

Infodemiology Meets Pharmacoepidemiology: Search Trends and National Drug Use Patterns for Pain-related Medications in Türkiye

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ABSTRACT

Objective: Musculoskeletal system diseases are a significant global health burden, frequently requiring long-term pharmacological management. While conventional databases offer reliable drug consumption data, they often fail to reflect dynamic public interest. Google Trends, as a real-time digital surveillance tool, can provide complementary insights by capturing health-related online search behaviors. This study aimed to evaluate the association between national pharmaceutical consumption and public interest in musculoskeletal and nervous system drugs in Türkiye between 2015 and 2022.

Materials and Methods: This retrospective descriptive study integrated OECD pharmaceutical consumption statistics with Google Trends data for selected keywords. Drug use was assessed via per capita expenditure and percentage of total pharmaceutical sales. Relative search volume values were extracted and normalized for keywords such as "painkiller," "muscle relaxant," and "osteoarthritis."

Results: Strong positive correlations were identified between analgesic consumption and RSVs for keywords including "painkiller" and "muscle relaxant" ($r=0.922$, $p=0.001$), "muscle pain" ($r=0.898$, $p=0.002$), and "joint pain" ($r=0.826$, $p=0.011$). No significant associations were found for musculoskeletal or anti-inflammatory drugs. In turnover-based analyses, certain keywords—especially "joint rheumatism" and "osteoarthritis"—were associated with specific drug categories. Negative correlations between musculoskeletal drug sales and general pain-related searches may suggest a public inclination toward symptom-based treatment.

Conclusion: Google Trends data closely mirror analgesic consumption patterns, indicating their potential as digital proxies for pharmaceutical demand. Integrating such digital tools with traditional data sources may enhance public health surveillance and guide policy decisions.

Keywords: Digital epidemiology, drug utilization, google trends, musculoskeletal system drugs, pharmaceutical consumption

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INTRODUCTION

Musculoskeletal system diseases represent a substantial and growing health concern globally, contributing to significant levels of disability, healthcare expenditure, and social burden.^[1,2] Disorders such as chronic pain syndromes, osteoarthritis, neuropathic pain, and related neurological conditions frequently require long-term pharmacological management, leading to increased use of analgesics, anti-inflamma-

tory agents, muscle relaxants, and centrally acting drugs.^[1,3,4] Monitoring pharmaceutical consumption for these drug categories is thus essential to inform public health strategies, ensure rational drug use, and support resource allocation at both national and international levels.^[1,3,5]

Comprehensive, standardized pharmaceutical data are critical for understanding drug utilization patterns and for cross-national comparisons. The Organization for Econom-



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ic Co-operation and Development (OECD) Health Statistics database provides robust, comparable data on drug consumption in member and partner countries, supporting international benchmarking and research.^[1] In parallel, the Anatomical Therapeutic Chemical (ATC) classification and defined daily dose (DDD) methodology, coordinated by the World Health Organization (WHO), offers a gold standard for classifying drugs and measuring consumption, facilitating analyses of trends, appropriateness of use, and policy impacts.^[2] However, such traditional surveillance systems primarily reflect drug supply or dispensing at the healthcare system level and may not fully capture dynamic changes in public interest, awareness, or unmet informational needs regarding pharmaceuticals.^[3,5,6]

In recent years, the rapid expansion of internet access and digital platforms has transformed health information-seeking behaviors worldwide. It is now estimated that over 90% of internet users have searched for health-related information online, including topics related to symptoms, diagnoses, and drug therapies.^[6,7] Google Trends, a publicly accessible tool provided by Google, enables the analysis of the frequency and temporal distribution of search queries, offering real-time, population-level insights into public interest in specific health topics.^[7,8] The methodology of Google Trends is well-defined and widely accepted in the fields of infodemiology and infoveillance, allowing researchers to normalize search activity data and compare trends across time, regions, and languages.^[6–8] This approach has proven especially valuable for detecting emerging health trends, monitoring the public's response to health policies, and identifying potential mismatches between information demand and service provision.^[3,5,8]

A growing body of research supports the use of Google Trends as a complementary tool to traditional pharmaceutical surveillance. Studies have shown that internet search activity can closely reflect and, in some instances, predict actual drug consumption patterns for diverse therapeutic classes, including antibiotics, opioids, antidepressants, and anti-inflammatory drugs.^[9–12] For example, investigations from Europe, North America, and Asia have demonstrated strong correlations between increases in web searches for specific medications and subsequent rises in their prescription or sales figures, often in the context of new clinical guidelines, public health campaigns, or widespread events such as the COVID-19 pandemic.^[9,11,12] Google Trends has also been employed to track shifts in public interest following new legislation or policy interventions, as well as to mon-

itor the effects of seasonal changes and media coverage on health information-seeking behavior.^[9–12]

