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Epidemiological and socioeconomic factors may influence online searches for antibiotics

Fatores epidemiológicos e socioeconômicos podem influenciar as buscas online por antibióticos

Factores epidemiológicos y socioeconómicos pueden influir en las búsquedas en línea de antibióticos

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ABSTRACT

Objective: To identify the factors that influence internet searches for "antibiotic," using Brazil as a case study. **Methods:** This is a quantitative study based on Google Trends data (2018-2022) for the terms "antibiotics," "amoxicillin," "azithromycin," and "cephalexin." Spearman's correlation test was performed to evaluate the relationship between RSV, mortality, and HDI, with a significance level of 5%. Additionally, a descriptive data analysis was conducted. **Results:** The Northern and Northeastern regions showed the highest search volumes. Spearman's correlation test revealed a positive and significant correlation between RSV for "azithromycin" ($rs = 0.7887$; $p < 0.0001$) and "amoxicillin" ($rs = 0.7423$; $p < 0.001$) with respiratory disease mortality. A significant negative correlation was observed between HDI and RSV ($rs = -0.7223$; $p < 0.05$), indicating that states with lower HDI tend to have higher search volumes for antibiotics. **Conclusion:** Google Trends has proven to be a useful tool for monitoring antibiotic use and self-medication patterns, especially in regions with low HDI and precarious health services**.**

Keywords: Anti-infective agents, Self-medication, Digital public health.

RESUMO

Objetivo: Identificar os fatores que influenciam as buscas sobre "antibiótico" na internet, usando o Brasil como estudo de caso. **Métodos:** Trata-se de um estudo quantitativo baseado em dados do Google Trends (2018-2022) para os termos "antibióticos", "amoxicilina", "azitromicina" e "cefalexina". Foi realizado o teste de correlação de Spearman para avaliar a relação entre RSV, mortalidade e IDH, com um nível de significância de 5%. Além disso, foi realizada uma análise descritiva dos dados. **Resultados:** As regiões Norte e Nordeste apresentaram os maiores volumes de busca. O teste de correlação de Spearman revelou uma correlação positiva e significativa entre o RSV de "azitromicina" ($rs = 0.7887$; $p < 0.0001$) e "amoxicilina" ($rs = 0.7423$; $p < 0.001$) com a mortalidade por doenças respiratórias. Observou-se uma correlação negativa significativa

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entre o IDH e o RSV (rs = -0.7223; p < 0.05), indicando que estados com menor IDH tendem a ter maiores volumes de busca por antibióticos. **Conclusão:** O Google Trends mostrou-se uma ferramenta útil para monitorar o uso de antibióticos e padrões de automedicação, especialmente em regiões com baixo IDH e precariedade nos serviços de saúde. Esses dados podem auxiliar em estratégias de vigilância e educação em saúde pública no Brasil**.**

Palavras-chave: Antimicrobianos, Automedicação, Saúde pública digital.

RESUMEN

Objetivo: Identificar los factores que influyen en las búsquedas sobre "antibiótico" en internet, utilizando Brasil como estudio de caso. **Métodos:** Se trata de un estudio cuantitativo basado en datos de Google Trends (2018-2022) para los términos "antibióticos", "amoxicilina", "azitromicina" y "cefalexina". Se realizó la prueba de correlación de Spearman para evaluar la relación entre RSV, mortalidad e IDH, con un nivel de significancia del 5%. **Resultados:** Las regiones Norte y Nordeste mostraron los mayores volúmenes de búsqueda. La prueba de correlación de Spearman reveló una correlación positiva y significativa entre el RSV de "azitromicina" (rs = 0.7887; p < 0.0001) y "amoxicilina" (rs = 0.7423; p < 0.001) con la mortalidad por enfermedades respiratorias. Se observó una correlación negativa significativa entre el IDH y el RSV (rs = -0.7223; p < 0.05), lo que indica que los estados con menor IDH tienden a tener mayores volúmenes de búsqueda de antibióticos. **Conclusión:** Google Trends ha demostrado ser una herramienta útil para monitorear el uso de antibióticos y los patrones de automedicación, especialmente en regiones con bajo IDH y precariedad en los servicios de salud. Estos datos pueden ayudar en la formulación de estrategias de vigilancia y educación en salud pública.

Palabras clave: Antimicrobianos, Automedicação, Saúde pública digital

INTRODUCTION

Antibiotics are medicines used to control bacterial infections and can exhibit bactericidal or bacteriostatic activity (FERRER M, et al., 2017). Their use is crucial for patient treatment and health restoration. However, incorrect use through self-medication will result in the selection of resistant strains, directly affecting therapeutic protocols (SILVA JUNIOR JG, et al., 2018). Self-medication is the act of consuming medications without proper professional guidance, acquiring them without a medical prescription in pharmacies, and often following dosage information found on the internet (XAVIER MS, et al., 2021).

