

Exploring increased online searches for unproven outpatient treatments in response to media coverage during the COVID-19 pandemic in Latin America

Explorando el aumento de las búsquedas en línea sobre tratamientos ambulatorios no probados en respuesta a la cobertura mediática durante la pandemia de COVID-19 en América Latina

Jennifer Hegewisch-Taylor¹ , Anahi Dreser-Mansilla¹ , Gabriel Millán-Garduño¹ ,
Veronika J. Wirtz² , Lucila I. Castro-Pastrana³ , Andrea Anaya-Sanchez⁴ ,
J. Isaac Rico-Cuevas³ , Pilar Torres-Pereda^{1,5*} 

¹ National Institute of Public Health (INSP), Cuernavaca, Mexico

² Boston University School of Public Health, Boston, USA

³ Universidad de las Américas Puebla (UDLAP), Cholula, México

⁴ University of California, Berkeley, USA

⁵ Universitat Rovira i Virgili, Tarragona, Spain.

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Abstract

Introduction: The early phase of the COVID-19 pandemic triggered unprecedented media coverage and widespread Internet searches for potential treatments. **Objective:** This study analyzed the daily search volume (DSV) in Latin American countries regarding unproven treatments for the outpatient care of COVID-19 patients. **Methodology:** The Google Trends search engine was used to retrieve DSV data for azithromycin, chlorine dioxide, colchicine, dexamethasone, hydroxychloroquine, and ivermectin, when searched alongside a COVID-19-related term during the first year of the pandemic. Peaks of high DSV (≥ 75) for each treatment were compared across 10 Spanish-speaking Latin American countries and correlated by date with online media coverage. An in-depth case study was conducted for Mexico. **Results:** Venezuela displayed the highest number of high DSV days ($n=27$) across all six treatments, followed by Mexico ($n=22$). Azithromycin ($n=41$) and dexamethasone ($n=24$) registered the highest number of high DSV days overall. Dates on which high DSV peaks occurred in three or more countries coincided with media coverage of clinical trials and other treatment-related communications. Increases in DSV for the selected treatments coincided with key milestones in COVID-19 case trends in Mexico, in comparison to the baseline. **Conclusions:** These findings highlight the relevance of digital media monitoring to understand public interests and concerns, anticipate potential demand for unproven treatments, and support timely and appropriate health promotion and risk communication.

Keywords: Drug-Seeking Behavior; Internet; COVID-19; Media Exposure; Health Communication

 * Correspondence: Pilar Torres-Pereda, pilar.torres@insp.mx Universitat Rovira i Virgili, Tarragona, Spain.

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Resumen

Introducción: La fase temprana de la pandemia de COVID-19 detonó una cobertura mediática sin precedentes y búsquedas en Internet sobre posibles tratamientos. **Objetivo:** Este estudio analizó el volumen diario de búsqueda (VDB) en países de América Latina a propósito de tratamientos no probados para la atención ambulatoria de pacientes con COVID-19. **Metodología:** Se utilizó el motor de búsqueda Google Trends para obtener los datos de VDB correspondientes a azitromicina, colchicina, dióxido de cloro, dexametasona, hidroxiclороquina e ivermectina, al ser buscados junto con un “término relacionado con COVID-19” durante el primer año de la pandemia. Se compararon los picos de VDB alto (≥ 75) para cada tratamiento entre los 10 países hispanohablantes y se correlacionaron por fecha con publicaciones de noticias en medios en línea. Se realizó un estudio de caso centrado en México. **Resultados:** Venezuela fue el país con mayor número de días ($n=27$) con VDB alto en la suma de los seis tratamientos, seguido por México ($n=22$). La azitromicina ($n=41$) y la dexametasona ($n=24$) presentaron el mayor número de días con VDB alto en general. Las fechas de los picos de VDB alto en más de tres países coincidieron con la cobertura mediática de ensayos clínicos y otras comunicaciones sobre tratamientos. Los aumentos de VDB alto por tratamiento coincidieron con hitos de los casos de COVID-19 en México en comparación con la línea base. **Conclusiones:** Los hallazgos muestran que el monitoreo de los medios digitales es relevante para comprender los intereses y las preocupaciones de la población, la posible demanda de tratamientos no comprobados, y para facilitar la promoción de la salud y la comunicación de riesgo oportuna y apropiada.

Keywords: Comportamiento de Búsqueda de Fármacos; Internet; COVID-19; Exposición a los Medios; Comunicación en Salud.

Introduction

In recent years, several Public Health Emergencies of International Concern (PHEICs), such as H1N1 influenza, Ebola, Zika, and COVID-19¹ have occurred. In these contexts, there is a continuous need to find answers to key questions about how to confront emerging diseases, from diagnosing and managing unfamiliar conditions, to addressing uncertainties surrounding transmission, prevention, treatment, and recovery. During these health crises, uncertainty is not only clinical but also informational. There is a constant demand from healthcare professionals, decision-makers, and the general public for timely and reliable information that satisfies the need for real-time knowledge to guide decision-making and health behaviors.

The advent of modern digital technology brought along new ways of obtaining information. In the past, traditional or legacy media such as television and newspapers took longer to reach audiences; however, today, users can access health information instantly from their computers or mobile devices². For instance, studies have shown that 31% of people found information about COVID-19 treatments through online searches³. Furthermore, social media platforms have enabled the amplification and dissemination of information, whether by sharing, modifying, or commenting on content. However, during health emergencies, this information can become excessive and diversified with varying levels of quality, accuracy, and reliability² which can fuel misinformation and inadequate public health responses⁴, particularly when uncertainties are not clearly communicated.

In particular, public anxiety frequently revolves around treatment, since there is usually an absence of proven therapies⁵. As a result, initial medical responses often rely on non-pharmaceutical interventions and supportive care. At the same time, researchers turn to drug repurposing, defined as the identification of new therapeutic uses for existing medicines, aiming to find a swift and low-cost solution⁶. However, this combination of factors can lead to the population's use of unproven remedies and therapies^{7,8}.

These behaviors can have serious health repercussions, including increased morbidity and mortality due to drug interactions and adverse effects, along with the exacerbation of antimicrobial resistance⁹. Understanding health-seeking behavior and treatment demands during emergencies may help anticipate, prevent, and control such consequences¹⁰. In that sense, novel data streams, such as web search data or social media activity, have demonstrated value in monitoring shifts in the population's information-seeking and content-sharing patterns, often faster than traditional epidemiological reporting^{11,12}. For example, the Google Trends platform has proven helpful in tracking geospatial and temporal patterns of online search volumes for specific user-specified queries¹³. This tool allowed researchers to capture the population's demand for public health topics, such as preventive measures and symptoms, during the COVID-19 pandemic^{10,14}.

Nevertheless, most infodemiology research during COVID-19 has focused on describing public interest in health topics, such as preventive measures, and disease awareness. However, few studies have examined the role and dynamics of media communications as specific triggers of information-seeking behavior related to unproven medication^{10,15}. The continuous, 24-hour flow of real-time online media coverage, distinct from the slower pace of print or television journalism, has made it increasingly important for media to ensure the accuracy and responsibility of medical reporting during crises^{4,16}. Such coverage can shape public information interests, particularly in less controlled outpatient settings.

This issue is especially relevant in Latin America, where previous health emergencies, such as the Zika outbreak, illustrated how media coverage can influence public behavior and even tourism⁸. Therefore, this study investigates Google search activity related to selected unproven treatments for ambulatory care for COVID-19 across 10 Spanish-speaking Latin American countries during the first year of the pandemic, analyzing these patterns in relation to online media communications.

Methodology

Pre-selection of treatments

This exploratory study focuses on unproven prophylaxis or ambulatory treatments for COVID-19: substances displaying insufficient evidence of efficacy or safety for regular use in outpatient care during the first year of the pandemic. These were identified through screening of the living international guidelines¹⁷ and media releases regarding coverage of public consumption of unproven or preliminary treatments for COVID-19 (free manual Google search in February 2021). Treatments already approved or recommended for COVID-19 outpatient or ambulatory treatment (such as acetaminophen) were excluded. Natural remedies such as teas were not considered. Fifteen unproven treatments were initially selected: amantadine, ambroxol, apixaban, azithromycin, chlorine dioxide, chloroquine, colchicine, dexamethasone, dextromethorphan, hydroxychloroquine, ivermectin, leflunomide, nitazoxanide, oseltamivir and salbutamol.

