

Research Article

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In search of the world's most popular painkiller: An infodemiological analysis of Google Trend statistics from 2004 to 2023

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Abstract: Analgesics are among the most frequently used drugs, but the analysis of their popularity is a tremendous challenge for the methods of classical epidemiology, hence the development of complementary infodemiological tools. Google Trends data from the years 2004 to 2023 was obtained in order to explore global interest in painkillers. Special attention was paid to time trends and geographical patterns related to their popularity. Globally, Google users most frequently searched for information regarding “Acetaminophen” (2.00 [times more frequently than “Aspirin”]), followed by “Ibuprofen” (1.68), “Aspirin” (1.00), “Diclofenac” (0.86), and “Tramadol” (0.74). Interest in all analysed drugs fluctuated seasonally but overall increased over time, with the greatest rise for non-opioid analgesics. The popularity of painkillers was dependent on the geographical region: non-opioid drugs were most searched in Latin America, while opioid analgesics in Northern European and English-speaking countries.

Keywords: Internet, analgesic, epidemiology, pain, acetaminophen, ibuprofen

1 Introduction

Analgesics, commonly known as painkillers, constitute one of the most frequently used groups of drugs worldwide [1]. Though the general public considers them relatively safe [2,3], even over-the-counter painkillers pose a substantial risk of side effects [4], and many prescribed analgesics are associated with the danger of abuse [5]. As a result, monitoring their popularity is of immense importance for

public health. Since the methods of classical epidemiology utilized for this purpose are expensive, time-consuming, and supply data sets of limited size, much research has been devoted to the development of alternative tools.

Infodemiology is centred around the idea of harnessing information from digital media to address public health problems [6]. As a discipline complementary to classical epidemiology, it takes advantage of the fast acquisition of real-time data from web-based sources, most popular of which include X (formerly known as Twitter), Facebook, Wikipedia, and Google Trends (GT) [7]. Over the past decade, infodemiology has been widely used to study pain [8], infectious diseases [9], malignancies [10], addictions [11], depression [12], and chronic diseases [13], but applications in the field of pharmacoepidemiology have also emerged.

Indeed, GT has recently been utilized to analyse the interest in anti-rheumatic [14], anti-diabetic [15], and prostate cancer drugs [16], among others. However, no study has applied infodemiological methods to investigate the global popularity of analgesics. Because such a study would expand the knowledge on Google searches of common painkillers, it could prove highly useful for both public health researchers and health care providers. Therefore, this work aims to explore Google users' interest in analgesics, along with underlying time trends and geographical patterns.

2 Methods

2.1 GT

GT is an open-source web tool that provides an unbiased sample of Google search data for a given query [17]. It accepts queries in the form of search terms, i.e. words literally typed by the searcher, or topics. The latter include synonyms and related searches in all available languages. The data is accessible from January 2004 and supplied as relative search volume (RSV). RSV is a measure of search volume adjusted to the total number of searches. It is

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scaled on a range of 0–100, with RSV = 100 reflecting the maximum search interest for the given geographical area and time period. GT enables simultaneous comparison of up to five queries [18].

2.2 Data gathering

The methodological framework of this work was inspired by a similar study on queries related to pain [8]. The preliminary list of commonly used analgesic drugs was created based on the author's expertise and general clinical knowledge. The search took place on 15 November 2024, with a timeframe set at 1 January 2004–31 December 2023 to cover the full 20 years. All chosen drugs were typed as topics and their mean RSV compared to “Aspirin” (as shown in Table S1). The ten most popular painkillers were then qualified for further in-depth analysis. Two data sets were collected for each of them. First, adjusted data was obtained by comparing the chosen topic to “Aspirin.” Second, non-adjusted data was gathered by typing all topics separately. In both cases, data was collected over time and by region. A modified checklist by Nuti et al. was utilized to present a more detailed description of the search inputs (Table S2) [18].