The information available regarding the use of antibiotics is not always accurate, yet public access and lack of verification contribute to misinformation and encourage self-medication (SANTOS RC, et al., 2019). This problem is exacerbated mainly in developing countries, as they have shortcomings in public health policies, resulting in long waits for consultations and treatment, making self-medication, without any knowledge, a solution for the low-income population (MALCHER CMSR, et al., 2022).

Monitoring of self-medication in Brazil, for example, is carried out through research in communities, physical and virtual, to study people's behavior and knowledge regarding antibiotic use (MALCHER CMSR, et al., 2022; NAVES JOS, et al., 2010). The data obtained from monitoring provide important information such as motivations for self-medication, contributing to the search for public strategies to address this issue in society (NAVES JOS, et al., 2010). Despite the goals set by the World Health Organization in the Global Action Plan against Antibiotic Resistance (2015), Brazil does not present health indicators related to self-medication, and the platforms for monitoring these indicators have limitations, such as data disaggregation (MARTINS ALJ, et al., 2022).

Pharmacovigilance plays a crucial role in monitoring the safety and efficacy of medications, especially in countries with unequal access to healthcare, such as Brazil. However, traditional pharmacovigilance methods, which rely heavily on the reporting of adverse events by healthcare professionals, face challenges such as underreporting, particularly in regions with limited medical infrastructure. In this context, the exploration of new

technological tools, such as Google Trends, becomes essential to complement traditional approaches. These tools allow for real-time monitoring of the population's behavior regarding medication use, identifying patterns of interest, such as increased searches for antibiotics during certain periods or in specific regions. Recent studies demonstrate that using these platforms can provide valuable insights to anticipate the misuse of medications and strengthen regulation, especially in areas with lower healthcare professional density (PULLAN S and DEY M, 2021). Thus, integrating these new technologies can increase the effectiveness of pharmacovigilance, making it more proactive and comprehensive, while also enhancing the responsiveness of health authorities.

Therefore, this study proposes to explore the potential of Google Trends for surveillance of a population's interest in antibiotic use, using Brazil as a case study, by analyzing the number of searches for the term "Antibiotic" (ARORA VS, et al., 2019).

METHODS

This research is characterized as a netnographic, qualitative, and quantitative study based on data available in the online tool Google Trends (https://trends.google.com.br/trends/), owned by Google Inc. (SOUSA AF, et al., 2021).

The Google Trends tool allows evaluating the parameter called Relative Search Volume (RSV), indicating the level of interest of Google platform users in a particular term. RSV values range from 0 (no interest in the term) to 100 (maximum quantifiable interest). It is a publicly available platform with an easy-to-understand interface (KAMIŃSKI M, et al., 2019).

The RSV data and main related topics were collected for the term "Antibiotics" from 2018 to 2022, covering all Brazilian states. Additionally, the three main antibiotics commonly associated with the searched term were identified: Amoxicillin, Azithromycin, and Cephalexin, which were also researched using their respective terms on Google Trends. Thus, data collection was conducted for the terms "Antibiotics," "Amoxicillin," "Azithromycin," and "Cephalexin." The raw data were obtained in a format readable in spreadsheet programs and subsequently organized into the following categories: 1) RSV values per month from 2018 to 2022; 2) RSV values by region of Brazil; 3) main topics related to the analyzed terms.

To assess whether RSV values could be influenced by an epidemiological factor, the number of deaths per month for the group "Respiratory Tract Diseases" and "Gastrointestinal Diseases" from 2018 to 2022 in Brazil were collected from the governmental platform TABNET/DATASUS (https://datasus.saude.gov.br/informacoes-de-saude-tabnet).

Furthermore, to evaluate the influence of socioeconomic factors, the Human Development Index (HDI) values of all Brazilian states were collected, available on the following link of the Brazilian government platform (http://www.atlasbrasil.org.br/ranking).

The RSV search values were transformed into monthly averages to optimize temporal analysis. Additionally, the mortality data for respiratory diseases reported by TABNET/DATASUS were also transformed into monthly averages to correlate with RSV data.