Selected unproven treatment searches in Google Trends

Google Trends is a tool that stores users' text searches and determines the relative search volume, or Daily Search Volume (DSV) on a scale from 0 to 100, of a particular term or a brief set of terms; otherwise, it approximates online interest or popularity at a specific time and can be categorized per region. DSV data corresponding to a specific term(s) (e.g., the name of an antibiotic) is normalized by dividing it by the maximum volume of Google searches at the selected time and place^{13,18}.

Pre-selected unproven treatments were sought by their generic name in Spanish, without quotation marks, in Google Trends and reported according to the Google Trends checklist¹⁹. Time parameters restricted the search to 6 months before the pandemic arrived in Latin American countries, from September 01, 2019, passing through February 2020 (baseline period, when most COVID-19 cases started to be reported in the region), up to February 28, 2021 (into the first year of the pandemic). The searches were executed and downloaded (CSV format) on March 01, 2021. The time parameters were selected because the first stages of an epidemic are when the most massive media risk communications happen, and the population is most susceptible to it. Criteria to identify "selected treatments" included those being ranked under the top-5 "related-topic" trend list¹⁸ and linked to a COVID-19-associated term (COVID-19, coronavirus, etc.). The ones that met the inclusion criteria were azithromycin [AZ] (an antibiotic), colchicine [CO] (an antimitotic used against gout and joint pain), dexamethasone [DX] (a corticoid), hydroxychloroquine [HCQ] (an antimalarial, used for systemic lupus erythematosus), ivermectin [IV] (an antiparasitic), along with a disinfectant: chlorine dioxide [CD]. Although the latter is not a drug, it was included in the study due to its popularity as a "miracle treatment" during the pandemic²⁰.

Daily Search Volume in Spanish-speaking Latin American Countries

Raw DSV data for each treatment per country were organized and integrated into a single database (available on demand). DSV was labeled as either low DSV, with peaks corresponding to a DSV of ≤ 25 ; medium DSV, with peaks corresponding to a DSV of ≥ 50 – ≤ 60 ; and high DSV, with peaks displaying the highest quartile of interest (≥ 75 DSV). DSV for the selected treatments was filtered for 10 Latin-American Spanish-speaking countries (Argentina, Bolivia, Chile, Colombia, Cuba, Ecuador, Mexico, Peru, Dominican Republic, and Venezuela) using the same search parameters for comparison. Spanish-speaking countries with insufficient DSV data were disregarded for this study. High DSV date-specific peaks were identified per country and treatment and were graphed over the selected period.

Matching high DSV to online media communications

For each selected treatment, we performed Google searches using the treatment name together with the term “COVID-19” and the month and day of publication. The first three pages of search results were reviewed to identify online media publications that could explain the observed peaks in high DSV, including international news (technical/academic or for the general public) and academic publications in English and Spanish. This cutoff was chosen as a pragmatic criterion, since Google’s ranking algorithm prioritizes content that is most relevant and widely disseminated on the first pages. To correlate high DSV peaks with news reports, for the international analysis (**Supplementary Material 1**), a threshold window of ± 3 days relative to the news publication date was applied. This interval reflects the dynamics of information diffusion: a story may first appear in traditional media outlets such as television, then be replicated online, or alternatively, originate online and subsequently be amplified through social networks or other channels. When three or more countries displayed date-specific high DSV for the same treatment, results were arranged on a heat map and matched to a potentially related media communication according to date.

Mexico’s case study

Given the high number of high DSV peaks observed, Mexico was chosen as a case study. National COVID-19 cases and deaths were plotted alongside DSV for all selected medicines. High DSV per treatment were then matched with national online media communications, such as news reports (complete list in **Supplementary Material 2**), and shown on a graph. For Mexico, a broader threshold of ± 5 days was considered appropriate, as the local uptake of news stories tends to be slower than in the international context, in either diffusion direction.

Results

When analyzing DSV as a proxy for interest, it was evident that as soon as the pandemic began, baseline low DSV peaks for all treatments shifted to marked DSV elevations and peaks of medium DSV or high DSV, which were not explained by seasonal disease occurrence (expected increases in diseases in cold/warm months). The number of high DSV events concerning each of the six unproven ambulatory treatments for COVID-19 was different for every country.

High Daily Search Volumes concerning different treatments across countries.

Country analysis revealed that Venezuela displayed the highest number of days with high DSV ($n=27$) during the selected period, considering the combined data for the six medicines, followed by Mexico ($n=22$ days) and Bolivia ($n=13$) (**Figure 1**).

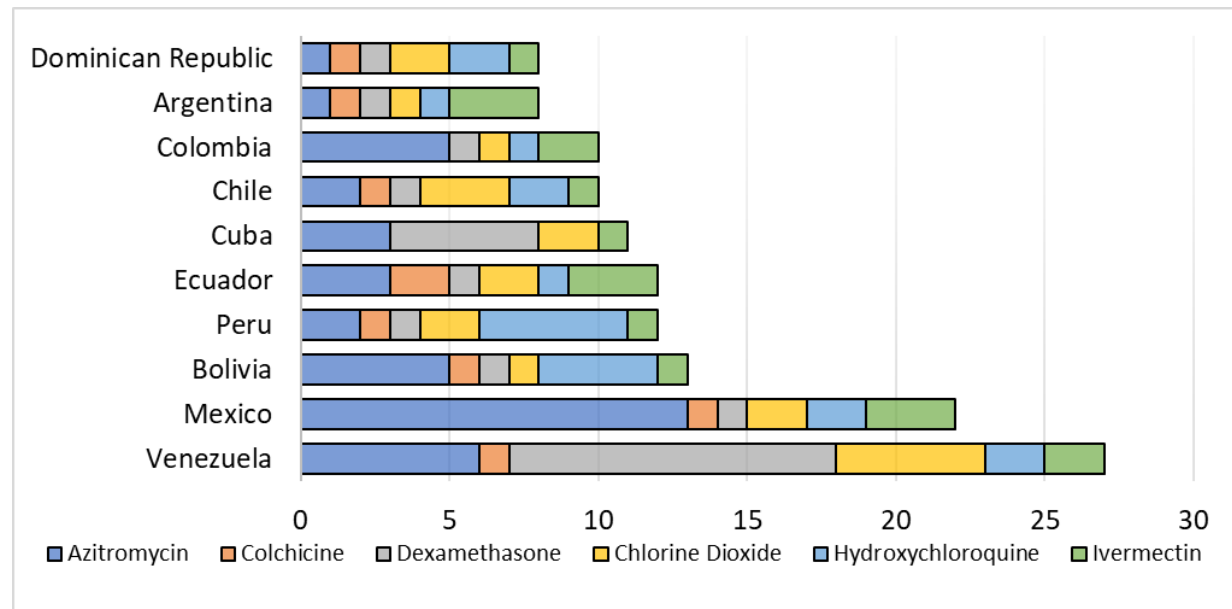


Figure 1. Stacked bar graph showing the number of days with high DSV per country for each treatment. The horizontal stacked bar graph shows the selected countries on the Y-axis. The X-axis depicts the frequency of days displaying high DSV ($DSV \geq 75$) according to treatment per country. The six selected treatments are shown in different colors. **Abbreviations:** High DSV: High Search Volume; DSV: Daily Search Volume

The Dominican Republic and Argentina had the fewest days of high DSV ($n=8$ each). AZ displayed the most days with elevated high DSV in Mexico ($n=13$ days), followed by Venezuela ($n=6$). CD showed the most significant trend in Venezuela ($n=5$) and Chile ($n=3$). Ecuador displayed the highest number of days of high DSV regarding CO ($n=2$). Dexamethasone's high DSV was the most common in Venezuela ($n=11$), followed by Cuba ($n=5$). Hydroxychloroquine showed high DSV more frequently in Peru ($n=5$) and Bolivia ($n=4$) than in other countries. Ivermectin showed equally high DSV days in Mexico, Ecuador, and Argentina ($n=3$). Finally, CO and HCQ did not trend in Cuba, and the first did not in Colombia.

