the publications on GIS and Public health (physical activity and walking) falls under. From the statistics it is observed that majority of publications belong to the field of medicine, followed by social sciences and environmental sciences respectively.

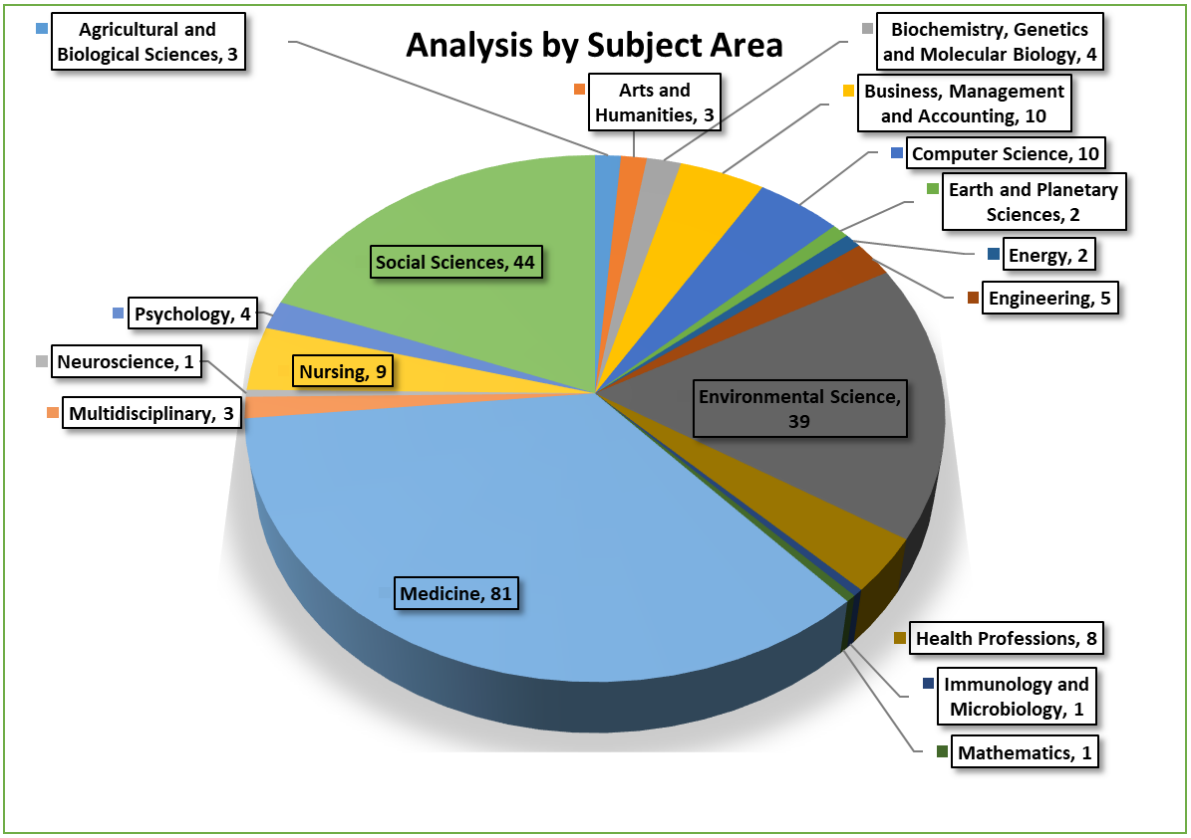

Figure 8 Analysis of publications by subject area

Source: https://www.scopus.com/ (Accessed on 07/07/2020)

Analysis by affiliation

As observed in the Region wise analysis, most research can be seen in the United States, however if we see the institutional affiliation, it can be observed that University of Melbourne and The University of Queensland located in Australia have key contribution. Affiliation analysis of top 10 institutions for the research on "GIS and Public Health (Physical activity and Walking)" can be observed in Figure 9.