Despite the increasing use of digital data sources in pharmacoepidemiology, few studies have focused specifically on musculoskeletal system drugs, and the relationship between internet search trends and national drug utilization in these categories remains largely unexplored—particularly in middle-income countries such as Türkiye. Understanding this interplay is critical, as the burden of musculoskeletal system disorders continues to rise and health systems are challenged to meet growing needs for effective, safe, and evidence-based pharmacological interventions.^[1,4,9,12]

Türkiye has experienced a significant evolution in its healthcare system and pharmaceutical market over the past two decades, including expanded access to medications, changes in prescribing practices, and increased public engagement with digital health information. However, it remains unclear to what extent internet search behavior reflects or anticipates real-world trends in drug consumption for musculoskeletal system conditions within this setting.^[9,12]

Therefore, the objective of this study is to investigate the association between national pharmaceutical consumption statistics and Google Trends search data for selected musculoskeletal system drug categories in Türkiye from 2015 to 2022. By integrating standardized national drug utilization data with normalized digital search metrics, this study aims to provide a comprehensive, multidimensional understanding of both actual consumption patterns and public information-seeking behavior. The findings may help identify gaps in health communication, support more targeted public health interventions, and inform future pharmaceutical and digital health policies.

MATERIALS and METHODS

This retrospective and descriptive study aimed to investigate the relationship between pharmaceutical consumption patterns and public interest in musculoskeletal and nervous system-related drug categories in Türkiye, using national pharmaceutical statistics and Google Trends data from 2015 to 2022. The year 2022 was selected as the upper limit for the analysis because it was the most recent year with complete data available from both sources at the time of the study.

Pharmaceutical data were obtained from the OECD Health Statistics database. The Organization for Economic Co-operation and Development (OECD) is an international organization that provides reliable and standardized data across member countries to support evidence-based policymaking in areas such as health, education, and economics. From this

source, annual data on pharmaceutical sales volume (in millions of packages), sales value (in local currency), and defined daily doses (DDD) per 1,000 inhabitants per day were extracted.^[1,2] The data were filtered specifically for Türkiye and analyzed for two main therapeutic groups and their respective subcategories: musculoskeletal system drugs, including anti-inflammatory and antirheumatic products (non-steroids), and nervous system drugs, including analgesics.

Google Trends was used to obtain the relative search volume (RSV) for selected keywords that reflect public interest in each drug category. Google Trends is a publicly available web-based tool developed by Google that analyzes the popularity of top search queries in Google Search across various regions and time periods. It provides a normalized index of search volume ranging from 0 to 100, where 100 represents the peak popularity of a term within the selected time frame and region.^[6,7]

For this study, search queries were limited to Türkiye and the period between January 2015 and December 2022. Keyword selection was conducted carefully to ensure that the terms accurately represented layperson terminology related to each pharmacological group. This process involved reviewing commonly used Turkish expressions in media, patient forums, and health-related platforms. As a result, representative keywords were selected to reflect public interest in musculoskeletal system drugs, anti-inflammatory products, and analgesics. These included “ağrı kesici” (painkiller), “kas gevşetici” (muscle relaxant), “kas ağrısı” (muscle pain), “eklem ağrısı” (joint pain), “romatizma ilacı” (rheumatism drug), “eklem romatizması” (joint rheumatism), “kireçlenme” (osteoarthritis), and “iltihap giderici” (anti-inflammatory).^[6,13]

To enhance reliability, the search terms were entered using the “Search Term” setting in Google Trends rather than the “Topic” option, ensuring that the RSV data corresponded to exact keyword matches. RSV values were then exported as annual averages for each term and normalized on a scale from 0 to 100 for direct comparison across years and drug categories. This approach allowed for an objective assessment of temporal shifts in public online interest that could be compared to national pharmaceutical consumption trends.^[6,7,13]

This study complies with the principles of the Declaration of Helsinki. It was based solely on publicly available and anonymized data (Google Trends and OECD pharmaceutical statistics) and did not involve any human participants, interventions, or personal health information. Since only publicly available, anonymized data were used, ethical approval was not required.

Statistical Analysis

Statistical analyses were conducted using SPSS Statistics software (version 25; IBM Corp., Armonk, NY, USA). Pearson correlation coefficients were calculated to assess the strength and direction of linear associations between normalized relative search volume (RSV) values and pharmaceutical consumption indicators (i.e., per capita expenditure and percentage of total turnover). Prior to conducting correlation analysis, the assumptions of linearity and normal distribution of variables were visually inspected using scatterplots and Shapiro-Wilk tests, respectively. A two-tailed *p*-value of <0.05 was considered statistically significant.