Thus, descriptive and inductive statistical analysis was conducted using the Bioestat version 5.3 program (SILVA ACS, et al., 2014). In the inductive analysis, the Spearman's Correlation test was performed to assess the influence of HDI and mortality rate on RSV data, considering a significance level of 5%. Spearman correlations (rs) were considered very strong when $rs > 0.7$, strong when $0.7 \geq rs > 5$, moderate when $0.5 \geq rs > 3$, and weak when $rs \leq 3$ (ROVETTA A, 2020).

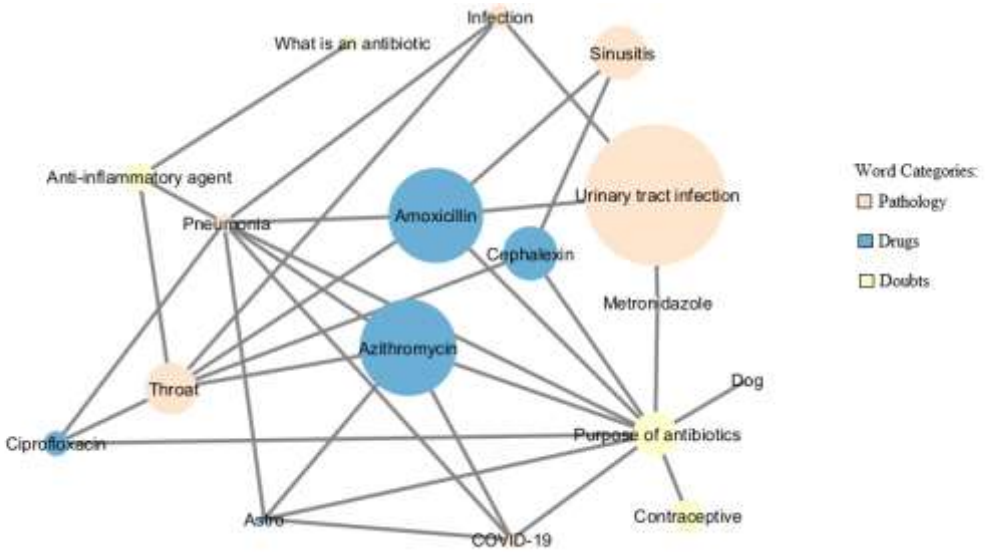
For the analysis of main related topics, the collected data were subjected to artificial intelligence using ChatGPT (Available: https://chat.openai.com/auth/login), requesting a list of possible connections between the topics counted during the study period. Subsequently, the presented connections were individually evaluated to verify if the established connection was related to the "antibiotic" theme. The established connections between topics were then represented through a Network graph, generated using the Cytoscape version 3.1 program (KOHL M, et al., 2011).

RESULTS AND DISCUSSION

The use of the Google Trends search tool contributes to understanding the interest in antibiotics, allowing the establishment of a relationship with time and geographical region, providing important insights into how the population relates to this group of drugs (ARORA VS, et al., 2019). Thus, it presents itself as an important health surveillance tool in Brazil.

The analysis of main related topics to the search indicated three categories: 1) Pathologies; 2) Medications; 3) Questions (**Figure 1**). The main associated pathologies are sinusitis (RSV=28), urinary tract infection (RSV=73), throat (RSV=27), and pneumonia (RSV=9). For questions, the search about "What is the purpose?" (RSV=59) stands out. Among medications, Azithromycin (RSV=50), Amoxicillin (RSV=49), and Cephalexin (RSV=28) are highlighted.

Figure 1 - The main topics associated with searches about the term "Antibiotic," obtained from Google Trends (2018-2022). The topics were categorized into three groups: Pathology (Beige); Drugs (Blue); and Doubts (Yellow).



Fonte: Favacho PHO, et al., 2025.

Factors influencing the observed search pattern were investigated. Spearman's test did not indicate a correlation between RSV values and mortality rates for respiratory and gastrointestinal diseases ($p<0.05$). From the analysis of the main related topics (**Figure 1**), three primary antibiotics related to the term "antibiotic" were identified: Azithromycin (**Figure 2A**), Amoxicillin (**Figure 2B**), and Cephalexin (**Figure 2C**). No significant correlation was found between the mortality rate of gastrointestinal diseases and the RSV of these antibiotics ($p<0.05$).