Of interest, AZ showed the highest number of accumulated high DSV days ($n=41$) in the countries analyzed during the period, followed by DX ($n=24$), CD ($n=21$), HCQ ($n=20$), IV ($n=18$), and CO ($n=9$).

Specific high Daily Search Volume increases in potential response to media communications per treatment.

High increases in Daily Search Volume were sometimes shared among three or more Latin American countries in potential response to media communications on a given date. Online media coverage of the publication of the preliminary positive results from a randomized controlled trial (now retracted)²¹ on the use of HCQ and AZ as a treatment for COVID-19^A (superindexes refer to media communications mapped in **Figure 2**) trended in 9 countries concerning HCQ and five countries regarding AZ (**Figure 2**). This coincided with the former President of the United States, President Trump^B, promoting the use of HCQ and the following FDA authorization of the emergency use to treat hospitalized COVID-19 patients^C. Further search interest elevations of HCQ & AZ in May and June-August, respectively, overlap with Trump's public mentions of the treatments^D and the piling evidence of the ineffectiveness of the treatments against COVID-19²² reflected in international trends^G.

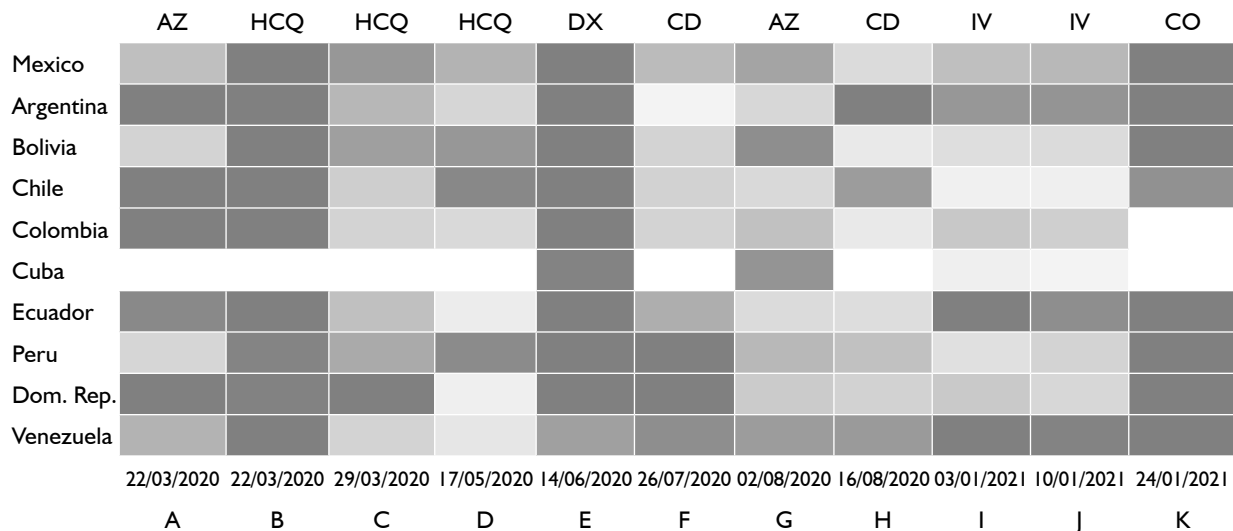


Figure 2. Heat map with date-specific high DSV shared trends across ≥ 3 countries for the six selected treatments. Countries on the vertical axis display date-specific high DSV in dark gray according to treatment (upper horizontal axis). Medium DSV is shown in light gray; lighter colors in the grayscale indicate low DSV; white squares indicate no DSV on that particular date. The lowest horizontal axis shows international media communications matched by date (DD/MM/YYYY) to high DSV shared across ≥ 3 countries. Sources can be found in Supplementary Material I. **Abbreviations:** AZ: Azithromycin; CD: Chlorine Dioxide; CO: Colchicine; Dom. Rep.: Dominican Republic; DX: Dexamethasone; FDA: U.S. Food and Drugs Administration; HCQ: Hydroxychloroquine; IV: Ivermectin; Medium DSV: Medium Daily Search Volume; High DSV: High Daily Search Volume

International media communications

- A. AZ** (22/03/2020): HCQ and AZ as a treatment of COVID-19: results of an open-label non-randomized clinical trial
- B. HCQ** (22/03/2020): Trump (POTUS) confirms he is taking HCQ and that it is a safe treatment
- C. HCQ** (29/03/2020): The FDA authorizes the emergency use of HCQ to treat hospitalized COVID-19 patients
- D. HCQ** (17/05/2020): Trump says he is taking HCQ despite it being an unproven treatment
- E. DX** (14/06/2020): DX reduces fatalities in hospitalized patients with severe COVID-19
- F. CD** (26/07/2020): Lawmakers push CD as COVID-19 treatment in Bolivia
- G. AZ** (02/08/2020): Study links more risks than benefits regarding HCQ & AZ used as a treatment for COVID-19
- H. CD** (16/08/2020): Death of infant in Argentina from chlorine dioxide use
- I. IV** (03/01/2021): Moderate-certainty evidence finds that large reductions in COVID-19 deaths
- J. IV** (10/01/2021): IV is associated with a higher proportion of hospitalized COVID-19 patients discharged alive
- K. CO** (24/01/2021): Study published linking colchicine use with reduced hospitalization and deaths in COVID-19 patients

Dexamethasone trended in ten countries on a single date in June 2020, following media publications^E covering the Oxford study²³ on Dexamethasone's COVID-19 mortality reduction in severe cases. Similarly, CO and IV trended with high DSV in January 2021 in 8 and 3 countries, respectively, after international media addressed studies linking these treatments with reduced hospitalization and deaths in COVID patients^{24,25, I, J, K}.

Regarding CD, high DSV peaks were identified between July and August 2020, which coincided with the news from Bolivian lawmakers pushing for its use as a treatment for COVID-19^F and the death of an infant in Argentina due to CD use^H.

Of note, although most of these high DSV peaks rose after the online written media communication was published, in some cases, a declaration was first made on TV, such as Trump's declaration on taking HCQ, which triggered high DSV by itself.

Mexico as a case study

DSV increases coincided with different events during the first year of the COVID-19 pandemic in Mexico, which can be divided into three periods: 1) March 2020 (onset of the epidemic) and implementation of the National Social Distancing when the population was told to stay at home to protect from the virus²⁶, 2) June-August 2020 (first significant increase in cases and deaths in the country) and 3) December 2020-January 2021 (second wave of cases and deaths) (**Figure 3**).