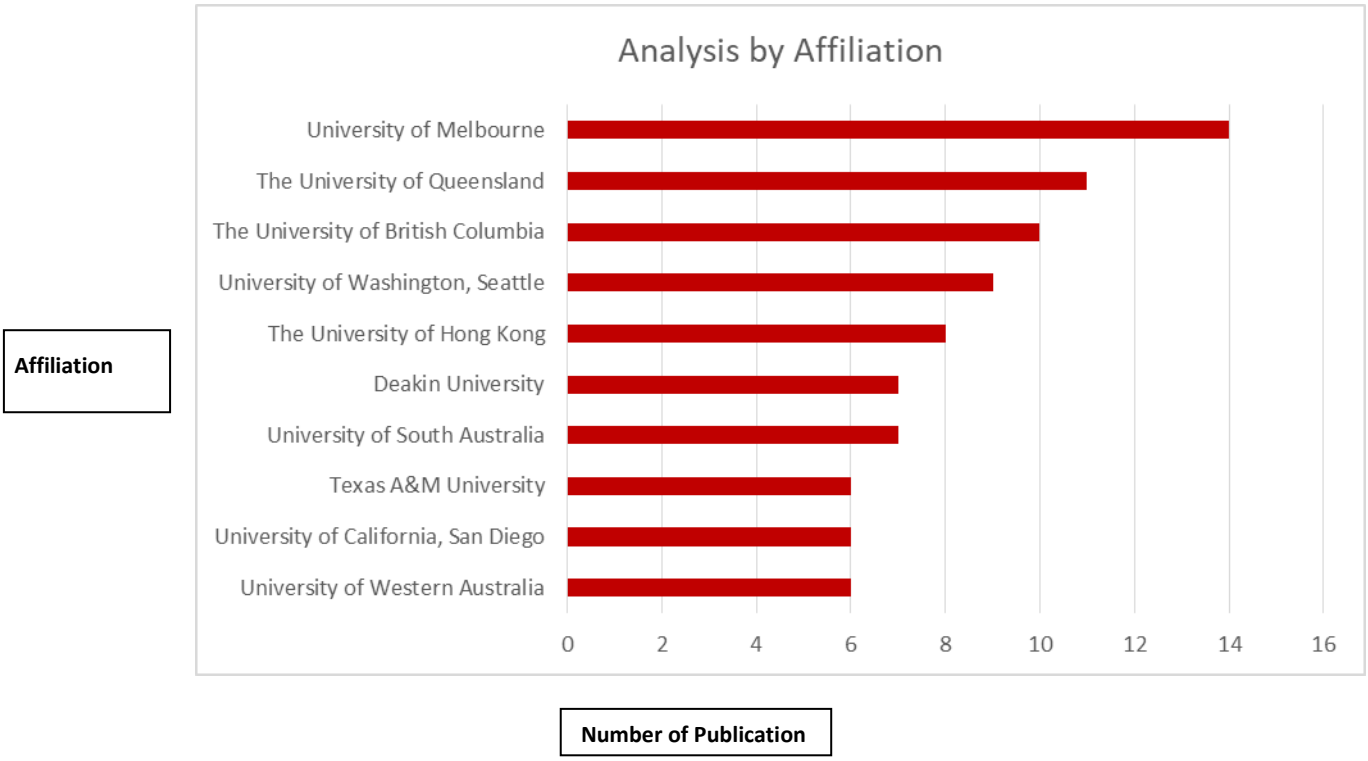

Figure 9 Analysis of publications on the basis of Affiliation authority

Source: https://www.scopus.com/ (Accessed on 07/07/2020)

Analysis by authors of the articles

In the area of GIS and Public health (physical activity and walking), the top 10 key authors and their contribution in the research area are depicted in figure 10.