2.3 Statistical analysis

In the case of adjusted data gathered over time, GT assigned RSV = 100 to the highest monthly popularity of one of the compared topics. This data was used to calculate the mean

relative popularity of analgesics with reference to “Aspirin.” For the topic “Aspirin” itself, this value was equal to 1.00.

The non-adjusted data over time was suitable for time-series analysis. Here, RSV = 100 refers to the highest monthly interest in each topic. At the beginning of time series analysis, a seasonal Kendall–Mann test was performed in R 4.4.1 Kendall package version 2.2.1 to account for potential secular trends in the data [19]. If a significant ($p < 0.05$) trend was detected, a linear model was fitted to estimate the annual changes in the popularity of a particular topic. For each of them, a slope was calculated, which represents the mean yearly increase in interest. In addition, locally estimated scatterplot smoothing (LOESS) analysis was performed using the forecast package version 8.23.0 of R to decompose the time series into trend, seasonal, and irregular components. Here, the trend component indicates the long-term progression of the series, while the seasonal component captures periodic fluctuations within the time series. Irregular component represents the residuals that remain after the other components are excluded, reflecting random influences. Each of these time-series components is expressed in the same units as the original series: RSV (y-axis) over time (x-axis) [20,21].

The adjusted data by region represents the relative popularity of the given painkiller compared to “Aspirin” in a specific country, excluding countries with low search volumes. In each country, the sum of RSVs of both drugs equals 100. To allow for direct between-regions comparisons, the data was normalized after collection so that the relative popularity of “Aspirin” is 1.00 in all countries. This methodology made it possible to determine which analgesics were most popular in different countries.

In the case of non-adjusted data by region, RSV = 100 corresponds to the country with the highest popularity of a particular drug, with low search volume countries excluded

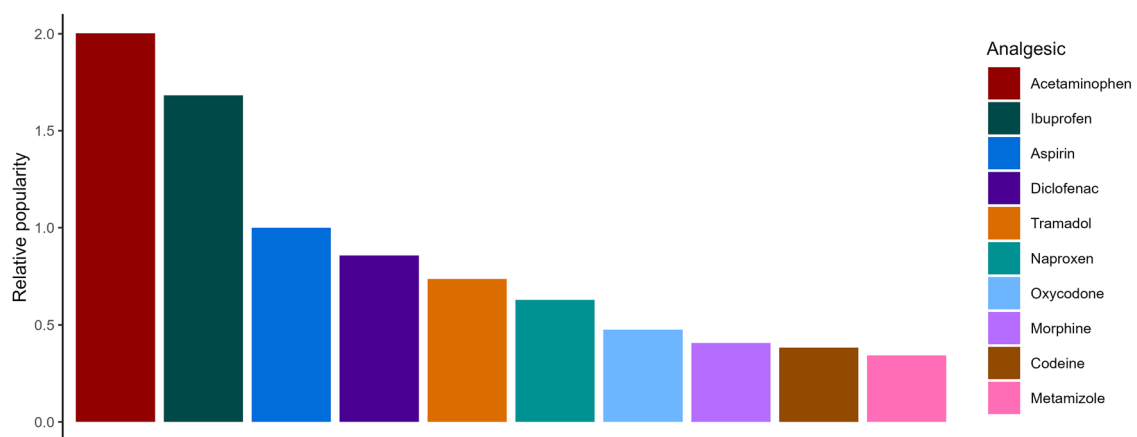


Figure 1: Relative popularity of the ten most popular analgesics in relation to “Aspirin.” Calculated from adjusted RSV data.

from analysis. Such data was used to determine in which countries there was the greatest interest in each painkiller.

3 Results

3.1 Global ranking of analgesics

On a global scale, Google users most frequently searched for information regarding “Acetaminophen” (2.00), followed by nonsteroidal anti-inflammatory drugs (NSAIDs) such as “Ibuprofen” (1.68), “Aspirin” (1.00), and “Diclofenac” (0.86). The most popular opioid analgesic, “Tramadol” (0.74), was classified fifth in terms of prevalence. Relative popularity of the ten most frequently searched drugs is visualized in Figure 1.