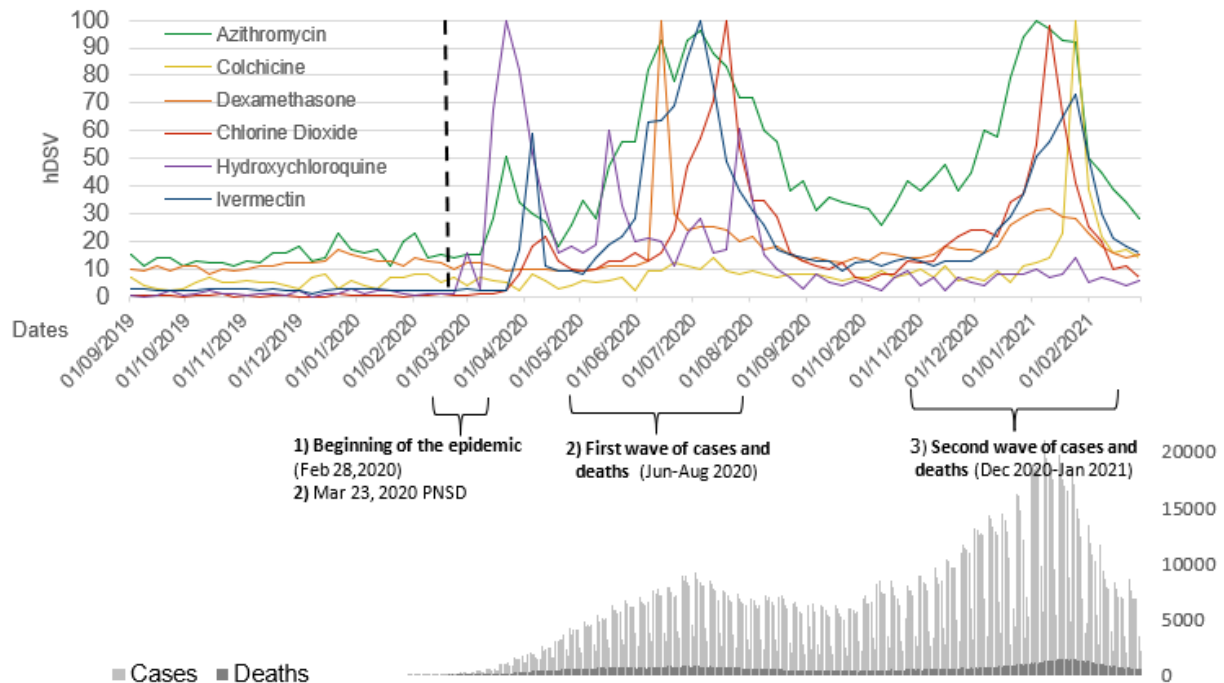


Figure 3. Line graph displaying online Google DSV in Mexico for unproven ambulatory treatments aligned to the country's COVID-19 cases and deaths.

Daily Search Volume (DSV) (0-100) is shown on the Y axis in the line graph. Time (dates in the DD/MM/YYYY format) is divided by months depicted in the X-axis below (three key periods have been highlighted). The six selected treatments are shown in different colors. The slashed line represents the start of the COVID-19 pandemic in Mexico (February 28, 2020). The graph below is aligned with the first one (at the beginning of the COVID-19 pandemic and represents the number of cases (light gray) and deaths (dark gray) in Mexico from the beginning of the pandemic to March 01, 2021. **Abbreviations:** AZ: Azithromycin; CD: Chlorine Dioxide; CO: Colchicine; DX: Dexamethasone; HCQ: Hydroxychloroquine; IV: Ivermectin; PNSD: Period of National Social Distancing

When looking at Mexico's specific high DSV peaks, some of these could be potentially related directly to international media but also to national communications in Spanish that picked up the original publications. High DSV peaks in Google trends concerning HCQ were identified as soon as one month after the first case of COVID-19 was reported in Mexico (**Figure 4**). Superindexes reflect media communications mapped in (**Figure 4 and 5**). The Mexican national press revisited the HCQ and AZ clinical trial publication, potentially sparking a search spike that derived into HCQ panic shopping in the country ^{A-B (HCQ)} (**Figure 4**. Upper graph). Later, in July, the Ministry of Health discouraged the use of AZ ^{C (AZ)} (**Figure 4**. Upper graph) and CD ^{A (CD)} (**Figure 5**. Lower graph), heightening interest in both substances. Also, IV began to be sought as a treatment for COVID-19 ^{A (IV)} in July 2020 (**Figure 4**. Lower graph). In January, AZ and IV sparked interest in the country, and physicians in Mexico City began providing this treatment for COVID-19, arguing that there was good evidence to justify its use ^{D-E (AZ)} (**Figure 4**. Upper and lower graph). Nevertheless, health specialists argued that the efficacy of IV and AZ remained unproven ^{B (IV)} (**Figure 4**. Lower graph).

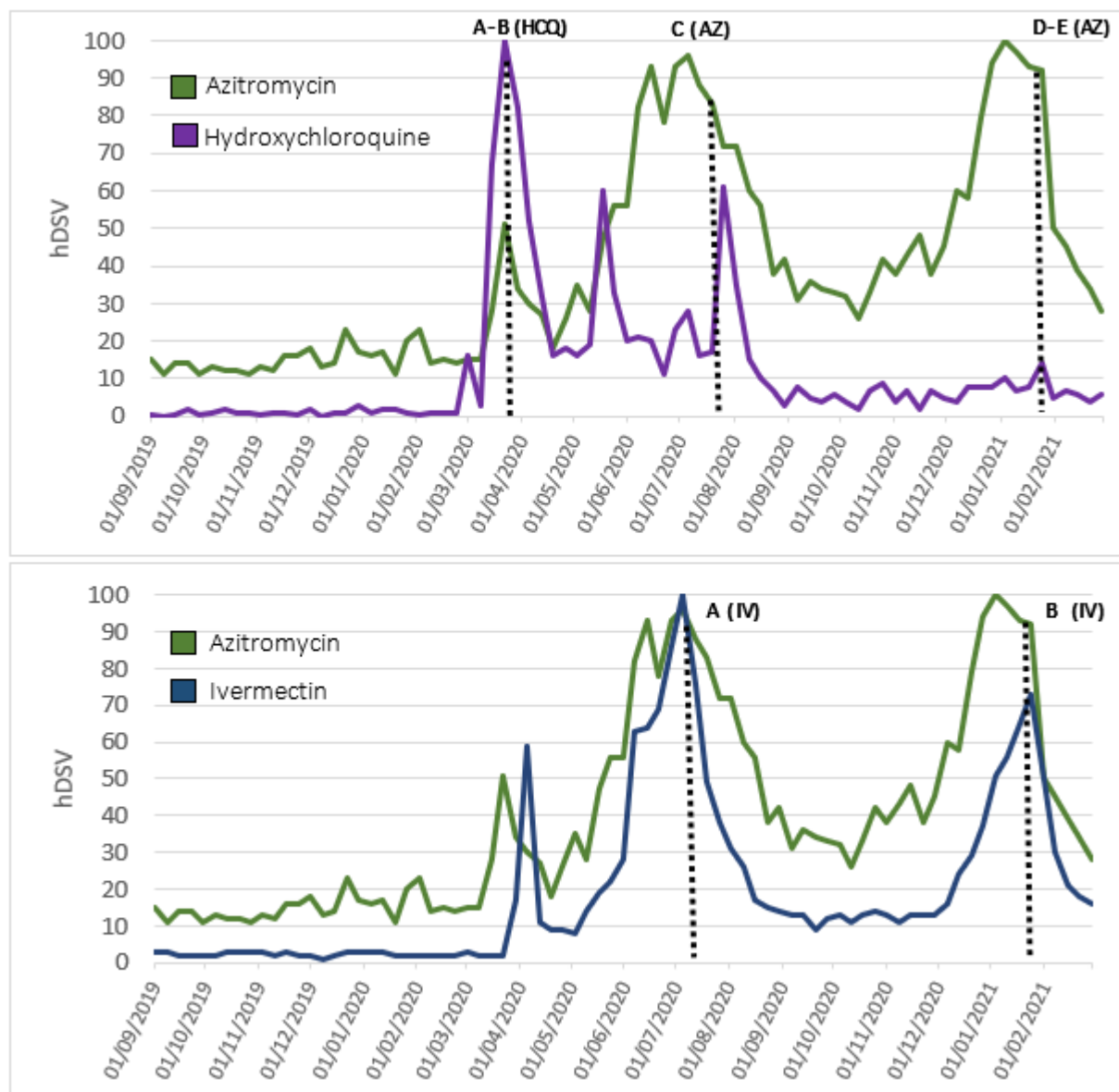


Figure 4. National online media communications matched to selected peaks of high DSV concerning the treatments included in the study in Mexico (AZ, HCQ, IV).

Sources can be found in Supplementary Material 2. The graphs only show selected high DSV for means of representation only. The dotted line does not correspond exactly to the indicated date.

Abbreviations: AZ: Azithromycin; CD: Chlorine Dioxide; CO: Colchicine; DX: Dexamethasone; HCQ: Hydroxychloroquine; hDSV: High Daily Search Volume; IV: Ivermectin.