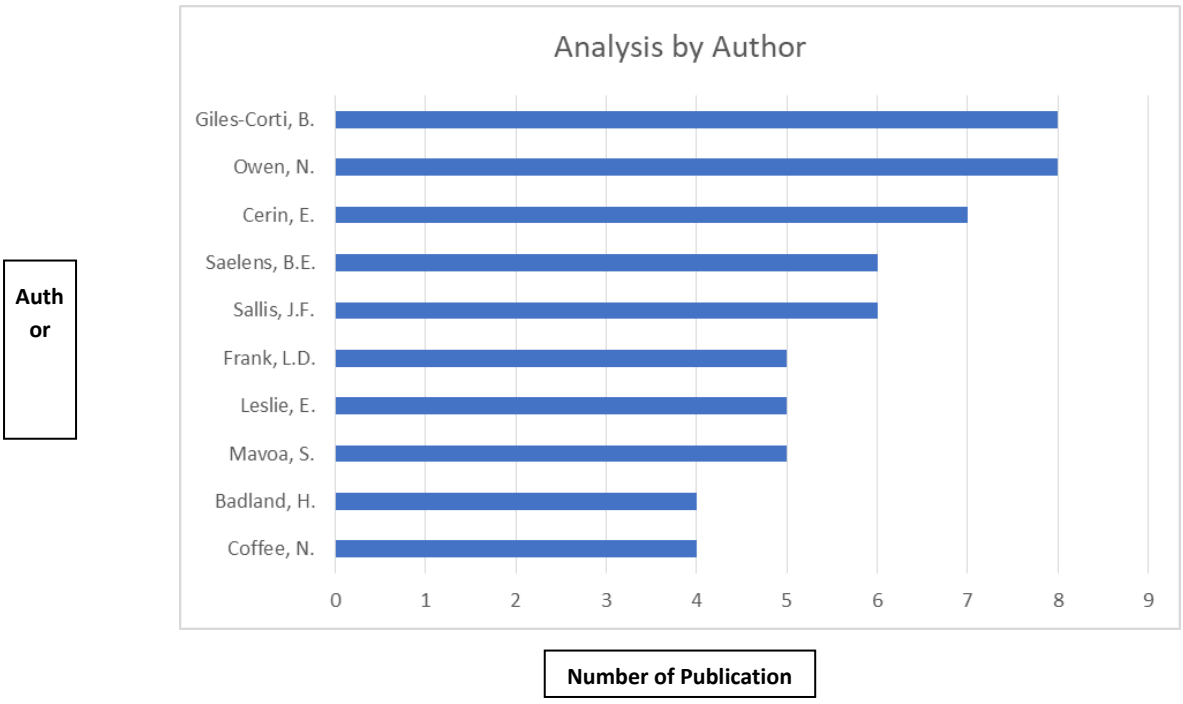

Figure 10 Analysis of publications on the basis of authors

Source: https://www.scopus.com/ (Accessed on 07/07/2020)

Analysis by document type

The publications on GIS and public health (physical activity and walking) were further narrowed on the basis of the document type. 149 documents were classified as article, review paper, conference paper and editorial. For the end results, 135 articles from the publications were considered in the study. The same can be observed in figure 11.

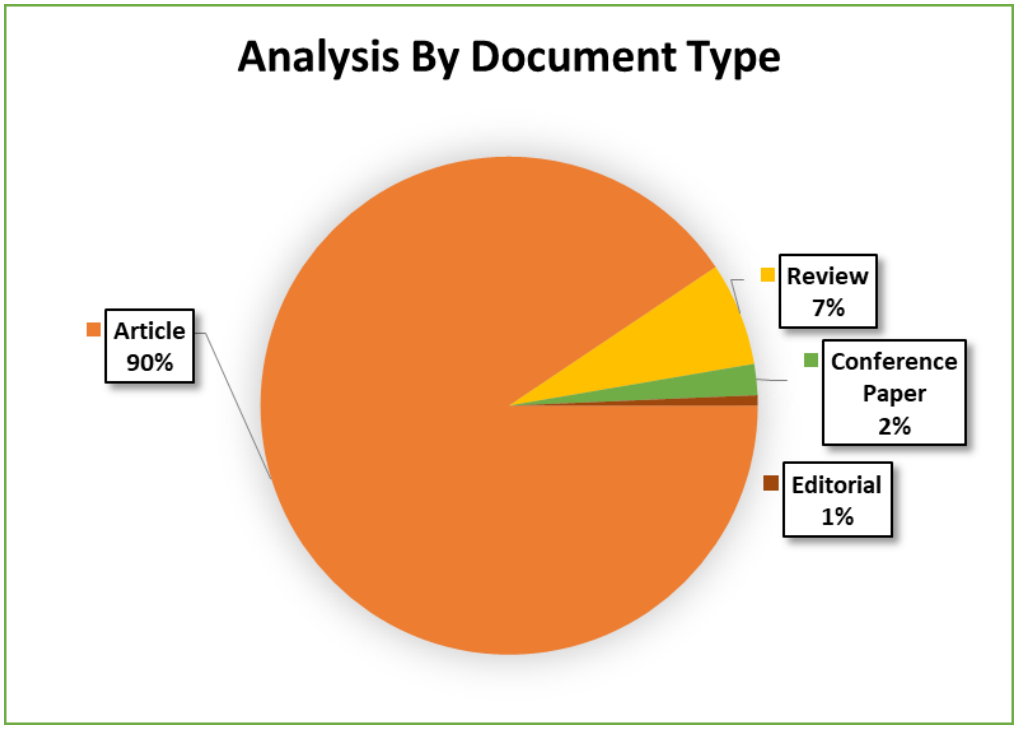

Figure 11 Analysis of document type of Scopus Publications

Source: https://www.scopus.com/ (Accessed on 07/07/2020)