3.2 Time trends

A significant upward trend in RSV was observed for all analgesics tested. The increase in popularity calculated from the linear model was the highest for “Metamizole” (3.862 RSV/year) and the lowest for “Oxycodone” (0.339 RSV/year). The time trends for each drug are outlined in Figure 2.

Interest in all analysed topics fluctuated monthly (Table 1). Based on LOESS analysis, “Codeine” had the highest annual amplitude of 12.21 RSV, with the most searches in January (+6.78 RSV) and the least searches in August (−5.43 RSV) (Figure 3). Similarly, “Acetaminophen” (annual amplitude of 5.14 RSV), “Ibuprofen” (4.67 RSV), and “Aspirin” (8.82 RSV) were the most searched in March, but their popularity

plummeted in the summer months. A noteworthy annual amplitude was also recorded for “Morphine” (6.57 RSV).

3.3 Regional patterns

Of 250 regions recognized by GT, 166 were characterized by low search volume and thus excluded from analysis. “Acetaminophen” emerged as the most searched analgesic in 56 countries, including North American and Eastern European ones. “Ibuprofen” was most popular in 24 countries, the majority of which lie in South Asia and Africa. RSVs for “Acetaminophen” and “Ibuprofen” were equal in two European countries – Poland and the Czech Republic. “Aspirin” was the most frequently searched painkiller in China and Hungary. The summary of the gathered data is outlined in Figure 4.

Five countries with the highest interest in each drug (i.e. countries with the highest worldwide RSVs for a given drug) were identified for each analgesic (Table 2). “Acetaminophen” and NSAIDs were most frequently searched in Latin American countries. Except for “Tramadol,” interest in opioid drugs was greatest in Western countries.

4 Discussion

4.1 Global ranking of analgesics

To the author’s knowledge, the global interest in analgesic drugs has not been described to date. GT data suggests that

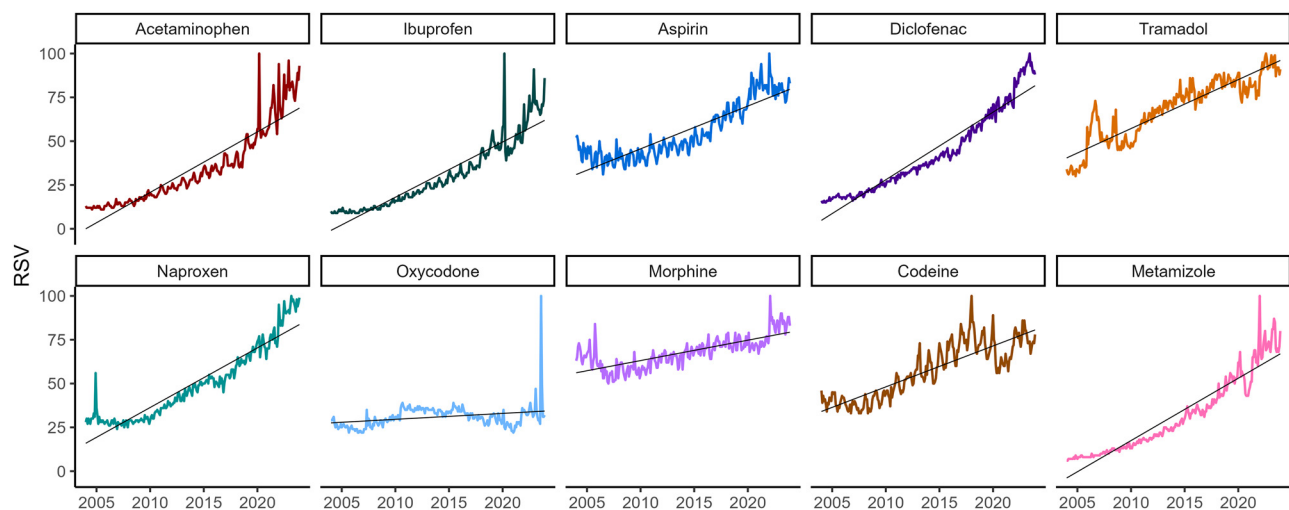


Figure 2: Time trends for non-adjusted RSV data for the ten most popular analgesics. Black lines represent linear models fitted to the data.