Upper graph (HCQ & AZ)

- A. HCQ** 22/03/2020 (100): Chloroquine treatment (HCQ claims) sparks support and ignites doubt
- B. HCQ** 29/03/2020 (82): HCQ panic shopping
- C. AZ** 19/07/2020 (83): AZ is not recommended as COVID-19 treatment
- D. AZ** 17/01/2021 (93): Physicians in CDMX provide IV and AZ to treat COVID-19 patients
- E. AZ** 24/01/2021 (92): Specialists call to avoid the use of IV and AZ against COVID-19

Lower graph (IV & AZ)

A. IV 05/07/2020 (100): Media reports on the use of IV as a treatment for COVID-19

B. IV 24/01/21 (73*): The Health Secretariat states that the efficacy of IV and AZ against COVID-19 has not been proven

*This peak was taken into consideration, although it did not equal or surpass the DSV of 75.

DX displayed a sharp high DSV peak in June 2020 following national media publications covering the Oxford study^{A (DX)} (**Figure 5. Upper graph**); similarly, CO trended in Mexico in January 2021 after the national media picked up the international news concerning an academic study earlier mentioned^{B (CO)} (**Figure 5. Upper graph**). Regarding CD use, the Pan American Health Organization (PAHO) advised against taking CD and derivatives²⁷; however, during the second COVID-19 wave in Mexico, several medical doctors requested to be able to use it in their clinics^{B (CD)} (**Figure 5. Lower graph**).

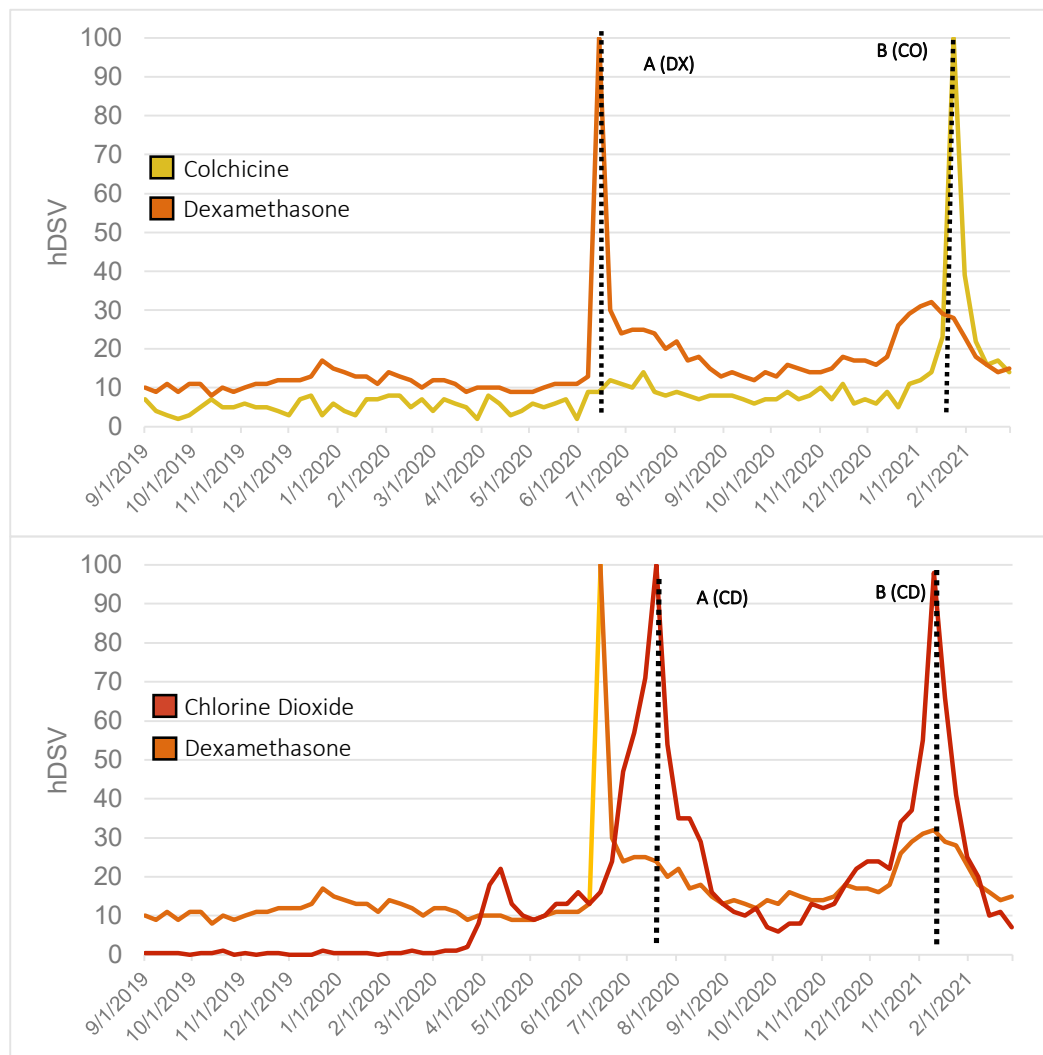


Figure 5. National online media communications matched to selected peaks of high DSV concerning the treatments included in the study in Mexico (CO, DX, CD).

Sources can be found in Supplementary Material 2. The graphs only show selected high DSV for means of representation only. The dotted line does not correspond exactly to the indicated date. **Abbreviations:** AZ: Azithromycin; CD: Chlorine Dioxide; CO: Colchicine; DX: Dexamethasone; HCQ: Hydroxychloroquine; hDSV: High Daily Search Volume; IV: Ivermectin.

Upper right graph (CO & DX):

- A. DX 14/06/2020 (100): DX reduces fatalities in hospitalized patients with severe COVID-19
- B. CO 24/01/2021 (100): Media shares study on colchicine and reduced hospitalization and death in COVID-19 patients

Lower right graph (CD & DX):

- A. CD 19/07/2020 (100): Warning on use of CD to fight coronavirus
- B. CD 10/01/2021 (98): Medical doctors request the Ministry of Health to allow the use of CD to treat COVID-19

Discussion

The impact of international media events in multiple countries

The study explored whether online searches for unproven outpatient COVID-19 treatments (AZ, CD, CO, DX, HCQ, and IV) in Latin America were linked to media coverage. When matching online media news in Google with DSV peaks, most headlines featured scientific reports from reputable sources (such as universities) on repurposed drugs. Media outlets often adapted these publications (e.g., non-randomized clinical trial results) for lay audiences with attention-grabbing headlines like “Trump is taking hydroxychloroquine, White House confirms” (**Supplementary Material I**).

Although not directly analyzed here, it is plausible that these reports also circulated widely through social media platforms (e.g., Facebook, Twitter, and WhatsApp), often stripped of context or source links²⁸. This may have prompted users to return to Google to search for specific terms, increasing DSV levels. Early coverage of preliminary findings was frequently misinterpreted as evidence of approved COVID-19 treatments²⁹, and renewed interest and confusion often followed announcements, public declarations, or regulatory changes such as the FDA’s withdrawal of HCQ authorization³⁰.

As Schulze et al³¹ argued, the effects of media coverage vary across countries depending on epidemiological, political, and sociocultural factors. Nonetheless, this study shows that a single news item or concept could rapidly spread across multiple, heterogeneous, Spanish-speaking countries, sometimes generating simultaneous DSV peaks in up to ten nations (as with dexamethasone). While causality cannot be confirmed, this cross-border transmission likely reflects a shared sense of global uncertainty and common information needs. A separate study, consistent with our findings, reported that a single television program created global spikes in Ozempic search interest across countries with different languages³².

Antibiotics, such as azithromycin, generated the highest search volumes across the selected countries in Latin America, despite not being recommended for mild or moderate COVID-19 cases¹⁷ likely reflecting persistent regional misconceptions about antibiotics and viral infections³³. Venezuela exhibited the highest number of DSV peaks, likely due to its political context and the central role of the Internet and social media as primary information sources³⁴. There, DX attracted significant attention following early trial results emphasizing the reduction of deaths, leading to ambulatory use despite subsequent evidence indicating that corticosteroids could worsen outcomes in non-severe COVID-19 cases³⁵.

