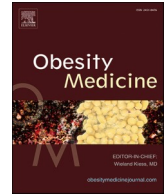




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Increased global online interest in diabetes during the COVID-19 pandemic: An infodemiology study

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ABSTRACT

Background: The public utilize the internet as their main source for health-related information during the pandemic. This was shown by the increase in global online searches related to health during the pandemic. In this study, the dynamics of public interest and awareness in diabetes before and during the pandemic was investigated and the possible factors associated with online interest in diabetes were determined.

Methods: Global online search interest for diabetes was measured using Google Trends™ database. The search terms “diabetes”, “type 1 diabetes”, “type 2 diabetes”, and “gestational diabetes” were used. The results were limited to the years 2010 until 2020 from all countries. Correlation between country-specific characteristics and search volume index (SVI) was determined using Spearman’s rank-order correlation.

Results: This study showed a steady increase in global online interest in diabetes during the last decade. SVI for all the diabetes search terms included in this study increased from 2019 to 2020. People searching for the term “diabetes” also searched for the different types of diabetes, causes, signs and symptoms, diagnostic tests, and treatments for diabetes. The increasing online interest in diabetes was positively correlated with percentage of individuals using the internet and the number of physicians in a country.

Conclusions: The results of this study showed an increasing global online interest in diabetes during the last decade. This increased global interest in diabetes should be maximized by medical doctors and public health officials in providing evidence-based information regarding prevention and control of diabetes in the internet.

1. Introduction

Diabetes continues to be a global public health concern that causes significant morbidity and mortality. The three main types of diabetes are type 1 diabetes (T1D), type 2 diabetes mellitus (T2D), and gestational diabetes mellitus (GDM). The incidence of diabetes continues to increase in some developed and developing countries (Saeedi et al., 2019). Globally, the prevalence of diabetes was 476 million in 2017. The prevalence is predicted to increase to 570.9 million 2025 (Lin et al., 2020). The increased prevalence of diabetes in the recent years also resulted in a significant increase in the economic costs of managing this disease. In the US, the total estimated cost of diagnosed diabetes in 2017 is \$327 billion (American Diabetes Association, 2018).

The challenge in controlling diabetes was compounded by global pandemic due to the coronavirus disease (COVID-19). Diabetes patients were also greatly affected by the pandemic because they are more prone to infections and complications due to COVID-19

; GDP, gross domestic product; SVI, search volume index.

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(Emami et al., 2021; Shrestha et al., 2021). These patients also need long-term care and constant check-up with their primary care physicians. However, this global pandemic has resulted in a huge burden in the healthcare services worldwide (Moynihan et al., 2021). The emergency departments and hospital beds were occupied mostly by COVID-19 patients. Due to the extraordinarily high number of COVID-19 patients and the limited resources, the COVID-19 pandemic greatly affected the management and care of non-COVID-19 patients, including the diabetes patients (Bodilsen et al., 2021; Ojetti et al., 2020). Since the pandemic started, there was a significant reduction of non-COVID-19 patients, including those with diabetes, seeking consultation in the outpatient clinics and treatment due to urgent medical conditions in the emergency department (Arcellana and Jimeno, 2020; Moynihan et al., 2021; Santi et al., 2021; Schofield et al., 2020; Sevinç et al., 2021). This resulted in a concurrent increase in out-of-hospital mortality mainly driven by deaths for neoplasms, cardiovascular and endocrine diseases (Santi et al., 2021).

During this pandemic, the public utilized the internet as their main source for health-related information (Vismara et al., 2021). This was shown by the increase in global online searches related to health during the pandemic (Du et al., 2020; Higgins et al., 2020). Recently, the internet search trends have been used to analyze the public interest and awareness of a particular disease. This research is called infodemiology, the science of distribution and determinant of information in an electronic medium (Eysenbach, 2006). Infodemiology has already been used in assessing the online public interest in non-communicable diseases such as asthma, allergy, cardiovascular diseases, and cancer (Dzaye et al., 2021; Eysenbach, 2004; E.W.J. Lee et al., 2021). However, infodemiology studies investigating the global interest in diabetes are lacking. Hence, this study described the trend of global online interest in diabetes in the last decade. The dynamics of public interest and awareness in diabetes before and during the pandemic was described and the possible factors associated with online interest in diabetes were determine. I hypothesize that the global pandemic would increase the global online interest in diabetes.

