

ORIGINAL RESEARCH

Shifts in trends of erectile dysfunction-related Google searches pre and post Covid-19 pandemic in Saudi Arabia

Raed M. Almannie¹, Meshari A. Alzahrani², Yazeed A. Alghtani^{3,*},
Moataz I. Altokhais¹, Hamad Alkhudhayri¹

¹Urology Division, Department of Surgery, College of Medicine, King Saud University, 11472 Riyadh, Saudi Arabia

²Department of Urology, College of Medicine, Majmaah University, 11952 Al-Majmaah, Saudi Arabia

³College of Medicine, King Saud University, 11461 Riyadh, Saudi Arabia

***Correspondence**

439100735@student.ksu.edu.sa

(Yazeed A. Alghtani)

Abstract

Background: Erectile dysfunction (ED) is defined as the inability to achieve or maintain penile erections that are sufficient for satisfactory sexual performance. It is a prevalent global health issue influenced by multiple physiological and psychological factors. The Covid-19 pandemic has significantly affected public health behaviors, including online health information-seeking patterns. This study aimed to evaluate ED-related online search trends in Saudi Arabia before, during and after the Covid-19 pandemic. **Methods:** Google trends (GT) was used to analyze search interest for “erectile dysfunction”, “sildenafil” and “tadalafil” across three periods: pre-pandemic (January 2016–February 2020), pandemic (March 2020–June 2022) and post-pandemic (July 2022–January 2024). The terms were chosen as they represent general ED awareness and the two most used phosphodiesterase type 5 (PDE5) inhibitors (“sildenafil” and “tadalafil”). Statistical analyses included the Mann-Kendall test for trend significance and one-way Analysis of Variance (ANOVA) with Bonferroni correction to compare search densities across study periods. **Results:** The average monthly percentage change (AMPC) for all search terms was 0.003 ($p < 0.001$). One-way ANOVA results revealed significant differences in search densities across the study periods ($p < 0.001$), showing a sustained post-pandemic increase compared with pre-pandemic levels. Sildenafil was the most searched ED medication in Saudi Arabia. **Conclusions:** This study highlights the pandemic-driven shift in ED-related online searches, which raises concerns for self-medication and emphasizes the importance of structured public health efforts to address ED awareness and treatment in Saudi Arabia.

Keywords

Erectile-dysfunction; Trend analysis; Online health-seeking behavior; Covid-19 pandemic

1. Introduction

Erectile dysfunction (ED) is defined as the inability to achieve or maintain penile erections that are sufficient for satisfactory sexual performance [1]. ED is a prevalent health issue affecting men globally, and can be influenced by vascular, neurological, psychological and hormonal factors [2]. The Covid-19 pandemic has significantly impacted global health systems and individual health behaviors, including patterns of seeking health-related information online [3]. This has contributed to an overall increase in online health-seeking behavior [4]. In particular, ED has seen an evolving trend in online searches during the pandemic [5], reflecting both the direct and indirect effects of Covid-19 on sexual health concerns. In Saudi Arabia, these challenges are further shaped by cultural norms, which play a significant role in the healthcare-seeking behaviors of men [6, 7]. Understanding these behaviors is essential for healthcare providers and policymakers to effectively address the evolving needs of men experiencing ED in this

region. This study aimed to assess how the global health crisis has influenced the public interest in sexual health information in Saudi Arabia.

2. Materials and methods

Trends data were obtained from Google Trends, a tool created by Google to analyze trends in different regions and languages, and provides a time analysis allowing users to specify a time period for the analysis [8]. This tool remains an asset in interdisciplinary research, facilitating the analysis of historical trends and the ability to predict future events such as viral outbreaks [9, 10]. In a healthcare setting, this tool has been valuable in analyzing public interests and trends relating to a health topic with the ability to specify a time range, which has allowed researchers to gain insight into the evolving health trends and concerns of the population.

Google Trends data were analyzed across three distinct periods: pre-pandemic, pandemic and post-pandemic. The pre-

pandemic period (January 2016 to February 2020) included the four years preceding the first confirmed Covid-19 case in Saudi Arabia in March 2020 [11]. The pandemic period (March 2020 to June 2022) corresponds to the timeframe during which Covid-19 was actively spreading throughout Saudi Arabia, accompanied by strict precautionary measures. The post-pandemic period (July 2022–January 2024) began after the Saudi Ministry of Health lifted Covid-19 restrictions in June 2022 [12].

