Burden of neurological diseases in the Philippines as revealed by web searches: an infodemiological study

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Research Article

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Abstract

Background

Due to the real time acquisition of big data from the internet, analysis of Google queries is now recognized as a valuable tool to explore and predict human behavior and interests. It has been suggested that online data can be correlated with actual health data. Although the data is not structured nor systematic, the huge data from search engines can easily identify frequencies and trends on diseases and other health concepts from a population perspective. Moreover, internet data with the use of web search advertising nowadays may not only reveal the interest of the general population but also the interests of healthcare industry as reflected by the bid prices in search terms for medications.

Objectives

In this study, we aimed to analyze the searches related to neurological diseases and nervous system drugs in the Philippines. We analyzed the monthly search volumes from Google, the most commonly used search engine in the country, and the bid prices in the web search advertising to infer the interests of the general population and the healthcare industry respectively.

Methods

Data used in this study was obtained from the Google Ads Application Programming Interface (API). This study evaluated the population's interest in neurological disorders by using the search volumes related to neurology, either disease diagnosis or medications, as this can be a good proxy for the interest of the general population. Bid values generated in API was used as a proxy for the interests of the healthcare industry.

Results

Among the neurologic diseases listed, the most searched were attention deficit hyperactivity disorder (ADHD), migraine, and Alzheimer's disease. ADHD has been one of the most popular health-related hashtag in social media, hence making it the most searched neurologic disease despite not being in the most prevalent diseases in the 2019 global burden of neurological disorders.

The most commonly searched drugs were medications for secondary stroke prevention such as oral antihypertensives (amlodipine, losartan, carvedilol), lipid-lowering agents (atorvastatin, simvastatin, rosuvastatin), and antiplatelets (acetylsalicylic acid, clopidogrel). Other most searched drugs were analgesics such as acetaminophen, tramadol, diclofenac, and morphine.

Conclusion

Web searches may reflect the interest of the general population and the healthcare industry and may be influenced by the frequency or social impact of the disease.
Introduction

Neurological disorders are the foremost cause of disability and second leading cause of death globally [1]. Increasing burden of deaths and disability caused by neurological disorders is now recognized as a global public health challenge, with the greatest burden in low-income and middle-income countries [1]. In 2019, the disability-adjusted life-years (DALY) of neurological disorders were 64.6 million in South-East Asia and 85.0 million in western Pacific regions, with the highest DALYs observed for stroke and Alzheimer's disease and other dementia [2]. In the Philippines however, there is no available data on the prevalence of neurological diseases in the country.

Due to the real time acquisition of fast and big data from the internet, analysis of Google queries is now recognized as a valuable tool to explore and predict human behavior and interests hence thought to be useful in health information [3]. It has been suggested that online data can be correlated with actual health data [3]. With the use of the internet and infodemiological studies, distribution and tracking of health information in a population can now be measured [4]. This may lead to reliable and meaningful indicators to track health information supply and demand [4]. Although the data is not structured nor systematic, the huge data from search engines can easily identify frequencies and trends on diseases and other health concepts from a population perspective [5–8]. Patients with neurological diseases are some of the most active in the internet and many of them utilize digital healthcare [9], likely due to the disability incurred from their neurological condition which limits their mobility. Moreover, internet data with the use of web search advertising nowadays may not only reveal the interest of the general population but also the interests of healthcare industry as reflected by the bid prices in search terms for medications.

In this study, we aimed to analyze the searches related to neurological diseases and nervous system drugs in the Philippines. We analyzed the monthly search volumes from Google, the most commonly used search engine in the country [10], and the bid prices in the web search advertising to infer the interests of the general population and the healthcare industry respectively.

Methods

Web Searches

All data in this study was obtained from Google Ads Application Programming Interface (API). The aggregate data from July 2021 to June 2022, longest time duration allowed by the API, was obtained. Due to the lack of formal Filipino translation of neurological diseases [11] and more frequent use of English terms in the Philippine hospital setting, only searches done in English were analyzed.

Databases

This study used the list of diseases from the National Institute of Neurological Disorders and Stroke, which provided a list of 448 neurological diseases. Common disease abbreviations were added in the list
to enrich the search. In addition, this study listed the drugs used for neurological disorders from the 2019 Philippine National Formulary, including generic and brand names, leading to a list of 463 drugs. Search volumes of brand name drugs were aggregated with their generic drug counterpart.