2. Materials and methods

Global online search interest for diabetes was measured using Google Trends™ database which provides reports on search trends in the unit of search volume index (SVI). This number represents the search interest relative to the highest point on the chart for the given region and time. An SVI of 100 corresponds to the peak popularity for the search term. A value of 50 means that the term is half as popular. A score of 0 means that there was not enough data for the search term. SVI has been shown in previous studies to provide insight into population health seeking behavior and collective health trends.

Google Trends™ was accessed by visiting <http://trends.google.com>. The terms “diabetes”, “type 1 diabetes”, “type 2 diabetes”, and “gestational diabetes” were used for this infodemiology study. The search was done with these settings: all categories, year 2010 until 2020, and worldwide. SVI and related queries were obtained from Google Trends™. The information about diabetes prevalence, gross domestic product (GDP) allocation (% GDP), physician-to-population ratio, and individuals using the Internet (% of population) were obtained from the World Bank (The World Bank, 2020). The figures and geographic maps were created using Datawrapper.

Correlation between country-specific characteristics and SVI was determined using Spearman’s rank-order correlation. A Spearman’s correlation coefficient (ρ) with a p-value of less than 0.05 was considered significant. This statistical analysis was done using GraphPad Prism software version 7 (GraphPad Software, San Diego, CA).

3. Results

The SVI for diabetes search terms from 2010 to 2020 were shown in Fig. 1. There was a gradual increase in interest in diabetes over the last decade. The trend was also increasing with the search terms type 1 diabetes and type 2 diabetes while the trend for gestational diabetes was only sustained. Of the three types of diabetes, type 2 diabetes had the highest SVI, followed by type 1 diabetes, and gestational diabetes.

To determine if the COVID-19 pandemic affected the global online interest in diabetes, the average SVI in 2020 (pandemic season) was compared to the SVI in 2019. The SVI for “diabetes” ($p < 0.0001$), “type 1 diabetes” ($p < 0.0001$), “type 2 diabetes” ($p < 0.0001$),

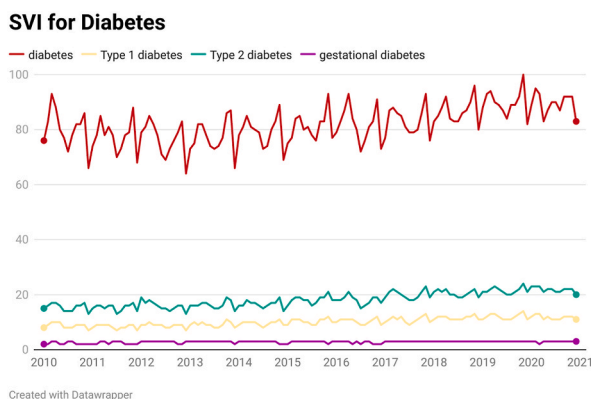


Fig. 1. Search volume indices for the terms “diabetes”, “type 1 diabetes”, “type 2 diabetes”, and “gestational diabetes” in the year 2010–2020. SVIs were calculated separately for each search term such that SVIs are normalized within each term.

and “gestational diabetes” ($p = 0.0002$) significantly increased during the pandemic compared to the same period before the pandemic (Table 1). There was a 12.36% increase in the average annual global interest (SVI) in diabetes from 2019 to 2020. Similarly, there was a 10.1% increase in the average annual global interest in diabetes in the during the pandemic compared to the pre-pandemic period (average SVI from 2010 to 2019).