In Peru, presidential endorsements for ivermectin appeared as early as May 2020, even before any randomized controlled trials were released^{36,37}. Such promotion can strongly influence public perception, fostering belief in the efficacy of unproven treatments despite contrary scientific evidence. Interestingly, ivermectin’s DSV levels were lower than those of other drugs without official backing, suggesting that additional factors beyond government messaging influenced public interest. In contrast, lower DSV countries, such as the Dominican Republic, may simply reflect smaller populations or more limited media exposure.

The consequences of these searches’ dynamics may not be trivial. Following HCQ promotion in the United States, stockpiling and shortages were reported by media in Latin American countries, including Mexico, like observed

in the headlines, affecting patients dependent on these medications and resulting in unnecessary out-of-pocket spending³⁸. In Latin America, these effects were exacerbated by pre-existing challenges such as self-medication and over-prescription. While this study cannot determine whether search activity directly influenced purchases, other research indicates both consumption and sales of these treatments increased during this period^{39,40}. In some cases, news about the misuse of unproven treatments resulted in direct harm. For example, the death of an infant in Argentina from CD ingestion drew national attention (high DSV) in several countries and may have inadvertently spurred further searches and use.

The amplification of news at the national level: the case of Mexico

In Mexico, the pattern of search interest closely mirrored the country's epidemiological curve, a trend also seen in other nations³¹. However, it remains unclear whether public interest in treatments was driven primarily by case numbers, pandemic uncertainty, or intense media coverage, a question future studies should explore⁴¹. Of note, subnational patterns likely contributed to national DSV peaks. A study focused on chlorine dioxide in Mexico found DSV differences across states, suggesting localized dissemination of information⁴².

Many high-profile international news stories were often echoed by Mexican media with minimal changes in publication dates, occasionally amplifying misinformation. Such coverage can unintentionally legitimize false or misleading claims, as audiences may struggle to distinguish between reporting on misinformation and endorsing it⁴³. For example, CD's alleged benefits led some Mexican physicians to request authorization from the Ministry of Health for its use, despite the lack of confirmed evidence of efficacy and the existence of proven toxicity²⁰.

Social media further amplified these effects. Many people were misled by non-experts who, in an attempt to share their opinions, recommended treatments with insufficient or null scientific evidence³. In Mexico, physicians in low-cost private retail clinics located next to pharmacies acknowledged prescribing combinations of "antivirals, antibiotics, analgesics, antipyretics, and anti-inflammatory drugs" as prophylaxis⁴⁴. These medications, sometimes prescribed together, may explain why their search trends rose simultaneously, reflecting both clinical practice and public uncertainty. Worryingly, antibiotics, despite requiring prescriptions, were used indiscriminately to treat viral infections, possibly explaining high DSV levels⁴⁵. The widespread circulation of online medical information likely reinforced such practices and influenced outpatient drug use across Mexico, as suggested by later studies⁴⁵.

The implications for risk communication and health literacy

Our findings suggest that early detection of spikes in online searches for unproven treatments could help authorities respond to misinformation, prevent stockpiling, and discourage self-medication. This is especially important in Latin America, where regulatory gaps and cultural beliefs may facilitate such practices.

Governments and regional bodies (e.g., WHO) should invest in real-time monitoring of search trends, media headlines, and social media activity to detect and counter misleading information that spreads rapidly across borders. Public health agencies should establish early warning systems that, upon detecting a surge in searches for a treatment, trigger communication protocols to clarify its proper use and risks, thereby counteracting the initial harmful media narrative.

Of note, the growing influence of social media bots⁴⁶ and Artificial Intelligence (AI) large language models (e.g., ChatGPT) further complicates the information landscape by automating content dissemination and influencing public debate usually in the form of single-response outputs⁴⁷. However, these same technologies and machine learning can also be harnessed to distinguish misinformation and computational propaganda from reliable evidence and feed response mechanisms⁴⁸.

Integrating Emergency Risk Communication (ERC) with **eHealth literacy** programs, ideally through a permanent, government-led **public health communication office**, is crucial to help both the public and health professionals critically interpret scientific evidence on treatments and recognize misinformation. Rapid, coordinated responses are also vital, as studies show that refuting false claims promptly is more effective than simply promoting accurate content^{15,16,49}. Timely, transparent, and coherent media coverage can reduce public anxiety and prevent panic^{15,50}.

Finally, as misinformation can re-emerge long after initial corrections (in the form of outdated headlines) as seen in this study, sustained risk communication efforts are needed to reinforce accurate messages, including in later phases of the pandemic, when old misinformation resurfaces among people who either did not see previous explanations or have forgotten them. Nuanced or overly technical headlines may also hinder comprehension⁴⁹; therefore, direct and well-framed communication from trusted sources remains fundamental to mitigating the health risks of misinformation during and after public health crises.

Limitations

As an exploratory study, this work has important limitations, (some of which have already been noted in each section), but it offers valuable insights for future research on how online data and media dynamics influence public information-seeking behavior. Firstly, commercial names and treatments with non-specific high DSV were excluded, which may have omitted some relevant searches; however, most online media used generic drug names. Google Trends provides only relative search volumes and cannot confirm whether treatments were purchased or used. The use of differentiated thresholds for international and national media analyses reflects the study's exploratory nature. The goal was not to establish causality but to highlight the evolving role of online media coverage in influencing online health-seeking behaviors, while offering insights for future epidemiological research. Because media articles were manually identified by date, results should be interpreted cautiously. The lack of transparency in Google's algorithms³² and the one-year observation period further limits generalizability. Future studies could explore how the quality of risk communication influences search behavior over time.

Conclusions

This multi-country explorative study using Google Trends sheds light on how online searches for unproven COVID-19 treatments (such as AZ, CD, CO, HCQ, and IV) increased in Latin America during the early phase of the pandemic. Although causality cannot be established, the observed patterns suggest that media coverage may have shaped public interest in certain aspects, contributing to the rapid spread of treatment-related searches across countries and the popularity of specific drugs within regions. Monitoring digital search trends at regional and national levels can help identify emerging health concerns, including search behaviors that may lead to self-medication, inappropriate prescription, or supply shortages. Infodemiology tools, when combined with effective health literacy initiatives and risk communication strategies, can support real-time, evidence-based public health responses. Strengthening media monitoring, improving the clarity of health messages, and fostering collaboration between governments are essential to counter misinformation and protect population health during health emergencies.

Authors' contributions

JHT and GMG conceived the idea of the paper. Acquisition of data and organization of data was executed by GMG and JIRC. GMG, JIRC and JHT were in charge of analysis. AAS & JHT processed the data. AD, PTP, GMG, AAS, and JHT collected news events related to specific dates. JHT and AD interpreted the data. JHT drafted the first version of the manuscript. VJW, LICP, AD, and PTP provided a critical revision of the manuscript for intellectual content. All authors provided technical support, contributed to subsequent versions of the manuscript, and approved the final version for publication. All authors agree to be accountable for all aspects of the work and to ensure that questions related to the accuracy/integrity of any part of the work are appropriately addressed.

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Ethical considerations

This study was conducted as part of a broader research project approved by the Ethics and Research Committees of the National Institute of Public Health of Mexico (No. 1697).

Competing interests

The authors report there are no competing interests to declare.

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While preparing this work, the author used the AI-assisted tool Grammarly™ to improve readability and language. The content and interpretation of the data given in this study are entirely the authors' responsibility.