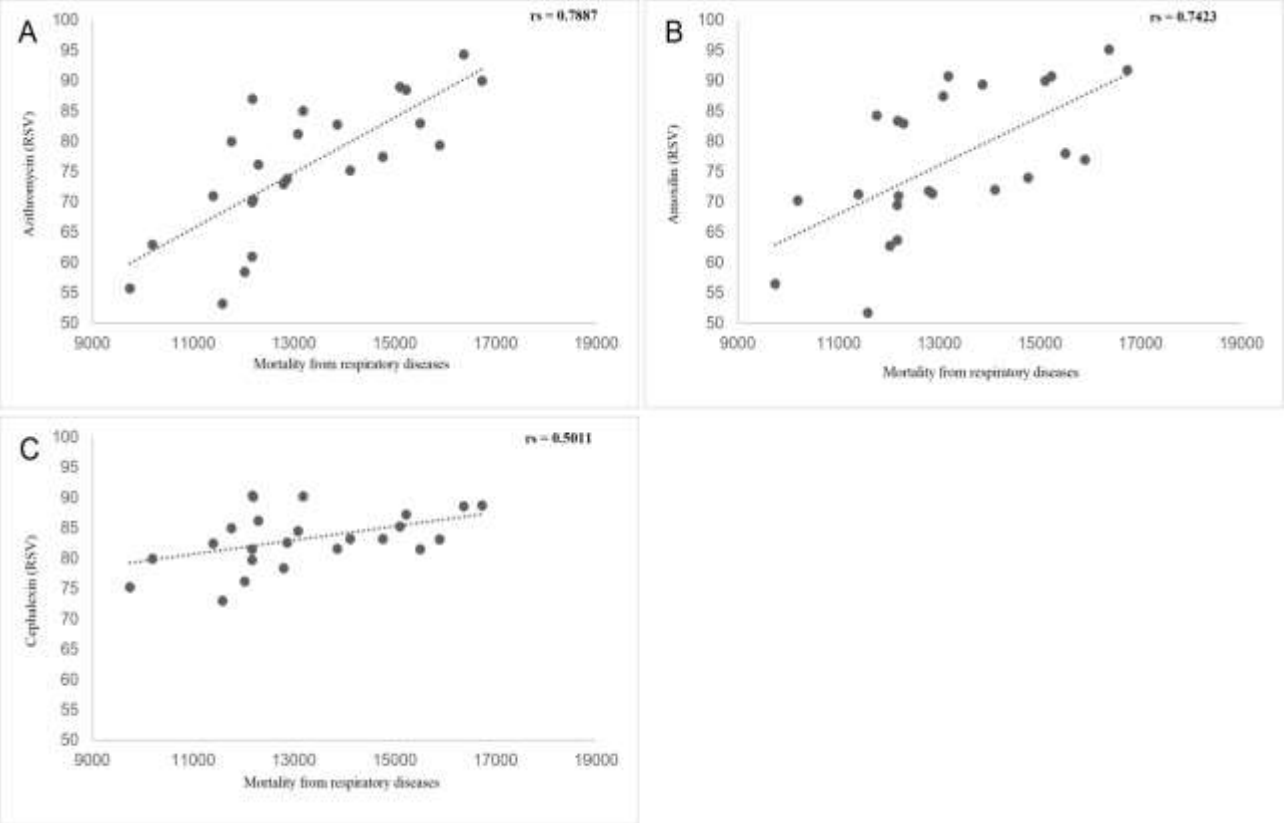
However, the correlation between antibiotics and respiratory diseases revealed significant associations ($p < 0.05$). These relationships indicate that an increase in searches for Azithromycin, Amoxicillin, and Cephalexin is associated with a significant and direct increase in mortality from respiratory diseases, with each showing a different strength of correlation. The search for Azithromycin (RSV) demonstrated a significantly positive and very strong correlation ($rs = 0.7887$; $p < 0.0001$) with mortality from respiratory diseases. Similarly, the search for Amoxicillin (RSV) also showed a positive and strong correlation ($rs = 0.7423$; $p < 0.001$).

However, the correlation between the search for Cephalexin (RSV) and mortality from respiratory diseases, although positive, was weaker than the previous correlations ($rs = 0.5011$; $p < 0.0126$). This suggests that

while an increase in searches for Cephalexin is associated with higher mortality from respiratory diseases, this relationship is less strong compared to Azithromycin and Amoxicillin.

Searches for the term "antibiotic" highlighted the frequency of these three antibiotics, which were then correlated with mortality rates from both respiratory and gastrointestinal diseases using Spearman's correlation analysis (**Figure 2**). For "respiratory diseases," as categorized by DATASUS, deaths from acute bacterial and viral infections, including pneumonia, asthma, and sinusitis, were considered.

Figure 2 - Spearman's Correlation between mortality rates for diseases provided by DATASUS and Relative Search Volume (RSV) on the term "Antibiotic," obtained from Google Trends, from 2018 to 2021. (A) Correlation between Azithromycin (RSV) and mortality from respiratory diseases; (B) Between amoxicillin (RSV) and mortality from respiratory diseases; (C) Between cephalexin (RSV) and mortality from respiratory diseases.