Based on the results of this study, it was also noted that people searching for the term “diabetes” also searched for specific types of diabetes such as “type 1 diabetes”, “type 2 diabetes”, “gestational diabetes”, “diabetes insipidus”. The other related terms were on the causes, signs and symptoms, diagnostic tests, and treatments for diabetes such as insulin (Table 2).

A geographic map showing the countries where the search terms for diabetes were most popular for the past 10 years was shown in Fig. 2. For the search term “diabetes”, the top countries were Ghana, Puerto Rico, Australia, United Kingdom, and United States (Fig. 2A). On the other hand, Australia, United States, United Kingdom, Norway, and Puerto yielded more searches for “type 1 diabetes” (Fig. 2B). “Type 2 diabetes” were more popular in Sweden, Norway, Australia, United Kingdom, and Algeria (Fig. 2C). Lastly, “gestational diabetes” was more popular in Australia, Trinidad & Tobago, Ireland, United States, and New Zealand (Fig. 2D).

Lastly, country-specific factors that may be correlated with online interest in diabetes were checked. The percentage of individuals using the internet was positively correlated with online interest in “type 1 diabetes” ($p < 0.001$), “type 2 diabetes” ($p = 0.005$), and “gestational diabetes” ($p = 0.017$). The number of physicians in a country was also positively correlated with online interest in “gestational diabetes” ($p < 0.0001$). On the other hand, diabetes prevalence was negatively correlated with online interest in “type 2 diabetes” ($p = 0.033$). The percentage of individuals using the internet and GDP were also negatively correlated with global online interest in “diabetes” (Table 3).

4. Discussion

The results of this study showed an increasing global online interest in diabetes during the last decade. It also increased significantly during the pandemic. This finding is similar to the results of other studies which showed an increase in global online interest and health-seeking behavior during the COVID-19 pandemic (Leochico and Espiritu, 2021; Paguio et al., 2020). Due to the COVID-19 pandemic, most of the hospitals had to decrease their hospital operations at less than 50% capacity (Hartnett et al., 2020). They had to decrease their elective surgery and other noncritical medical services so they can allocate their resources to treating COVID-19 patients. There was also a significant decrease in hospital admissions and healthcare utilization for other illnesses that are not caused by COVID-19 infection due to the imposed travel restrictions and the fear of getting infected with COVID-19 in the clinics and hospitals (Birkmeyer et al., 2020; Saah et al., 2021). This may have contributed to the increased global online interest to seek information regarding diabetes during pandemic.

This study also showed that the percentage of individuals using the internet was positively correlated with online interest in diabetes. Access to technological devices and the internet were shown to be associated with more health-related information-seeking behavior on the internet (Guo et al., 2021; H.Y. Lee et al., 2021). While the internet access continues to grow worldwide, there are still poorer nations with low access to internet (Poushter, 2016). This exacerbates the disparity in health and healthcare during this pandemic. This is also one of the reasons why the top countries where the search terms for diabetes were most popular were mostly developed countries such as Australia, Ireland, Norway, Sweden, United Kingdom, and United States. This study highlights the need to improve access to internet and online health information in developing countries. Closing the digital gap may help in enhancing the health seeking behavior and health-related decision making especially during this pandemic (Benigeri and Pluye, 2003; Friis et al., 2016).

Only few developing countries were included in the top countries with the highest online interest in diabetes. Several studies have shown that internet search patterns may serve as a gauge for population health interest and health-seeking behavior (Dey et al., 2020; Ginsberg et al., 2009; Jellison et al., 2018). This low interest in seeking online information regarding diabetes can be due to the lack of access or poor connectivity to the internet and the lower socioeconomic status of patients in developing countries (Nouhjah and Jahanfar, 2020; Scott et al., 2020). This is problematic because the prevalence of diabetes has been rising more rapidly in developing countries compared to developed countries. The COVID-19 pandemic also posed several challenges in the management of diabetic patients in developing countries. The pandemic resulted in fewer number of hospital visits due to the recommendations on social isolation and travel restrictions, loss of the traditional method of communication with the patient, impaired routine diabetic care, and absences of telehealth services. Previous studies have shown that the pandemic resulted in poor glycemic control and increasing incidence of diabetes complications (Elhenawy and Eltonbary, 2021; Kshanti et al., 2021; Önmez et al., 2020).