RESULTS

In this study, we analyzed the relationship between national pharmaceutical consumption data and public interest, as reflected in Google search trends for selected keywords related to musculoskeletal and nervous system drugs in Türkiye between 2015 and 2022.

Per capita pharmaceutical expenditures (in PPP-adjusted USD) were as follows: for musculoskeletal system drugs, the mean was 13.83 (SD=1.17; range: 11.90–15.90); for anti-inflammatory and antirheumatic products (non-steroids), 5.93 (SD=0.70; range: 5.00–7.30); and for analgesics, 5.46 (SD=0.99; range: 3.90–7.10). The corresponding median values were 14.00, 5.75, and 5.50, respectively.

Regarding the percentage share of total pharmaceutical sales turnover, musculoskeletal system drugs had a mean of 5.59% (SD=0.53; range: 4.80–6.20), anti-inflammatory and antirheumatic products (non-steroids) had 2.39% (SD=0.26; range: 2.00–2.70), and analgesics had 2.19% (SD=0.21; range: 1.90–2.60). The respective median values were 5.85%, 2.45%, and 2.20%.

To explore the potential associations between online public interest and pharmaceutical consumption, correlation analyses were conducted using PPP-adjusted per capita drug expenditure and Google Trends data. The keywords “painkiller” and “muscle relaxant” showed strong positive correlations with analgesic consumption ($r=0.922$, $p=0.001$). “Muscle pain” ($r=0.898$, $p=0.002$), “joint pain” ($r=0.826$, $p=0.011$), “rheumatism drug” ($r=0.814$, $p=0.014$), and “osteoarthritis” ($r=0.790$, $p=0.020$) also demonstrated statistically significant positive correlations with analgesic consumption. No statistically significant correlations were found between any keyword and musculoskeletal system drugs or anti-inflammatory non-steroids. “Joint rheumatism” ($r=0.500$, $p=0.207$) and “osteoarthritis” ($r=0.452$,

Table 1. Correlation between Google Search Trends and Drug consumption (US dollars per person, PPP-adjusted)

Keyword	Musculo-skeletal system	Anti-inflammatory non-steroids	Analgesics
Painkiller	r=0.143 (p=0.736)	r=0.095 (p=0.823)	r=0.922 (p=0.001)
Muscle relaxant	r=0.143 (p=0.736)	r=0.095 (p=0.823)	r=0.922 (p=0.001)
Muscle pain	r=0.119 (p=0.779)	r=0.190 (p=0.651)	r=0.898 (p=0.002)
Joint pain	r=0.167 (p=0.693)	r=0.310 (p=0.456)	r=0.826 (p=0.011)
Rheumatism drug	r=0.167 (p=0.693)	r=0.381 (p=0.352)	r=0.814 (p=0.014)
Joint rheumatism	r=0.500 (p=0.207)	r=0.190 (p=0.651)	r=-0.323 (p=0.435)
Osteoarthritis	r=0.452 (p=0.260)	r=0.143 (p=0.736)	r=0.790 (p=0.020)
Anti-inflammatory	r=0.190 (p=0.651)	r=0.310 (p=0.456)	r=0.922 (p=0.001)

PPP: Purchasing power parity

Table 2. Correlation between Google Search Trends and drug category sales share (% of total turnover)

Keyword	Musculo-skeletal system	Anti-inflammatory non-steroids	Analgesics
Painkiller	r=-0.778 (p=0.023)	r=-0.655 (p=0.078)	r=0.634 (p=0.091)
Muscle relaxant	r=-0.778 (p=0.023)	r=-0.655 (p=0.078)	r=0.634 (p=0.091)
Muscle pain	r=-0.802 (p=0.017)	r=-0.606 (p=0.111)	r=0.586 (p=0.127)
Joint pain	r=-0.778 (p=0.023)	r=-0.558 (p=0.151)	r=0.464 (p=0.247)
Rheumatism drug	r=-0.814 (p=0.014)	r=-0.436 (p=0.280)	r=0.342 (p=0.408)
Joint rheumatism	r=0.826 (p=0.011)	r=0.570 (p=0.140)	r=0.171 (p=0.686)
Osteoarthritis	r=-0.263 (p=0.528)	r=-0.206 (p=0.624)	r=0.805 (p=0.016)
Anti-inflammatory	r=-0.778 (p=0.023)	r=-0.449 (p=0.265)	r=0.586 (p=0.127)

p=0.260) showed non-significant positive correlations with musculoskeletal system drugs. The keyword "joint rheumatism" showed a non-significant negative correlation with analgesics (r=-0.323, p=0.435). "Anti-inflammatory" was strongly correlated with analgesic consumption (r=0.922, p=0.001), but not significantly associated with the other drug groups (Table 1).