Fonte: Favacho PHO, et al., 2025.

In contrast, mortality from gastrointestinal diseases showed no correlation with antibiotic use, suggesting that concerns about this type of disease do not influence interest in antibiotics or self-medication. A study by Ewald TA, et al. (2021) further supports this, revealing a declining trend in mortality from gastrointestinal diseases across most age groups in Brazil, indicating less concern about these conditions (EWALD TA, et al., 2021). Consequently, the declining mortality rate may have influenced the lower number of searches for antibiotics. However, further research is necessary to investigate the potential for self-medication with antibiotics in gastrointestinal diseases, even in the absence of significant mortality (MENEZES AS, et al., 2021).

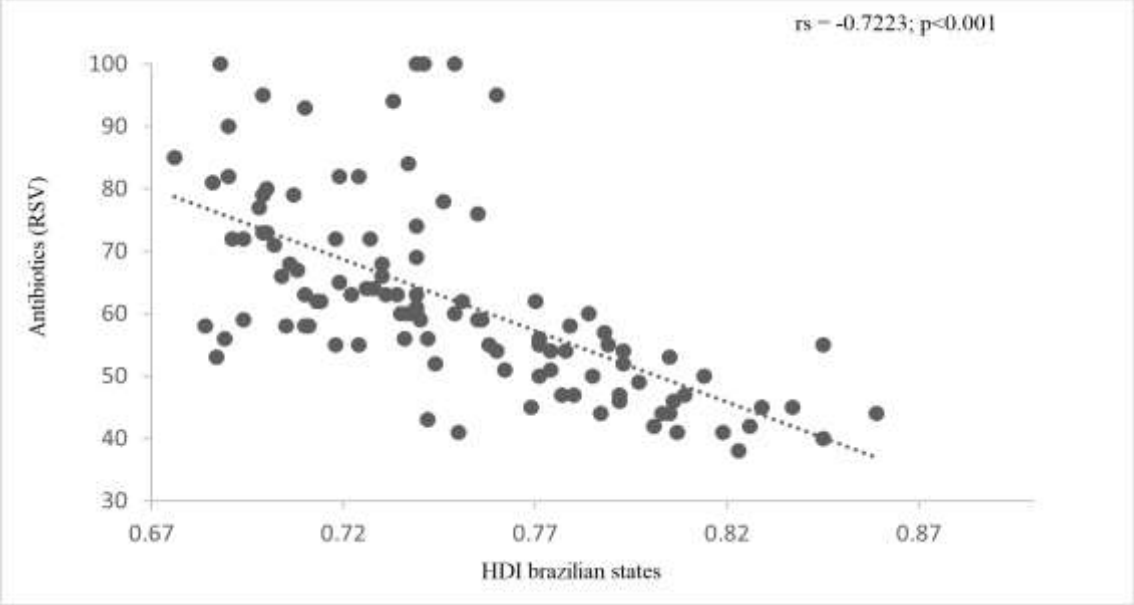
Conversely, the data for respiratory diseases suggest a tendency for indiscriminate use of antibiotics in response to respiratory conditions. The increase in antibiotic searches coincides with periods of higher mortality from respiratory diseases, such as pneumonia and influenza. These findings align with data from Del

Fiol et al., which showed a rise in the purchase of these antibiotics during the same period, largely driven by the COVID-19 pandemic (DEL FIOL FS, et al., 2022). In Brazil, there is a high rate of self-medication among low-income adults, many of whom disregard whether the cause of respiratory illness is viral or bacterial (SCHMID B, et al., 2010).

This issue is exacerbated by the prevalence of misinformation ("fake news") in Brazil, leading to the adoption of unproven treatment protocols (MEDEIROS KKCO, et al., 2022). Self-medication refers to the use of medications without professional guidance, ranging from acquiring and consuming drugs without a prescription to determining dosage and treatment duration without healthcare supervision (BENNADI D, 2013). In Brazil, self-medication is increasingly common for anti-inflammatory drugs, painkillers, and antibiotics, with internet usage fueling interest in the consumption and stockpiling of these medications at home (SOUZA LF, et al., 2023).

Regarding socioeconomic factors, the correlation study between HDI of Brazilian states and RSV values indicated a strong negative correlation with high significance (rs: -0.7223; $p<0.05$), suggesting a hypothesis of an inversely proportional relationship, where the higher the search for antibiotics, the lower the HDI of the studied state (**Figure 3**).