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Supplementary Material I. International media matched to high DSV in ≥ 3 countries

Search Term	DSV (≥ 3 countries)	Type of publication	Date of publication	Online media headline	Publisher	Main message	URL
Hydroxy-chloroquine	22/03/2020	Academic publication	March 20, 2020	Hydroxychloroquine and azithromycin as a treatment of COVID-19: results of an open-label non-randomized clinical trial	International Journal of Antimicrobial Agents	HCQ & AZ RCT promising results for the treatment of COVID-19 are published	Gautret P, Lagier JC, Parola P, et al. Hydroxychloroquine and azithromycin as a treatment of COVID-19: results of an open-label non-randomized clinical trial. <i>Int J Antimicrob Agents</i> 2020; 56: 105949 (accessed 28 September, 2021 from https://pubmed.ncbi.nlm.nih.gov/32205204/)
Hydroxy-chloroquine	22/03/2020	Online media (news)	March 20, 2020	Trump is taking hydroxychloroquine, White House confirms	The Guardian	Trump (POTUS) confirms he is taking HCQ and that it is a safe treatment	McCarthy T, Greve JE. Trump is taking hydroxychloroquine, White House confirms, https://www.theguardian.com/us-news/2020/may/19/trump-hydroxychloroquine-covid-19-white-house (accessed 28 September 2021)
Hydroxy-chloroquine	29/03/2020	Academic/ Technical news	March 30, 2020	Coronavirus (COVID-19) Update: Daily Roundup March 30, 2020	FDA	The FDA authorizes the emergency use of CQ and HCQ to treat hospitalized COVID-19 patients.	U.S. Food and Drug Administration. Coronavirus (COVID-19) Update: Daily Roundup March 30, 2020, https://www.fda.gov/news-events/press-announcements/coronavirus-covid-19-update-daily-roundup-march-30-2020 (2020, accessed 11 October 2021).
Hydroxy-chloroquine	17/05/2020	Online media (news)	May 18, 2020	Tratamiento de coronavirus Trump dice que está tomando hidroxiclороquina pese a que no está demostrado que sea seguro ni efectivo	BBC	Trump says he is taking HCQ despite it being an unproven treatment.	Redacción BBC News Mundo. Tratamiento de coronavirus Trump dice que está tomando hidroxiclороquina pese a que no está demostrado que sea seguro ni efectivo. BBC News Mundo, https://www.bbc.com/mundo/noticias-internacional-52717284 (2020, accessed 11 October 2021).
Dexamethasone	14/06/2020	Academic/ Technical news	June 16, 2020	Low-cost dexamethasone reduces death by up to one third in hospitalised patients with severe respiratory complications of COVID-19	University of Oxford	DX reduces fatalities in hospitalized patients with severe COVID-19 (RCT)	Nuffield Department of Population Health; University of Oxford. Low-cost dexamethasone reduces death by up to one third in hospitalised patients with severe respiratory complications of COVID-19, https://www.recoverytrial.net/news/low-cost-dexamethasone-reduces-death-by-up-to-one-third-in-hospitalised-patients-with-severe-respiratory-complications-of-covid-19 (2020, accessed 28 September 2021).
Chlorine Dioxide	19/07/2020	Academic/ Technical news	Jul 16, 2020	La OPS no recomienda tomar productos que contengan dióxido de cloro, clorito de sodio, hipoclorito de sodio o derivados, 16 de julio del 2020	PAHO	PAHO advises against taking Chlorine Dioxide and derivatives	PAHO. La OPS no recomienda tomar productos que contengan dióxido de cloro, clorito de sodio, hipoclorito de sodio o derivados, https://iris.paho.org/handle/10665.2/52484 (2020, accessed 6 October 2021)
Chlorine Dioxide	26/07/2020	Online media (news)	July 29, 2020	Lawmakers push toxic disinfectant as Covid-19 treatment in Bolivia, against Health Ministry's warnings	CNN	Lawmakers push CD as COVID-19 treatment in Bolivia	Gigova R. Lawmakers push toxic disinfectant as Covid-19 treatment in Bolivia, against Health Ministry's warnings. CNN, https://edition.cnn.com/2020/07/29/americas/bolivia-disinfectant-covid-19-intl/index.html (2020, accessed 6 October 2021).

Search Term	H ₂ DSV (≥ 3 countries)	Type of publication	Date of publication	Online media headline	Publisher	Main message	URL
Azithromycin	02/08/2020	Academic publication	August 02, 2020	Macrolides and viral infections: focus on azithromycin in COVID-19 pathology	International Journal of Antimicrobial Agents	Study links more risks than benefits regarding HCQ & AZ used as a treatment for COVID-19	Pani A, Lauriola M, Romandini A, et al. Macrolides and viral infections: focus on azithromycin in COVID-19 pathology. <i>Int J Antimicrob Agents</i> 2020; 56: 106053. (accessed 28 September, 2021 from https://www.sciencedirect.com/science/article/abs/pii/S0924857920302235)
Chlorine Dioxide	16/08/2020	Online media (news)	August 16, 2020	Muere un niño de cinco años en Argentina al que dieron dióxido de cloro para “curar” el coronavirus	Cadena SER Argentina	Death of infant in Argentina from chlorine dioxide use	Cadena SER. Muere un niño de cinco años en Argentina al que dieron dióxido de cloro para ‘curar’ el coronavirus. Cadena SER, https://cadenaser.com/ser/2020/08/16/internacional/1597572899_783805.html (2020, accessed 11 October 2021).
Ivermectin	03/01/2021	Academic publication	Published on June 21, 2021, but the original document was published on January 03, 2021	Ivermectin for Prevention and Treatment of COVID-19 Infection: A Systematic Review, Meta-analysis, and Trial Sequential Analysis to Inform Clinical Guidelines	American Journal of Therapeutics	Moderate-certainty evidence finds that large reductions in COVID-19 deaths	Bryant A, Lawrie TA, Fordham EJ. Ivermectin for Prevention and Treatment of COVID-19 Infection: A Systematic Review, Meta-analysis, and Trial Sequential Analysis to Inform Clinical Guidelines. <i>American Journal of Therapeutics</i> , 28, e434-e460, July 2021. <i>Am J Ther</i> 2021; 28: E573–E576. (accessed 28 September, 2021 from https://pubmed.ncbi.nlm.nih.gov/34145166/) Original: Lawrie TA. Ivermectin reduces the risk of death from COVID-19 -a rapid review and meta-analysis in support of the recommendation of the Front Line COVID-19 Critical Care Alliance. 2021. Epub ahead of print 2021. DOI: 10.13140/RG.2.2.27751.88486.
Ivermectin	10/01/2021	Academic publication	January 09, 2021	Ivermectin as a potential treatment for mild to moderate COVID-19 – A double blind randomized placebo-controlled trial	MedRxiv	IV is associated with a higher proportion of COVID-19 hospitalized patients discharged alive.	Ravikirti, Roy R, Pattadar C, et al. Ivermectin as a potential treatment for mild to moderate COVID-19 – A double blind randomized placebo-controlled trial. <i>medRxiv</i> 2021 (accessed 28 September, 2021 from https://www.medrxiv.org/content/10.1101/2021.01.05.21249310v1)
Colchicine	24/01/2021	Academic publication	January 27, 2021	Efficacy of Colchicine in Non-Hospitalized Patients with COVID-19	MedRxiv	Study published linking colchicine use with reduced hospitalization and deaths in COVID-19 patients	Tardif J-C, Bouabdallaoui N, L'Allier PL, et al. Efficacy of Colchicine in Non-Hospitalized Patients with COVID-19. <i>medRxiv</i> 2021; 2021.01.26.21250494. (accessed 28 September, 2021 from https://www.medrxiv.org/content/10.1101/2021.01.26.21250494v1)

Abbreviations: AZ: Azithromycin; CD: Chlorine dioxide; CO: Colchicine; CQ: Chloroquine; FDA: United States Food and Drugs Administration; DX: Dexamethasone; HCQ: Hydroxychloroquine; IV: Ivermectin; PAHO: Pan American Health Organization; POTUS: President of the United States; RCT: Randomized-controlled trial.