**Analysis**

This study evaluated the population's interest in neurological disorders by using the search volumes related to neurology, either disease diagnosis or medications. Frequency or search volume of a query can be a good proxy for the interest of the general population, specifically internet users. Similarly, real-time bids for web queries by advertisers may evaluate the interests of healthcare industry. In search advertising, an auction is performed for each query, where for each click from an internet user the advertiser pays for what the next advertiser is willing to pay [9]. Therefore, the bid values generated in API is a good proxy for the interests of the healthcare industry (advertiser). The total market value for a query is called spend and is equivalent to query volume multiplied by the bid [9]. For this study, the standard advertising API of Google that is restricted to Philippine market was used to evaluate the interests of the healthcare industry in the country.

**Results**

**Frequency of neurological diseases in web searches**

The interest of internet users in neurological diseases was evaluated using the search volume of terms related to neurological diseases (full name or common abbreviations) in Google. Among the neurologic diseases listed, the most searched were attention deficit hyperactivity disorder (ADHD), migraine, and Alzheimer's disease (see Fig. 1).

In the 2019 global burden of neurological disorders, ADHD was not included in the most prevalent neurologic disorders. However, in this study, ADHD was noted to be the most searched among the neurologic diseases. Tourette syndrome, which is also not part of the common neurologic disorders worldwide, was also seen to be one with high search volume.

Although belonging to the Top 20 most searched diseases, stroke, the most prevalent neurologic disease, [1] surprisingly did not have the highest search volume. Migraine, Alzheimer's disease, Parkinson's disease, multiple sclerosis, and meningitis were noted to be both seen with high search volume and were in the most prevalent neurologic diseases in the 2019 global burden of neurologic diseases [1].

The average bids were also analyzed for the neurologic diseases, which showed highest bid for dyslexia, Alzheimer's disease, and meningitis (see Fig. 1).

**Frequency of central nervous system (CNS) drugs searches**

The most commonly searched drugs were medications for secondary stroke prevention such as oral antihypertensives (amlodipine, losartan, carvedilol), lipid-lowering agents (atorvastatin, simvastatin,
rosuvastatin), and antiplatelets (acetylsalicylic acid, clopidogrel) (see Fig. 2). The other most searched drugs were analgesics such as acetaminophen, tramadol, diclofenac, and morphine.

Average bids were seen to be high for medications that are usually maintained for stroke patients such as amlodipine, acetylsalicylic acid, and simvastatin. Among the analgesics, drugs with highest bids are over-the-counter medications like acetaminophen and diclofenac.

Although the search volumes of migraine, Alzheimer's disease, Parkinson's disease, multiple sclerosis were noted to be high, medications for these diseases were not the most searched drugs nor found to have bids.

**Market analysis based in web searches**

The relation between query volume and query bid (value per click) was analyzed. Migraine, brain aneurysm, and dyslexia were ranked high in both dimensions (see Fig. 3). “AD”, which is an abbreviation for Alzheimer's disease, was also noted to have ranked high. However, “AD” may also refer to “advertisement” hence this can be falsely high. Among those with high search volumes were diseases that are commonly diagnosed in younger population such as dyslexia, ADHD, and migraine. This was likely due to younger population using the internet more frequent [12]. For CNS drugs, acetaminophen and amlodipine ranked high in both dimensions (see Fig. 4).