Table 1: Time-series analysis of non-adjusted data for the ten most popular analgesics

Analgesic	Tau from the seasonal Mann–Kendall test	Slope [RSV/year]	Month with the highest seasonal component; value [RSV]	Month with the lowest seasonal component; value [RSV]	Annual amplitude [RSV]
Acetaminophen	0.97***	3.46	March; 3.02	August; −2.12	5.14
Ibuprofen	0.96***	3.16	March; 3.01	June; −1.66	4.67
Aspirin	0.79***	2.45	March; 3.80	July; −5.02	8.82
Diclofenac	0.98***	3.86	August; 0.98	December; −2.41	3.39
Tramadol	0.79***	2.79	August; 1.96	November; −1.54	3.50
Naproxen	0.90***	3.40	July; 1.30	November; −1.97	3.27
Oxycodone	0.21***	0.34	August; 3.58	November; −1.17	4.75
Morphine	0.67***	1.17	February; 2.68	August; −3.88	6.57
Codeine	0.74***	2.35	January; 6.78	August; −5.43	12.21
Metamizole	0.97***	3.56	March; 1.43	September; −1.12	2.55

A Kendall–Mann test was performed to detect potential secular trends in the data, and the slope was calculated using linear regression to assess the annual change in interest in each drug. LOESS analysis allowed the identification of months in which the interest in analgesics was the highest and the lowest, and the determination of its annual amplitude.

*** $p < 0.001$.

acetaminophen is the most searched painkiller worldwide. Indeed, it remains one of the most popular over-the-counter medications [22,23], used both as an analgesic and antipyretic agent [24]. In the United States alone, about 43 million patients take it every week [25], and more than 5,000 are hospitalized due to overdose [26].

NSAIDs: ibuprofen, aspirin, diclofenac, and naproxen, were, respectively, classified second, third, fourth, and sixth in terms of prevalence in Google queries – an order that resembles their estimated global sales [27]. The relatively high interest in aspirin may be linked to the use of its low-dose forms in the prevention of atherosclerotic thrombosis [28], apart from historical and marketing reasons. In general, the popularity of NSAIDs seems to be natural, given their over-the-counter availability in many countries. Because NSAIDs are widely used to treat diverse types of pain, inflammatory diseases, and pyrexia, often as a form of self-medication [29,30], examination of their popularity with methods of classical epidemiology proves especially difficult.

Tramadol, oxycodone, morphine, and codeine are the four opioid analgesics most frequently searched by Google users. Despite that, their RSVs are still much lower than those of acetaminophen and most popular NSAIDs. This can be explained by greater control over the sale of opioids and their availability only by prescription in most countries [31]. On the contrary, the epidemic of opioid misuse and other factors related to opioid addiction might have increased their observed RSVs [32]. The global popularity of different opioid drugs has not yet been investigated in detail. One study noted that codeine, fentanyl, hydrocodone, hydromorphone, morphine, oxycodone, and tramadol are the most

available pharmaceutical opioids worldwide [33], which is consistent with the results of this work. While oxycodone is the most widely consumed opioid analgesic in high-income countries, tramadol and codeine keep the lead in middle- and low-income ones [34].

Metamizole was ranked the tenth most searched painkiller worldwide, a result that might seem surprising, as the drug is not approved in the United States, India, and some European countries due to concerns about its safety [35]. Nevertheless, there is a substantial interest in metamizole in other countries, mainly Latin American, which drives its global popularity.