Google Trends provides search indices on an arbitrary scale from 0 to 100, where 100 represents the peak search interest within a specified period. To assess trends, keywords including “erectile dysfunction”, “sildenafil” and “tadalafil” in English were analyzed individually. Other medications like “varde-nafil” and “avanafil”, did not yield significant search interest in any language in google trends, and were therefore excluded. The region was set to Saudi Arabia, and an average trend was calculated to represent the overall interest in ED and its treatments. Statistical analyses were performed using R packages, in which two primary statistical tests were conducted. The Mann-Kendall test was used to assess the significance of trends in the average monthly percentage change (AMPC) for each search term during the study period, with p-values calculated to determine statistical significance. One-way Analysis of Variance (ANOVA) was applied to compare the mean search den-

sities across the pre-pandemic, pandemic and post-pandemic periods. Following ANOVA, the Bonferroni correction was used in *post-hoc* pairwise comparisons to identify significant differences in search trends between time periods. Statistical significance was set at $p < 0.05$.

3. Results

The Average Monthly Percentage Change (AMPC) showed distinct trends for erectile dysfunction and tadalafil, but not for sildenafil, as presented in Table 1 and Fig. 1. For “erectile dysfunction”, the AMPC was 0.0047 (95% confidence interval (CI): 0.003 to 0.0063), with a tau statistic of 0.35 and a significant p -value < 0.001 , showing a significant upward trend. Similarly, “tadalafil” had an AMPC of 0.008 (95% CI: 0.0053 to 0.0108), with a tau statistic of 0.306 and a $p < 0.001$, indicating a strong positive trend. For “sildenafil”, the AMPC was 0.0003 (95% CI: -0.0007 to 0.0013), with a Mann-Kendall tau statistic of 0.0216 and a non-significant p -value of 0.75, indicating no significant trend over time. For the average across all terms, the AMPC was 0.003 (95% CI: 0.0021 to 0.0039) with a tau statistic of 0.393 and a $p < 0.001$, suggesting an overall increase in search interest during the study period.

Further analysis using a one-way ANOVA revealed significant differences in search densities across the pre-pandemic, pandemic and post-pandemic periods, as presented in Table 2.

TABLE 1. Average monthly percentage change results of the search terms.

Search terms	AMPC	95% CI		Tau test statistic	p -value*
		Lower limit	Upper limit		
Sildenafil	0.0003	-0.0007	0.0013	0.022	0.750
Erectile dysfunction (impotence)	0.0047	0.0030	0.0063	0.350	<0.001
Tadalafil	0.0080	0.0053	0.0108	0.306	<0.001
Average	0.0030	0.0021	0.0039	0.393	<0.001

CI: Confidence interval; AMPC: Average monthly percentage change.
 *: The Mann Kendall Test was applied to get the p -value.