In general, there was a significant increase in the global SVI for all types of diabetes during the pandemic compared to the year before the pandemic started. This increased global interest in diabetes should be maximized by medical doctors and public health

Table 1

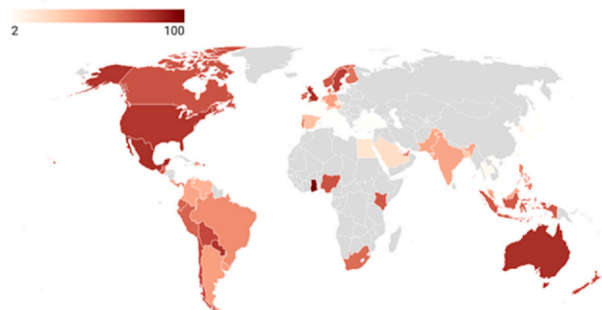
Comparison of search volume indices for diabetes search terms in 2019 (before the pandemic) vs 2020 (during the pandemic).

Search Term	Average Annual SVI		p-value	
	Pre-pandemic (2010–2019)	2019		2020
diabetes	79.53 ± 3.02	77.56 ± 5.66	87.58 ± 5.43	<0.0001
type 1 diabetes	9.72 ± 0.66	10.33 ± 1.06	11.48 ± 0.90	<0.0001
type 2 diabetes	17.32 ± 1.11	18.44 ± 1.47	21.27 ± 1.47	<0.0001
gestational diabetes	2.68 ± 0.20	2.64 ± 0.49	2.94 ± 0.24	0.0002

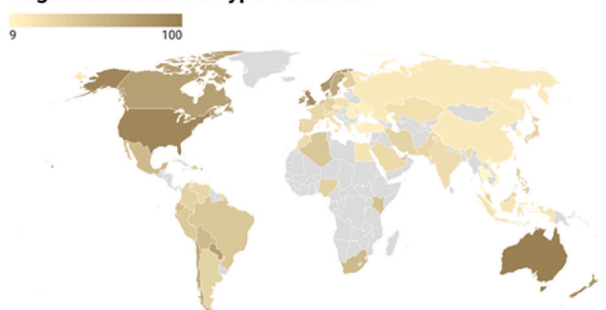
Table 2
Top associated search terms also used by people searching for “diabetes” (2010–2020).

Search Query	Search Volume Index
diabetes type 2	100
symptoms diabetes	98
diabetes type 1	69
la diabetes	64
diabetes mellitus	64
gestational diabetes	49
sugar diabetes	47
symptoms of diabetes	47
what is diabetes	44
diabetes diet	35
insulin	29
diabetes test	28
diabetes sintomas	28
diabetes signs	28
diabetes insulin	26
signs of diabetes	23
diabetes tipo 2	22
diabetes causes	21
diabetes treatment	20
diabetes insipidus	19