Figure 3 - Spearman's Correlation between HDI of Brazilian states and Relative Search Volume (RSV) on the term "Antibiotic," obtained from Google Trends, from 2018 to 2021.



Fonte: Favacho PHO, et al., 2025.

The Northern (average RSV = 79.61) and Northeastern (average RSV = 63.47) regions showed the highest search concentration in Brazil from 2018 to 2022. Additionally, the states of Roraima (RSV = 97.5), Amapá (RSV = 91.5), and Acre (RSV = 84.75) had the highest averages. In contrast, São Paulo (RSV = 39.2), Santa Catarina (RSV = 44.25), and Paraná (RSV = 43.5) had the lowest values (**Table 1**).

From a socioeconomic perspective, the Northern and Northeastern regions of Brazil showed the highest search volume from 2018 to 2022 (**Table 1**). These regions also experience the greatest precarization of health services in the country.

The poor state of these services results in delays in patient care, often extending to three months or more, which affects the start of treatment and leads to the worsening of diseases (DANTAS MNP, et al., 2021). As a result, patients are likely forced to seek alternative forms of treatment, such as self-medication.

This hypothesis is supported by the correlation analysis with the Human Development Index (HDI), a measure calculated by the United Nations Development Program (UNDP). The HDI assesses regional human

development by considering three dimensions: longevity, education, and income, with an index ranging from 0 to 1 (SOARES NETO JJ, et al., 2016). States with low HDI scores show a higher interest in the analyzed search terms (**Figure 2**).

Table 1 - Values of Relative Search Volume (RSV) for the term "Antibiotic" per region of Brazil, obtained from Google Trends, from 2018 to 2022.

Brazilian regions	Average RSV	Median RSV
North	**79.61**	**80.5**
Roraima	97.5	97.5
Amapá	91.5	92
Acre	84.75	85.5
Pará	77.25	80.5
Rondônia	70.75	68.5
Amazonas	70.25	72
Tocantins	65.25	62.5
Northeast	**63.47**	**60.5**
Maranhão	79.25	80
Piauí	74.5	70.5
Paraíba	64.75	62
Sergipe	62.5	60.5
Pernambuco	61.25	60.5
Bahia	61.25	59
Ceará	58.5	59.5
Alagoas	56.5	57
Rio grande do norte	52.75	53
Center west	**53.81**	**55**
Mato Grosso	56.75	57
Goiás	55.25	55
Mato Grosso do sul	54.75	55
Distrito Federal	48.5	47.5
Southeast	**49.18**	**51.25**
Minas Gerais	55.25	54.5
Espirito Santo	52	52
Rio de janeiro	50.25	50.5
São Paulo	39.2	40.5
South	**45.42**	**44.5**
Rio Grande do sul	48.5	48
Santa Catarina	44.25	44.5
Paraná	43.5	44

Fonte: Favacho PHO, et al., 2025.

There are few publications that examine the relationship between HDI and online antibiotic searches. According to Pereira CM, et al. (2021), the Brazilian state of Pará (RSV = 77) has a low HDI, and only 34% of its population uses a medical prescription to acquire antibiotics. In contrast, a study in the Federal District (RSV = 48.7) shows that high school students have better knowledge about antibiotics, which may be linked to the region's higher HDI (PEREIRA CM, et al., 2021). Thus, the relationship between HDI and RSV for antibiotics on Google Trends could be further explored as a surveillance indicator in different regions.

It is also worth noting that the main associated topics were amoxicillin, azithromycin, and cephalexin. All of these are linked to the "purpose of antibiotics" (**Figure 1**), indicating gaps in the population's knowledge about their use. A study on the Brazilian population's knowledge of amoxicillin reveals that 39.4% understand it is used to treat bacterial infections, while 26.9% mistakenly believe it is for inflammation (SOUZA VP, et al., 2019).

Urinary tract infection (UTI) was the most frequently associated condition with the search term (**Figure 1**), suggesting a high incidence of this pathology. However, more research is needed as there is no official data on the incidence of UTIs in the Brazilian population.

Moreover, UTIs were specifically associated with amoxicillin (**Figure 3**). UTIs are common, especially among females, and antibiotics like amoxicillin are frequently used for treatment. However, some bacteria involved in these infections have developed resistance (BEZERRA KDG, et al., 2018). Therefore, searches for amoxicillin related to UTIs likely reflect patients' interest in understanding its use, which may lead to the acquisition of this antibiotic without a prescription or appropriate dosage, thus contributing to bacterial resistance (SOUZA VP, et al., 2019).