Analysis by citation

The Publication data on GIS and public health (physical activity and walking) retrieved and extracted from Scopus database for the time span 2005-2020 is analysed on the basis of citation index.

Table 6 depicts the total citation count of 135 publications over the given time frame.

In table 7, top 10 most cited publication along with the total citation count is shown.

Table 6 Year wise trend in Citation

Year	Number of Publications
2005	2
2006	5
2007	35
2008	69
2009	152
2010	217
2011	255
2012	293
2013	382
2014	420
2015	501
2016	597
2017	631
2018	688
2019	865
2020	493
Total	5605

Source: https://www.scopus.com/ (Accessed on 07/07/2020)

Table 7 Top 10 Cited Publications

Publication Title	Citation Count
Neighborhood Walkability and the Walking Behavior of Australian Adults (Owen N., et. al., 2007)	371
Walkability of local communities: Using geographic information systems to objectively assess relevant environmental attributes	366

(Leslie E., et. al., 2007)	
Residents' perceptions of walkability attributes in objectively different neighbourhoods: A pilot study (Leslie E., et. al., 2005)	258
The relation between neighborhood built environment and walking activity among older adults (Nagel C.L., et. al., 2008)	222
Validation of Walk Score® for estimating neighborhood walkability: An analysis of four US metropolitan areas (Duncan D.T., et. al., 2011)	221
The relationship between access and quality of urban green space with population physical activity (Hillsdon M., et. al., 2006)	196
City structure, obesity, and environmental justice: An integrated analysis of physical and social barriers to walkable streets and park access (Cutts B.B., et. al., 2009)	183
Built Environment, Adiposity, and Physical Activity in Adults Aged 50-75 (Li F., et. al., 2008)	177
GPS tracking in neighborhood and health studies: A step forward for environmental exposure assessment, A step backward for causal inference? (Chaix B., et. al., 2013)	167
Childhood obesity and proximity to urban parks and recreational resources: A longitudinal cohort study (Wolch J., et. al., 2011)	167

Source: https://www.scopus.com/ (Accessed on 07/07/2020)

Analysis by source of the document

A statistical Analysis on the basis of source of the publication in the area of GIS and public health (physical activity and walking) is done and depicted in Figure 12. From the graph, we can conclude that maximum publications belong to "International Journal of Environmental Research and Public Health".