Supplementary Material 2. National media matched to corresponding to H_{DSV} in Mexico

Search Term (sought in Spanish)	H_{DSV} (≥ 3 countries)	Date of H_{DSV} in Mexico	H_{DSV} in Mexico	Type of publication	Date of publication	Online media headline	Publisher	Main message	URL
Hydroxy- chloroquine	22/03/2020	22/03/2020	100	Online media (news)	March 25, 2020	Coronavirus: el tratamiento con cloroquina del infectólogo francés despierta apoyos y dudas entre científicos	Infobae	Chloroquine treatment sparks support and ignites doubt	Infobae. Coronavirus: el tratamiento con cloroquina del infectólogo francés despierta apoyos y dudas entre científicos, https://www.infobae.com/america/tendencias-america/2020/03/25/coronavirus-el-tratamiento-con-cloroquina-del-infectologo-frances-despierta-apoyos-y-dudas-entre-cientificos/ (2020, accessed 11 October 2021)
Hydroxy- chloroquine	29/03/2020	29/03/2020	82	Online media (news)	April 02, 2020	El otro drama del COVID-19. Mercado negro de Hidroxicloroquina.	EME EQUIS	HCQ panic shopping after Trump's declarations	Saldana N. El otro lado del mercado negro de hidroxicloroquina. EME EQUIS, https://www.m-x.com.mx/al-dia/el-otro-drama-del-covid19-mercado-negro-de-hidroxicloroquina (2020, accessed 11 October 2021)
Dexame- thasone	14/06/2020	14/06/2020	100	Online media (news)	June 16, 2020	Dexametasona: la nueva terapia promesa contra el COVID-19 reduce muertes hasta en un tercio, según investigadores de Oxford	Xataka	Oxford study on DX & COVID-19 mortality reduction revisited in the media	Steve O. Dexametasona: la nueva terapia promesa contra el COVID-19 reduce muertes hasta en un tercio, según investigadores de Oxford. Xataka, https://www.xataka.com.mx/medicina-y-salud/dexametasona-nueva-terapia-promesa-covid-19-reduce-muertes-tercio-investigadores-oxford (2020, accessed 10 October 2021)
Ivermectin		05/07/2020	100	Online media (news)	July 05, 2020	Ivetxerm, fármaco antiparasitario que mataría a la COVID-19 en 48 hrs, comienza a probarse en México	Sin Embargo	Media reports on the use of IV as a treatment for COVID-19	Redacción/SinEmbargo. Ivetxerm, fármaco antiparasitario que mataría a la COVID-19 en 48 hrs, comienza a probarse en México. Sin embargo, https://www.sinembargo.mx/05-07-2020/3817858 (accessed 11 October 2021).
Azithromycin		12/07/2020	88	Online media (news)	July 16, 2020	No hay cura para COVID: estos medicamentos no acaban con el virus e incluso pueden dañarte	Animal político	There is no cure for COVID (including AZ), media echoes	Vega A. No hay cura para COVID: estos medicamentos no acaban con el virus e incluso pueden dañarte. Animal Político, https://www.animalpolitico.com/2020/07/no-hay-cura-covid-medicamentos-no-matan-virus/ (2020, accessed 29 September 2021).

Search Term (sought in Spanish)	H ₁ DSV (≥ 3 countries)	Date of H ₁ DSV in Mexico	H ₁ DSV in Mexico	Type of publication	Date of publication	Online media headline	Publisher	Main message	URL
Azithromycin		19/07/2020	83	Academic/ Technical news	July 15, 2020	Versión estenográfica. Conferencia de prensa. Informe diario sobre coronavirus COVID-19 en México	Gobierno de México	AZ is not recommended as COVID-19 treatment	Presidencia de la República. Informe diario sobre coronavirus COVID-19 en México. Versión estenográfica. Conferencia de prensa., https://www.gob.mx/presidencia/es/articulos/ version-estenografica-conferencia-de-prensa- informe-diario-sobre-coronavirus-covid-19- en-mexico-245171?idiom=es (accessed 29 September 2021).
Chlorine Dioxide	19/07/2020	15/07/2020	100	Online media (news)	July 15, 2020	Advierten sobre uso de dióxido de cloro para combatir coronavirus	Milenio	Warning on use of chlorine dioxide to fight coronavirus	Morales C. Advierten sobre uso de dióxido de cloro para combatir coronavirus. Milenio Noticias., https://www.milenio.com/ciencia-y- salud/coronavirus-en-puebla-advierten-sobre- uso-de-dioxido-de-cloro (2020, accessed 20 September 2021)
Azithromycin		20/12/2021	79	Online media (news)	December 17, 2020	Patients with COVID-19 treated with ivermectin and azithromycin have shorter periods of fever: study	El Financiero	Media revisits a study where COVID-19 patients treated with IV had shorter periods of fever. AZ and HCQ were also used.	Redacción. Pacientes con COVID-19 tratados con ivermectina presentan períodos de fiebre más cortos: estudio. El Financiero, https:// www.elfinanciero.com.mx/salud/pacientes- con-covid-19-tratados-con-ivermectina- presentan-periodos-de-fiebre-mas-cortos- estudio/ (accessed 4 March 2022).
Chlorine Dioxide		10/01/2021	98	Online media (news)	January 07, 2021	Piden usar el dióxido de cloro	El Norte	Medical Doctors request the Ministry of Health to allow the use of CD to treat COVID-19.	González L. Piden usar el dióxido de cloro. El Norte, https://www.elnorte.com/ aplicacioneslibre/preacceso/articulo/default. aspx?__rval=1&urlredirect=https://www. elnorte.com/piden-usar-el-dioxido-de-cloro/ ar2101161?referer=-7d616165662f3a3a62 62623b727a7a7279703b767a783a-- (2021, accessed 11 October 2021).
Azithromycin		17/01/2021	93	Online media (news)	January 22, 2021	Médicos en CDMX suministran ivermectina y azitromicina para tratar pacientes con COVID-19	El Financiero	Physicians in the capital of Mexico provide IV and AZ to treat COVID-19 patients.	Ferrer A. Médicos en CDMX suministran ivermectina y azitromicina para tratar pacientes con COVID-19, https://www. elfinanciero.com.mx/salud/medicos-en-cdmx- suministran-ivermectina-y-azitromicina- para-tratar-pacientes-con-covid-19/ (2020, accessed 28 September 2021).

Search Term (sought in Spanish)	H ₁ DSV (≥ 3 countries)	Date of H ₁ DSV in Mexico	H ₁ DSV in Mexico	Type of publication	Date of publication	Online media headline	Publisher	Main message	URL
Ivermectin		24/01/2021	73	Online media (news)	January 24, 2021	Secretary of Health: the efficacy of Ivermectin and Azithromycin against COVID-19 has not been proven.	Infobae	The Health Secretariat states that the efficacy of IV and AZ against COVID-19 has not been proven	InfoBae. Secretaría de Salud: no se ha comprobado la eficacia de la Ivermectina y Azitromicina contra el COVID-19. InfoBae, https://www.infobae.com/america/mexico/2021/01/24/secretaria-de-salud-no-se-ha-comprobado-la-eficacia-de-la-ivermectina-y-azitromicina-contra-el-covid-19/ (2021, accessed 29 September 2021).
Colchicine	24/01/2021	24/01/2021	100	Online media (news)	January 23, 2021	Fármaco contra la gota reduce mortalidad de Covid-19, según estudio de Canadá	Forbes Mexico	Media shares study on colchicine and reduced hospitalization and death in COVID-19 patients	Forbes Staff. Fármaco contra la gota reduce mortalidad de Covid-19, según estudio de Canadá, https://www.forbes.com.mx/internacional-farmaco-gota-mortalidad-covid-19-estudio-canada/ (accessed 11 October 2021).
Azithromycin		24/01/2021	100	Online media (news)	January 29, 2020	Especialistas piden evitar uso de ivermectina y azitromicina contra Covid-19	Aristegui Noticias	Specialists call for avoiding the use of IV and AZ against Covid-19	Redacción AN / GH. Especialistas piden evitar uso de ivermectina y azitromicina contra Covid-19. Aristegui Noticias, https://aristeguinioticias.com/2901/mexico/especialistas-piden-evitar-uso-de-ivermectina-y-azitromicina-contra-covid-19/ (accessed 29 September 2021).

Abbreviations: AZ: Azithromycin; CD: Chlorine dioxide; CO: Colchicine; DX: Dexamethasone, HCQ: Hydroxychloroquine; IV: Ivermectin.