The present study highlights the importance of data obtained through Google Trends to support pharmacovigilance in Brazil, particularly in regions with greater precariousness in access to information and healthcare services. In this regard, pharmacovigilance needs to ensure the safe and effective use of medications, especially antibiotics, as self-medication is a common practice in various regions of Brazil, particularly in the North and Northeast. In these regions, limited access to healthcare services, combined with misinformation, contributes to the improper use of antibiotics, exacerbating the problem of bacterial resistance (MALCHER CMSR, et al., 2022; NAVES JOS, et al., 2010).

The use of tools like Google Trends allows for real-time monitoring of the population's interests and behaviors concerning the use of antibiotics, which represents a significant advantage in terms of pharmacovigilance. According to Pullan S and Dey M (2021), the analysis of internet search trends data, such as that provided by Google Trends, can identify patterns of interest in medications and offer insights into the population's behavior regarding self-medication, especially in contexts of low healthcare coverage. In Brazil, where access to healthcare services varies significantly between regions, monitoring searches for antibiotics in regions with lower HDI can provide crucial insights for public health decision-making (MALCHER CMSR, et al., 2022).

In this context, Google Trends can be a valuable tool to identify and map areas where self-medication is more prevalent, offering important information for targeted interventions. Moreover, the use of this tool can help identify peaks in interest for antibiotics during outbreaks of respiratory diseases, such as COVID-19, when searches for these medications increased (BATOOl M, et al., 2021).

The integration of digital monitoring tools, such as Google Trends, with traditional pharmacovigilance practices allows for more comprehensive and real-time surveillance. However, one of the main challenges faced by traditional pharmacovigilance is the underreporting of adverse events, especially in regions with a low density of healthcare professionals, such as the North and Northeast of Brazil (NAVES JOS, et al., 2010). In these areas, traditional monitoring often fails to adequately capture the unsupervised use of antibiotics due to a lack of resources and limited regulatory capacity. The use of tools like Google Trends can help fill this gap by providing data on the population's behavior regarding self-medication and the misuse of antibiotics, allowing health authorities to respond more quickly (PULLAN S and DEY, 2021).

The use of Google Trends as a support tool for pharmacovigilance in Brazil is essential, particularly in regions such as the North and Northeast, where the improper use of antibiotics is more prevalent. Continuous monitoring of search trends can provide valuable data for the formulation of more effective public health policies aimed at raising awareness about the risks of self-medication and promoting the rational use of medications. Additionally, the integration of digital tools with traditional pharmacovigilance practices can enhance the capacity of health authorities to identify and mitigate the risks associated with the improper use of antibiotics (PULLAN S and DEY M, 2021).

Although there have been significant findings, using Google Trends to monitor interest in antibiotics has limitations. Firstly, the tool does not provide contextual details about the searches. Additionally, Google Trends lacks detailed demographic information, such as the age range or health status of the individuals conducting these searches, which restricts the analysis of the population profile involved. Temporal factors and seasonal events, such as health campaigns or specific outbreaks, may also influence search volumes, creating peaks

that do not necessarily reflect an actual increase in antibiotic use. Finally, the tool has regional limitations, as internet usage varies between urban and rural areas in Brazil, leading to a potentially biased data sample in regions with limited internet access.

Therefore, further studies that evaluate additional factors are needed. Despite these limitations, the Google Trends platform shows promise for monitoring self-medication while more accurate databases on the subject remain under development.

CONCLUSION

The use of an online tool such as Google Trends proved highly useful in this study for monitoring public interest in antibiotic use, providing valuable data that can aid in formulating public health surveillance and education strategies, taking into account the country's diverse socioeconomic and epidemiological conditions. Continuous monitoring of searches related to antibiotics, combined with public policies that promote the rational use of these drugs and improve access to health services, is essential to mitigate the risks of self-medication and to combat the growing problem of antimicrobial resistance in Brazil. These data provide a foundation for developing more targeted interventions in vulnerable regions. In this regard, further studies are recommended to expand the use of this tool to other countries, as it could serve as a valuable instrument for monitoring the use of medications, such as antibiotics.