4.2 Time trends

Google users' interest in analgesics, especially non-opioid ones, has been growing steadily over the past 20 years. This is in good agreement with similar upward trends observed in their worldwide consumption [36–39]. Regardless of this constant global growth, changes in the popularity of different drugs vary greatly between individual countries. For instance, the use of pharmaceutical opioids has increased in most regions, but decreases were noted in the United States, Canada, and Germany during the last decade [34]. Similarly, although the number of countries that have withdrawn metamizole is rising [40], the drug has grown popular in other countries [41]. Apart from purely pharmaceutical reasons, some factors accountable for the surge in popularity of the analysed painkillers may be associated with the expansion of the Internet. For example, a broader range of medical websites may encourage people to consult the Internet on drug-

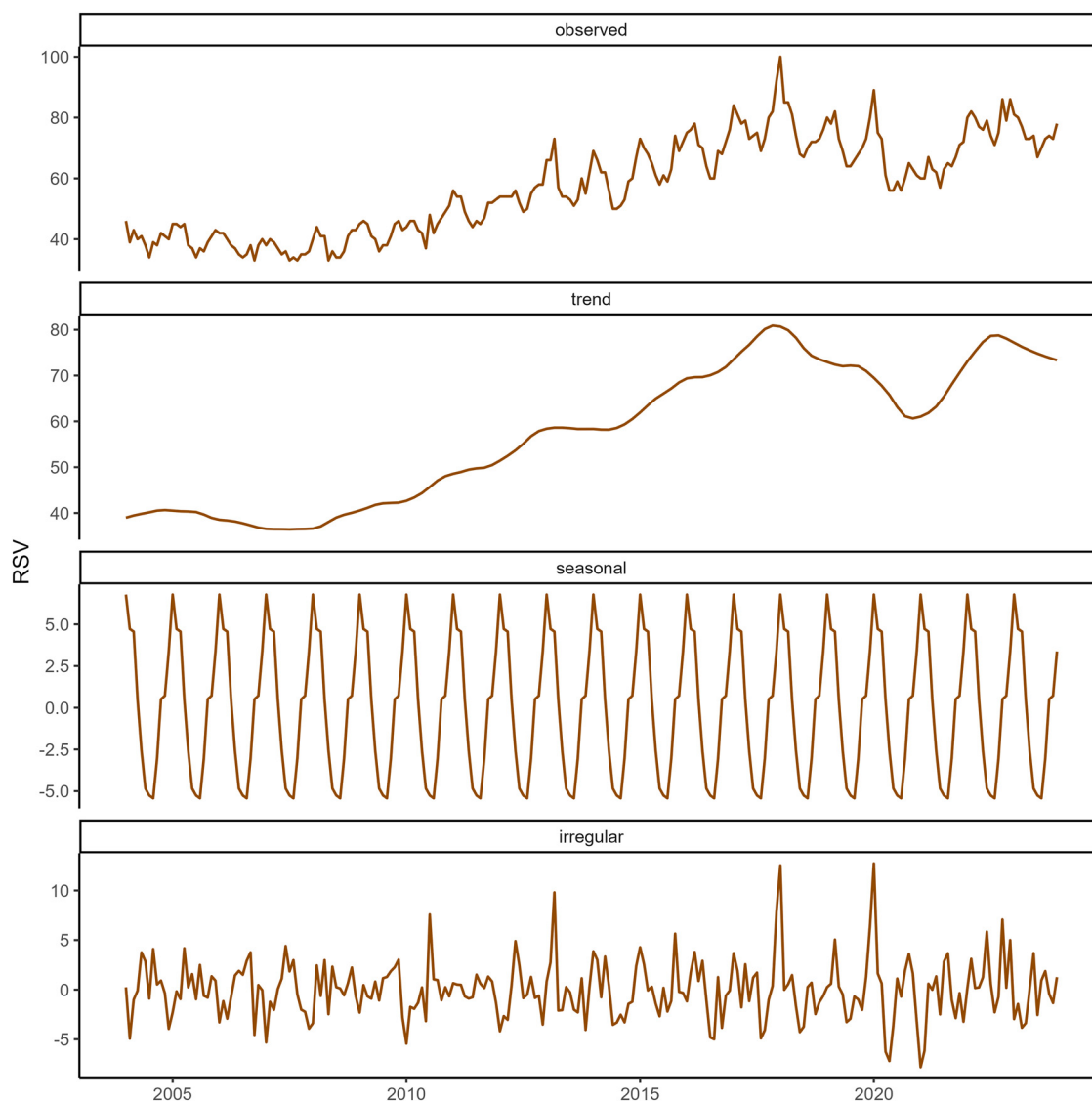


Figure 3: LOESS seasonal trend decomposition of non-adjusted RSV data for “Codeine.” The “observed” part shows RSV of “Codeine” over time, the “trend” part presents the time trend, the “seasonal” part displays the seasonal component, and the “irregular” part accounts for the variability independent of the time trend and seasonal component.