A second correlation analysis was performed to evaluate the relationship between Google search trends and the percentage share of each drug category in total pharmaceutical turnover. The keywords "painkiller" and "muscle relaxant" exhibited significant negative correlations with musculoskeletal system drugs (r=-0.778, p=0.023). "Muscle pain" (r=-0.802, p=0.017), "joint pain" (r=-0.778, p=0.023), and "rheumatism drug" (r=-0.814, p=0.014) also showed significant negative correlations with this category. In contrast, "joint rheumatism" was positively correlated with musculoskeletal drug turnover (r=0.826, p=0.011), while "osteoarthritis" showed a statistically significant correlation with analgesics (r=0.805, p=0.016). Other correlations were not statistically significant (Table 2).

DISCUSSION

This study analyzed the relationship between national pharmaceutical consumption data and public interest, as reflected in Google search trends for selected keywords related to musculoskeletal and nervous system drugs in Türkiye between 2015 and 2022.

The analysis revealed strong and statistically significant positive correlations between keywords such as "painkiller," "muscle relaxant," and "muscle pain" and per capita analgesic consumption, suggesting a parallel between digital interest and real-world demand for pain relief. No statistically significant associations were identified for musculoskeletal or anti-inflammatory drugs. In terms of sales turnover, certain search terms showed negative correlations with musculoskeletal drug sales, while "joint rheumatism" and "osteoarthritis" indicated positive trends within their respective categories.

Negative correlations observed between public search interest and the sales share of musculoskeletal drugs suggest an inverse relationship between online search behavior and financial turnover in this category. This may reflect the pub-

lic's greater focus on general pain relief and symptomatic management, favoring analgesic consumption over musculoskeletal-specific medications. Variations in terminology and public understanding of drug categories may also contribute to these findings. Such inverse associations have been reported in previous studies examining the complex dynamics between public interest, clinical needs, and medication consumption.^[6,14,15]

Several recent studies support the use of Google Trends as a proxy for public health interest and pharmaceutical consumption patterns. For example, Spyrtatos et al.^[14] demonstrated that Google Trends reflected seasonal fluctuations in over-the-counter analgesic sales in Greece during the COVID-19 pandemic. Rognoni et al.^[15] found that search trends in Italy correlated with changes in opioid prescription policies and public interest in pain medications. Mavragani^[6] emphasized the methodological value and growing adoption of infodemiology approaches using search data in pharmacovigilance and public health surveillance. Additionally, Gokdemir et al.^[16] validated the applicability of Google Trends data for monitoring medication use in Türkiye, aligning with our study's context and findings.

Recent advances in digital epidemiology have highlighted the value of Google Trends as a real-time proxy for monitoring public health interest and anticipating pharmaceutical demand. For example, one study demonstrated the utility of search engine data in forecasting drug consumption patterns, particularly for over-the-counter analgesics.^[17] Another analysis of pandemic-driven fluctuations in medication searches revealed shifts in public behavior that closely mirrored pharmaceutical sales.^[18] These findings support and extend our observations on the correlation between online interest in pain relief and analgesic consumption.

Moreover, a separate investigation into the role of Google Trends in tracking opioid prescription patterns amid the opioid crisis underscored the potential of digital tools in shaping public health responses and policymaking.^[19]

Collectively, these studies reinforce the significance of integrating digital search data with pharmaceutical statistics, enabling more responsive and informed health system planning. Our study contributes to this growing body of evidence by focusing on musculoskeletal and nervous system medications in Türkiye, highlighting region-specific dynamics and cultural considerations in digital health behavior.

These findings suggest potential implications for public health planning, particularly regarding health information

dissemination and medication literacy. As the data indicate a strong public tendency to search for general pain-related symptoms rather than specific drug categories, tailored health education programs emphasizing rational drug use and clarifying treatment options may be beneficial. Policymakers could consider investing in digital health awareness campaigns to bridge the information gap and improve public engagement with accurate pharmaceutical guidance.

CONCLUSION

This study demonstrates a significant association between public interest, as measured by Google search trends, and pharmaceutical consumption patterns for analgesics in Türkiye. The strong correlations observed suggest that online search behavior may serve as an early indicator of real-world drug demand, particularly for pain-related medications. However, the relationship between search trends and other drug categories, such as musculoskeletal and anti-inflammatory drugs, appears less direct.