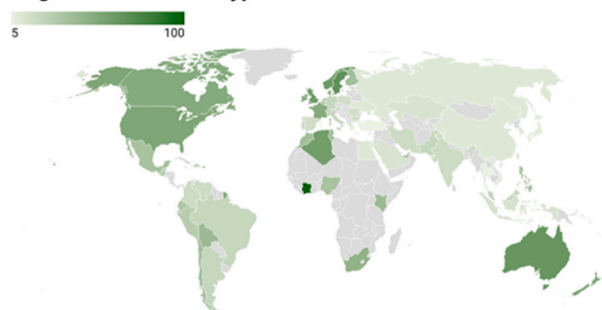
Regional interest for Diabetes



Regional interest for type 1 diabetes



Regional interest for type 2 diabetes



Regional interest for gestational diabetes

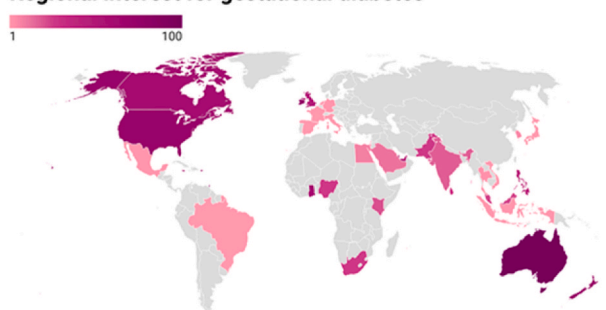


Fig. 2. Search frequencies for “diabetes” (A), “type 1 diabetes” (B), “type 2 diabetes” (C), and “gestational diabetes” (D) by country in the year 2010–2020. The color intensity represents the percentage of searches for the leading search term in a particular region. Search term popularity is relative to the total number of Google searches performed at a specific time, in a specific location. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

officials for health promotion and education. A lot of diabetes patients still prefer using the internet to find answers to general diabetes health questions. Previous studies also showed that internet-delivered diabetes education provided easier access to information for many individuals with diabetes (Pereira et al., 2014; Wilson, 2013). Self-management education on the internet also helped in controlling the blood sugar levels, weight, and blood pressure of patients with diabetes (Rasoul et al., 2019). The availability of reliable

Table 3

Correlations between SVIs for diabetes search terms and country specific characteristics (i.e., diabetes prevalence, internet usage, number of physicians, and GDP).

Country-specific characteristics	Search Terms	r	p-value
Diabetes prevalence	"diabetes"	0.229	0.155
	"type 1 diabetes"	−0.096	0.555
	"type 2 diabetes"	−0.337	0.033
Individuals using the Internet (% of population)	"gestational diabetes"	0.134	0.561
	"diabetes"	−0.512	<0.001
	"type 1 diabetes"	0.589	<0.001
Physicians (per 1000 people)	"type 2 diabetes"	0.434	0.005
	"gestational diabetes"	0.516	0.017
	"diabetes"	−0.176	0.279
GDP (current US\$)	"type 1 diabetes"	0.146	0.368
	"type 2 diabetes"	0.171	0.29
	"gestational diabetes"	0.754	<0.0001
	"diabetes"	−0.327	0.039
	"type 1 diabetes"	0.392	0.012
	"type 2 diabetes"	0.246	0.126
	"gestational diabetes"	0.268	0.24

health information online can help in the management of diabetes patients during this pandemic especially those patients who are afraid to go to the clinics and hospital for health consultation due to the fear of contracting COVID-19.

This study has several limitations: 1) The use of SVI from Google Trends only serve as a proxy for population interest for diabetes. The data obtained from this study did not capture the diabetes internet searches from those who used other search engines and those who do not have access to internet. However, the analysis of web-based activity is considered as a valid indicator of public health information seeking behavior. 2) The study only used four search terms related to diabetes, however, these search terms cover all types of diabetes. 3) This study was limited from 2010 until 2020. Despite these limitations, this study still provided an analysis of global online interest in diabetes before and during the pandemic. It also showed country-specific factors such as percentage of individuals using the internet and the number of physicians in a country are associated with online interest in diabetes.

5. Conclusion

This study showed a steady increase in global online interest in diabetes during the last decade. SVI for all the diabetes search terms included in this study increased from 2019 (before the pandemic) to 2020 (during the pandemic). People searching for the term "diabetes" also searched for the different types of diabetes, causes, signs and symptoms, diagnostic tests, and treatments for diabetes. The online interest in diabetes was positively correlated with percentage of individuals using the internet and the number of physicians in a country. This increased global interest in diabetes should be maximized by medical doctors and public health officials in providing evidence-based information regarding prevention and control of diabetes in the internet. This may help in increasing the awareness and knowledge of the public regarding diabetes especially during this pandemic season.

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Declaration of competing interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Declaration of competing interest

The author states no conflicts of interest regarding this study.

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