related matters. In addition, easier access to the Web may allow previously digitally excluded seniors to search for information regarding health [42], thus driving interest in common painkillers. Such phenomena are of special importance in regions with poor availability of healthcare [8].

Interest in all analgesics was subject to regular seasonal fluctuations of varying degrees. Because the majority of Internet users live in the Northern Hemisphere, the observed fluctuations mainly reflect their population. Of the analysed drugs, codeine was characterized by the highest amplitude of popularity, being most searched in January and least in August. This comes naturally – aside from analgesia, codeine is used for cough suppression [43]; thus, its popularity may

rise during flu season and drop during summer months. Likewise, interest in acetaminophen, ibuprofen, and aspirin was also observed to decline during summer months, a fact that can be attributed to the extensive use of these drugs in the treatment of influenza and common cold [44].

Unusual peaks in the popularity of acetaminophen and ibuprofen were recorded in March 2020. This may be related to the outbreak of the Covid-19 pandemic, causing an increased demand for painkillers and NSAIDs. In fact, acetaminophen and ibuprofen were among the drugs most commonly used to self-treat Covid-19 [45]. Contrary to this hypothesis, there was no sudden increase in the popularity of aspirin, another NSAID used in Covid-19, in March 2020.

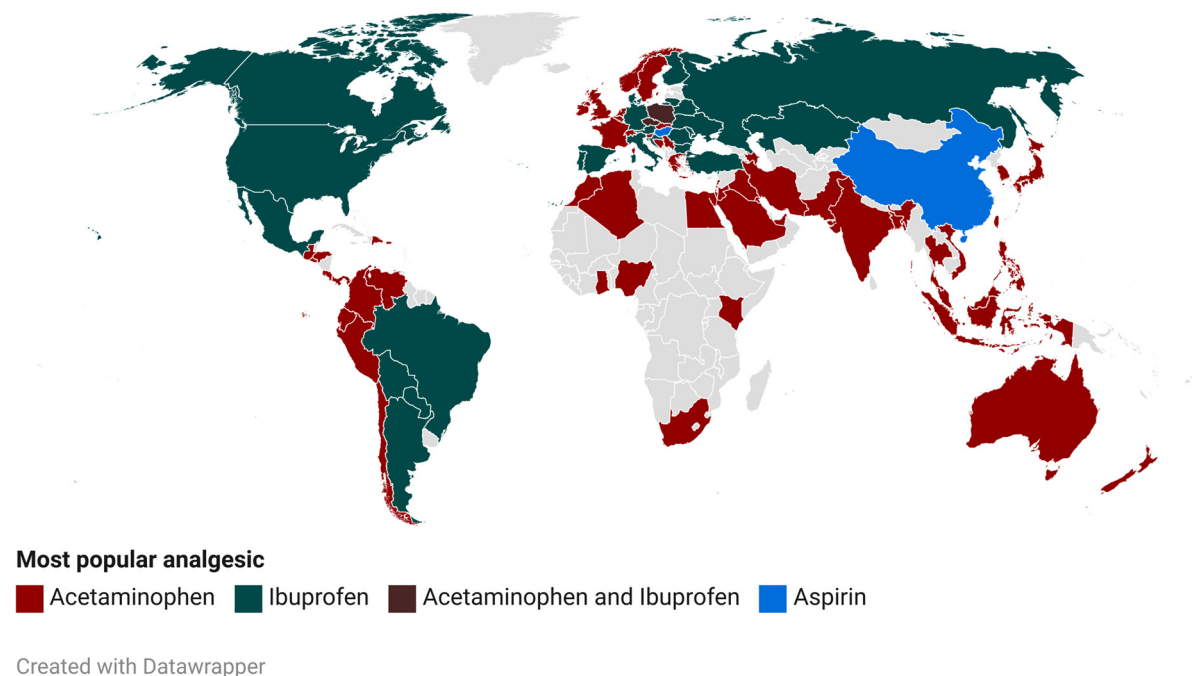


Figure 4: World map showing which analgesic is most popular in a given country based on adjusted RSV data.

4.3 Regional patterns

The geographic distribution of interest in painkillers has not been described until now. The results of the present study show that acetaminophen, metamizole, and NSAIDs were most searched in Latin America. Such a pattern may be linked to the low use of opioids [46], which has led to the enhanced popularity of alternative drugs in this region. In line with this hypothesis, the interest in opioids was highest in Northern European and English-speaking countries, where the consumption of opioids is greatest [34,39]. Still, the observed patterns may be influenced by historical, marketing, and legal factors, as well as be related to the availability of individual drugs and the organization of

national healthcare systems. Their in-depth analysis is beyond the scope of this work.

4.4 Limitations

This study has several limitations. First, the demographic distribution and health-seeking behaviours of populations utilizing Google vary across regions, as does the access to Google services. Differences regarding age, gender, education, or socioeconomic status may thus introduce bias into observed regional trends. For example, analgesics most commonly used by elderly patients may be underrepresented in certain regions, where such patients have less