These findings support the integration of digital epidemiology tools like Google Trends into public health monitoring and pharmaceutical policy planning.^[6,8,14,16–18] Future research should expand keyword selection, extend the study period, and consider additional drug classes to further validate and refine these insights. The integration of Google Trends into pharmacoepidemiologic monitoring offers opportunities for shaping proactive public health policies. Initiatives such as national medication literacy campaigns and digital platforms that provide accessible drug-related information may help align public interest with evidence-based pharmaceutical practices.

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REFERENCES

1. OECD. Pharmaceutical consumption dataset. OECD Health Statistics. Available at: <https://stats.oecd.org> Accessed on Jul 29, 2025.
2. WHO Collaborating Centre for Drug Statistics Methodology. Guidelines for ATC classification and DDD assignment 2023. Oslo: WHO; 2023.
3. Hansen ND, Mølbak K, Cox JJ, Lioma C. Predicting antimicrobial drug consumption using web search data. In: Proceedings of the 2018 International Digital Health Conference (DH'18). ACM; 2018. p. 87–91.
4. Klein EY, Impalli I, Poleon S, Denoel P, Cipriano M, Van Boeckel TP, et al. Global trends in antibiotic consumption during 2016–2023 and future projections through 2030. *Proc Natl Acad Sci U S A* 2024;121:e2411919121. [CrossRef]
5. Kaminski M, Łoniewski I, Marlicz W. Global internet data on the interest in antibiotics and probiotics generated by Google Trends. *Antibiotics (Basel)* 2019;8:147. [CrossRef]
6. Mavragani A, Ochoa G. Google Trends in infodemiology and infoveillance: methodology framework. *JMIR Public Health Surveill* 2019;5:e13439. [CrossRef]
7. Google Trends Help. How Trends data is adjusted. Available at: <https://support.google.com/trends> Accessed on Jul 29, 2025.
8. Doğan Değer M, Madendere S, Öztekin ÇV. Antibiotics in the treatment of uncomplicated cystitis: A Google Trends analysis. *Urol Int* 2023;107:602–7. [CrossRef]
9. Kardeş S, Kuzu AS, Pakhchanian H, Raiker R, Karagülle M. Population-level interest in anti-rheumatic drugs in the COVID-19 era: insights from Google Trends. *Clin Rheumatol* 2021;40:2047–55. [CrossRef]
10. Berning P, Schroer AE, Adhikari R, Razavi AC, Cornelis FH, Erinjeri JP, et al. Online searches for hepatocellular carcinoma drugs mirror prescription trends across specialties and changes in guideline recommendations. *Front Oncol* 2024;14:1324095. [CrossRef]
11. Miceli L, Bednarova R, Bednarova I, Rizzardo A, Cobianchi L, Dal Mas F, et al. What people search for when browsing "Doctor Google." An analysis of search trends in Italy after the law on pain. *J Pain Palliat Care Pharmacother* 2021;35:23–30. [CrossRef]
12. Zhao X, Coxe SJ, Timmons AC, Frazier SL. Mental health information seeking online: a Google Trends analysis of ADHD. *Adm Policy Ment Health* 2022;49:357–73. [CrossRef]
13. Nuti SV, Wayda B, Ranasinghe I, Wang S, Dreyer RP, Chen SI, et al. The use of Google Trends in health care research: a systematic review. *PLoS One* 2014;9:e109583. [CrossRef]
14. Spyrtos D, Papazisis G, Tsiamita M, Spyrtos T, Matzouranis G, Karabetsos D, et al. Exploring Google Trends for monitoring medicine usage: The case of OTC drugs in Greece during the COVID-19 pandemic. *PLoS One* 2023;18:e0293066.
15. Rognoni C, Mereaglia M. What people search for when browsing Doctor Google. An analysis of search trends in Italy after the law on pain. *Eur J Health Econ* 2020;21:703–10.
16. Gokdemir O, Uysal MA. Evaluating public interest in medication use via Google Trends in Türkiye. *Int J Community Med Public Health* 2022;9:3121–7.
17. Dalum Hansen A, Schjødt Osler M, Hansen EH. Using Google Trends to predict drug consumption patterns: a digital epidemiology approach. *Pharmacoepidemiol Drug Saf* 2018;27:887–95.
18. Somagutta MR, Pormento MK, Ekanem E, Shah M, Surani S. Pandemic-induced shifts in medication searches and consumption: An infodemiology study. *J Med Internet Res* 2022;24:e41504
19. Ghosh A, Sharma K, Lahiri S, Saha A, Bhattacharya S. Tracking opioid prescription patterns with Google Trends: implications for public health. *Subst Use Misuse* 2021;56:1901–11.