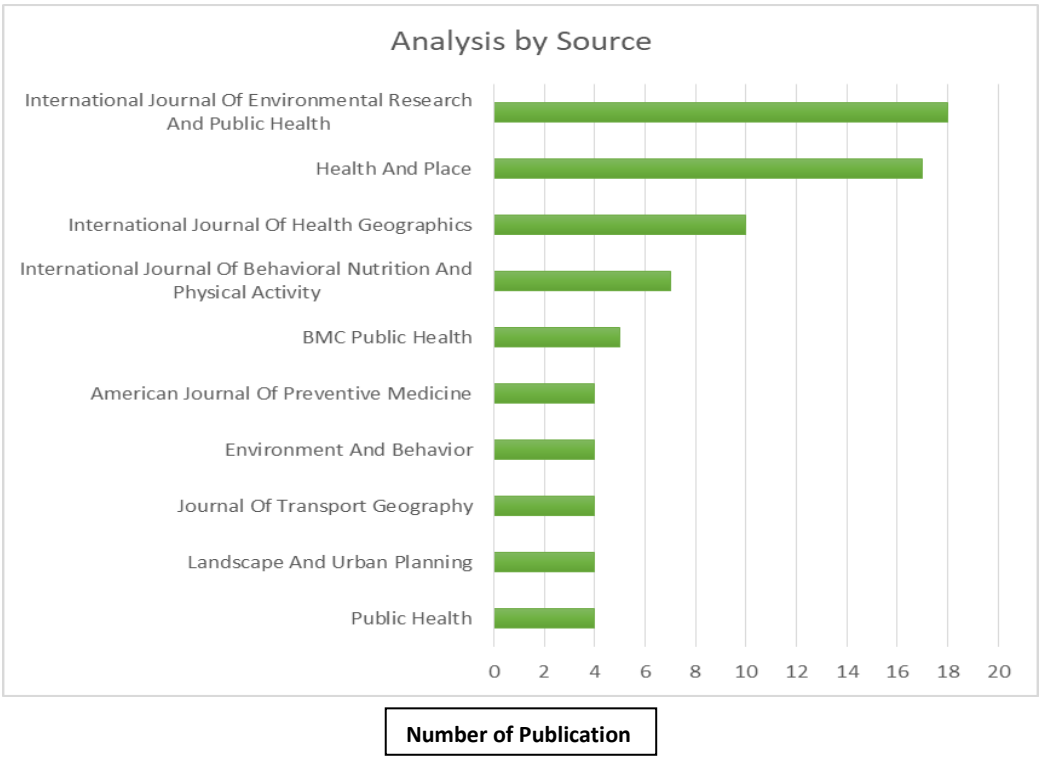

Figure 12 Analysis by Source statistics of Publications

Source: https://www.scopus.com/ (Accessed on 07/07/2020)

Result

Even GIS is fairly a new area of research area in the field of Public health, it is vastly explored to improve the health of the community. From the above analysis using Scopus Database we can conclude that there is a great scope of research in the field of GIS and Public Health. In table 1, a set of apt and specific keywords using Boolean operators was used in specific combinations to yield 149 documents out of which 135 article publications were considered for the analysis. Majority articles are published in English (132), followed by French (2) and Spanish (1). The first publication came in 2005 in Scopus database. The majority of research is conducted in United states mainly attributing to their advanced technology and information systems. University of Melbourne is found to have highest affiliation followed by University of Queensland, indicating the increasing scope of research in Australia. About 88% of the publications belong to Medicine area followed by social science (44). International Journal of Environmental Research and Public Health accounts for majority of the publications. From the above analysis, it can be concluded that Giles-Corti is the key contributing author and expert in the domain of GIS and Public Health (physical activity and walking). The 135 publications considered in the study are cited 5605 times in the span of 2005-2020, "Neighborhood Walkability and the Walking Behavior of Australian Adults" being the most cited publication accounting for 371 citations.

Limitations

This Study was conducted using Scopus Database as the source of data for the keyword analysis. Many important publications and journal papers are not a part of the Scopus database. This can lead to missing out of papers which have been published in this domain, but are not a part of the Scopus database. Using keyword such as "Geographic Information System" and "Geographic Information Systems" lead to different results. This minor difference in keywords if not noticed, could leave potential papers out of the study area.

The research conducted is based on environmental factors as well as behavioral factors affecting the physical health, thus it is difficult to reciprocate the results in the different demographic region. Hence interventions planned for on research may or may not be effective in other geographic region or with other population.

Conclusion

This Bibliometric Survey on "GIS and Public Health (Physical activity and Walking)" gives an insight of the distinctiveness of available literature, prominent researchers and ongoing research with respect to attributes such as Geographical region of research, affiliation organization, source journals and key contributors.

This survey helps to identify the research gaps, available opportunities, the domain for further research and gives an idea to where collaborate. From the statistics we can observe that almost negligible research is conducted in India where Physical inactivity is highest among 18 countries as per a research by Fitbit (6533 steps, which is 3600 steps lesser than the average of most active country). As the prevalence of lifestyle diseases increases, physical activity is the most viable preventive solution to reduce the same.

On analysis from Public health perspective, the statistics suggest that there is minimal diversity among the population considered in the study which makes it difficult to reciprocate or universalize the results and difficult to plan a universal intervention.

There is a scope to conduct a research on "GIS and Public Health (Physical activity and Walking)" in a diverse population to get a clear insight on causes of Physical inactivity. But the above analysis gives a great scope for Meta-Analysis for the regions where research on the same has already been conducted in good numbers.

This analysis aims to help end user in identification of collaborators for the research in this particular domain. In current times, United States is a hub for research collaborators in this domain. Also as most studies are affiliated to University of Melbourne and The University of Queensland, Australia is emerging as research and collaboration hub for this domain.

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