**Discussion**

This study evaluated the interest of internet users in the Philippines on neurological diseases by analyzing the frequency of web searches in Google. Stroke, which was the most prevalent neurological disease [1], only had 27,100 average monthly searches. While ADHD, which was the most searched neurological disease, had an average monthly search of 110,000. This was likely because ADHD has been one of the most popular health-related hashtag in social media and awareness videos regarding it had been rampant in the internet, where some users seek diagnosis after watching some videos about it in different platforms [13]. This can also be noted with Tourette Syndrome, which is not a common neurological disease, but had an average monthly search of 40,500. Over the last few years, there has been marked increase in tic-like behaviors after consumption of videos on platforms such as TikTok or YouTube, that were mistakenly associated as Tourette Syndrome [14]. Therefore, findings in the average monthly searches of neurological diseases in this study was influenced not just by the prevalence of the diseases but also by social media trends, which raises awareness among the general population regarding these uncommon diseases. Other most commonly searched neurologic diseases were also among the most prevalent diseases worldwide such as migraine, Alzheimer's disease, aneurysm, Parkinson's disease, multiple sclerosis, and meningitis. Surprisingly, epilepsy, which is one of the prevalent neurological diseases, was not part of the most searched neurological disease. This may reflect as lack of awareness among the general population [15].
Among the medications, the most commonly searched were anti-hypertensives, analgesics, statins, and anti-thrombotics. Amlodipine (generic and brand names) had an average monthly search volume of 73,790. Other medications for secondary stroke prevention were also among the most searched, such as losartan, acetylsalicylic acid, atorvastatin, and clopidogrel. These medications are available for free in local health units as part of the Philippine government’s campaign on treating non-communicable diseases such as stroke [16]. The high search volume for these drugs possibly reflects the vast number of people taking the said medications as secondary stroke prevention or even for other non-communicable diseases that is not necessarily neurologic. Over-the-counter analgesics, such as acetaminophen and tramadol, also had high average monthly search volume.

Although neurological diseases such as Alzheimer’s diseases, Parkinson’s disease, and multiple sclerosis were seen to be one of the most searched, medications particular for said diseases such as immunosuppressants, cholinesterase inhibitors, N-methyl-D-aspartate receptor antagonist, dopamine agonists, monoamine oxidase B and catechol-O-methyl transferase inhibitors, however, were not found among the most searched drugs. This was likely because these are expensive drugs that are either not readily accessible nor locally available [17, 18], hence not very familiar to most internet users. This may also be reflective of the awareness of the general population regarding these diseases. However, those with poor-health-seeking behavior tend to self-diagnose instead (for example all dementias are attributed as Alzheimer’s disease), hence the high search volume of some neurological diseases but not the medications particular to it.

In comparison to the study done in a developed country, the most commonly searched neurological diseases in the United States (US) were almost the same as with this study, but unique to the US list were shingles, sleep apnea, amyotrophic lateral sclerosis (ALS), and Bell’s palsy [9]. Sleep apnea and ALS are diseases that would require extensive workup, which are not very accessible to Filipino patients. For medications, the more commonly searched in the US were opioid analgesics (such as oxycodone, morphine, and hydrocodone) and antiseizure medications (such as gabapentin, clonazepam, and topiramate).

Several limitations should be considered in the interpretation of this data. First, these web searches may have only covered the Filipino population with access to internet, which is 70% of the population, [12] and may not be considered representative of overall population interests. To our knowledge this was the first infodemiological study on burden of neurological diseases done in a developing country. Second, search strategies may differ between internet users due to use of abbreviations, synonyms, or colloquial expression. However in this study, only disease terms in English and their abbreviations were used for analysis due to the lack of Filipino translation of neurological diseases and the more frequent use of English terms in the Philippine hospital setting [11]. Lastly, this study only did analysis limited to a single year (due to restriction from the API). However, analysis may be performed on a yearly basis in order to reveal trends in the frequency or interest in neurological diseases.

**Conclusion**
ADHD, migraine, and Alzheimer's disease are the most searched neurologic diseases in the Philippines for the past year. This may reflect the prevalence of these diseases in the country, but this may also be highly influenced by social media trends in the internet such as awareness campaigns and videos. Medications used as secondary stroke prevention were the most searched medications. This may possibly reflect high number of people taking these drugs since these are medications that can also be used in other non-communicable diseases. Web searches may reflect the interest of the internet users and the healthcare industry and can be influenced by social impact of the disease.

**Abbreviations**

ADHD: Attention deficit hyperactivity disorder

API: Application Programming Interface

DALY: disability-adjusted life-years

**Declarations**

**Ethical Approval**

Not applicable.

**Competing interests**

The authors declare that they have no competing interests.

**Ethical considerations**

Not applicable.

**Authors’ contributions**

AHDA and ADAOA contributed to acquisition, analysis, drafted and critically revised the manuscript. ADAOA and RDGJ contributed to the conception and design, drafted and critically revised the manuscript. All authors gave their final approval and agree to be accountable for all aspects of the work. All authors read and approved the final manuscript.

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**Availability of data and materials**
The data sets generated and/or analyzed during the current study are not publicly available but are available from the corresponding author on reasonable request.

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Figures

**Figure 1**

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Figure 2

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Figure 3

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Figure 4

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