Table 2: Non-adjusted RSVs of the five countries with the highest RSVs for a given analgesic

Analgesic	Five countries with the highest interest in a drug (RSV)
Acetaminophen	Mexico (100), Honduras (96), Peru (94), Lebanon (92), Guatemala (88)
Ibuprofen	Mexico (100), Moldova (79), Bolivia (67), Kazakhstan (67), Ukraine (65), Belarus (65)
Aspirin	Puerto Rico (100), Mexico (90), Bulgaria (73), Dominican (72), Iran (72)
Diclofenac	Panama (100), Honduras (92), Puerto Rico (87), Mexico (82), Costa Rica (81), Venezuela (81)
Tramadol	Puerto Rico (100), Mexico (84), Chile (80), Ghana (80), Norway (75)
Naproxen	Mexico (100), Iran (79), Peru (79), Puerto Rico (70), Colombia (69)
Oxycodone	United States (100), Sweden (79), Puerto Rico (69), Australia (64), Norway (61)
Morphine	Sweden (100), Iran (99), Denmark (98), New Zealand (95), Norway (93)
Codeine	New Zealand (100), United Kingdom (76), Australia (66), Paraguay (61), Ireland (52)
Metamizole	Cuba (100), Nicaragua (57), Brazil (53), Mexico (44), Paraguay (37)

access to the internet. Second, this study only included a limited number of drugs, so painkillers with high local but low global popularity may not have been included. Additionally, for less popular painkillers, media events strongly influence RSV and analyse more general trends difficult [47]. Finally, the internet popularity of drugs cannot be directly translated into their consumption. Most commonly used analgesics may be underrepresented in search data, as patients may either already be familiar with these medications or lack the incentive to seek additional information about them online. Likewise, more potent analgesics may be underrepresented because information concerning them may be more comprehensively conveyed by prescribing physicians, which reduces the likelihood that patients seek additional details on Google. While this study provides novel insight into global trends in analgesic use, its results should be further verified by real-world research based on methods of classical epidemiology.

5 Conclusions

To conclude, “Acetaminophen,” “Ibuprofen,” and “Aspirin” were the painkillers most searched by Google users. The interest in all analysed topics was subject to seasonal fluctuations, but overall increased over time, with the sharpest upward trend for non-opioid analgesics. The popularity of different drugs was also dependent on the geographical region. These findings may prove useful for health care providers, as well as spur further research in the field of pharmaceutical infodemiology.

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