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REFERENCES

1. ARORA VS, et al. Google Trends: Opportunities and limitations in health and health policy research. Health Policy (New York), 2019; 123(3): 338-341.
2. BATOOI M, et al. How COVID-19 has shaken the sharing economy? An analysis using Google trends data, Economic Research-Ekonomska Istraživanja, 2021; 34 (1): 2374-2386.
3. BENNADI D. Self medication: a current challenge. Journal of Basic and Clinical Pharmacy, 2013; 5(1): 19-23.
4. BEZERRA KGD, et al. Infecções urinárias registradas em um laboratório de análises clínicas do sertão paraibano. Anais III CONBRACIS, Campina Grande: Realize Editora, 2018; 2525-6696.
5. DANTAS MNP, et al. Fatores associados ao acesso precário aos serviços de saúde no Brasil. Revista Brasileira de Epidemiologia, 2020; 24: e210004.
6. DEL FIOL FS, et al. Consumption trends of antibiotics in Brazil during the COVID-19 pandemic. Frontiers in Pharmacology, 2022; 13: 844818.
7. EWALD TA, et al. Tendência temporal de mortalidade por doenças do trato gastrointestinal. COORTE - Revista Científica do Hospital Santa Rosa, 2021; 12.
8. FERRER M, et al. Antibiotic use and microbiome function. Biochemical Pharmac, 2017; 134: 114-126.
9. KAMIŃSKI M, et al. Global Internet data on the interest in antibiotics and probiotics generated by Google Trends. Antibiotics, 2019; 8(3): 147.
10. KOHL M, et al. Cytoscape: software for visualization and analysis of biological networks. In: Cytoscape Software for Visualization and Analysis. 2011; 291-303.
11. MALCHER CMSR, et al. Automedicação e uso de antibióticos: análise qualitativa em uma comunidade virtual. Research, Society and Development, 2022; 11(11): e25111133191.

12. MARTINS ALJ, et al. Potential and challenges of health monitoring in the 2030 Agenda in Brazil. Ciência & Saúde Coletiva, 2022; 27(7): 2519-2529.
13. MEDEIROS KKCO, et al. COVID-19 e o impacto das fake news no uso racional de medicamentos no Brasil e no mundo. Revista JRG de Estudos Acadêmicos, 2022; 5(10): 147-162.
14. MENEZES AS, et al. A automedicação da população mundial: uma revisão integrativa. Research, Society and Development, 2021; 10(10): e125101018660.
15. NAVES JOS, et al. Automedicação: uma abordagem qualitativa de suas motivações. Ciência & Saúde Coletiva, 2010; 15(1): 1751-1762.
16. PEREIRA CM, et al. Antibióticos: percepções dos estudantes do 2o ano do ensino médio de uma escola do Distrito Federal. Anais do XIII Encontro Nacional de Pesquisa em Educação em Ciências, Campina Grande: Realize Editora, 2021; 978-85-61702-70-0.
17. PULLAN S & DEY M. Vaccine hesitancy and anti-vaccination in the time of COVID-19: A Google Trends analysis. Vaccine, 2021; 39(14): 1877-1881.
18. ROVETTA A. Raiders of the lost correlation: a guide on using Pearson and Spearman coefficients to detect hidden correlations in medical sciences. Cureus, 2020; 12(11): e11794.
19. SANTOS RC, et al. A influência da internet no processo de automedicação: uma revisão integrativa. Brazilian Journal of Health Review, 2019; 2(5): 4310-4323.
20. SCHMID B, et al. Automedicação em adultos de baixa renda no município de São Paulo. Revista de Saúde Pública, 2010; 44(6): 1039-1045.
21. SILVA ACS, et al. Avaliação do software Bioestat para o ensino de estatística nos cursos de graduação. Revista da Universidade Vale do Rio Verde, 2014; 12(2): 375-385.
22. SILVA JUNIOR JG, et al. Auto medicação com antibióticos e suas consequências fisiopatológicas: uma revisão. RIOS Saúde – Revista Científica da Faculdade Sete de Setembro, 2018; 1: 7-17.
23. SOARES NETO JJ, et al. Programa Mais Médicos, a infraestrutura das Unidades Básicas de Saúde e o Índice de Desenvolvimento Humano Municipal. Ciência & Saúde Coletiva, 2016; 21(9): 2709-2718.
24. SOUSA AF, et al. Uso de dados do Departamento de Informática do Sistema Único de Saúde (DATASUS) em pesquisas científicas. Revista Científica Multidisciplinar Núcleo do Conhecimento, 2021; 171-185.
25. SOUZA LF, et al. Automedicação: impactos no tratamento médico e diagnóstico da doença. Brazilian Journal of Implantology and Health Sciences, 2023; 5(5): 6564-6582.
26. SOUZA VP, et al. Avaliação do conhecimento da população sobre o antibiótico amoxicilina. Publicatio UEPG: Ciências Biológicas e da Saúde, 2019; 25 (2).
27. XAVIER MS, et al. Automedicação e o risco à saúde: uma revisão de literatura / Self medication and health risk: a literature review. Brazilian Journal of Health Review, 2021; 4(1): 225-240.