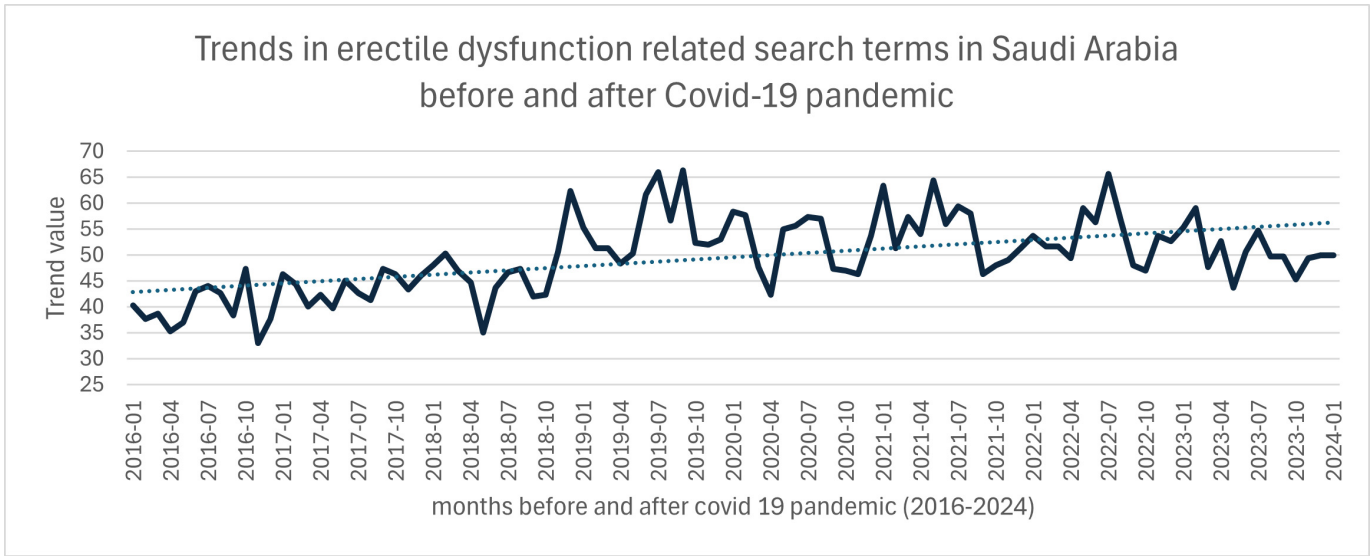


FIGURE 1. Trends in erectile dysfunction-related search terms in Saudi Arabia pre and post-Covid-19 pandemic using an average of all the keywords tadalafil, sildenafil and erectile dysfunction.

TABLE 2. Comparison of the search density for the three time periods.

	Pre-pandemic N = 50		During pandemic N = 28		Post-pandemic N = 19		One-Way ANOVA	Post-hoc analysis		
	Mean	SD	Mean	SD	Mean	SD		Pre- pandemic vs. pandemic	Pre- pandemic vs. Post- pandemic	Pandemic vs. Post- pandemic
	Mean	SD	Mean	SD	Mean	SD	<i>p</i> -value*	<i>p</i> 1**	<i>p</i> 2**	<i>p</i> 3**
Sildenafil	68.80	8.60	63.18	8.62	69.11	9.21	0.017	0.023	1.000	0.074
Erectile dysfunction (impotence)	51.88	12.94	73.96	11.17	60.16	14.28	<0.001	<0.001	0.053	0.001
Tadalafil	19.74	9.10	22.43	6.88	25.68	7.04	0.025	0.495	0.024	0.545
Average	46.81	7.83	53.19	5.39	51.65	5.16	<0.001	<0.001	0.027	1.000

**p*-value is reported for the one-way ANOVA test.

***p*-value is reported for post hoc pair-wise comparisons using Bonferroni correction.

ANOVA: analysis of variance; SD: Standard deviation.

For “sildenafil”, the mean search density decreased from 68.80 (Standard deviation (SD) = 8.60) pre-pandemic to 63.18 (SD = 8.62) during the pandemic, while the mean search density in the post-pandemic period was 69.11 (SD = 9.21). One-way ANOVA showed a significant difference ($p = 0.017$), with *post-hoc* analysis indicating a significant difference between the pre-pandemic and pandemic periods ($p = 0.023$).

For “erectile dysfunction”, there was an increase in mean search density from 51.88 (SD = 12.94) pre-pandemic to 73.96 (SD = 11.17) during the pandemic, which then decreased to 60.16 (SD = 14.28) post-pandemic. One-way ANOVA showed significant differences ($p < 0.001$), with *post-hoc* tests showing a higher search density during the pandemic period than during pre- ($p < 0.001$) and post- ($p = 0.001$) pandemic periods.

The search density for “tadalafil” increased from 19.74 (SD = 9.10) pre-pandemic to 22.43 (SD = 6.88) during the pandemic and 25.68 (SD = 7.04) post-pandemic. One-way ANOVA results showed a significant difference ($p = 0.025$), with *post hoc* analysis identifying a significant difference between the pre- and post-pandemic periods ($p = 0.024$).

When examining the average search density across all terms, there was an increase from 46.81 (SD = 7.83) pre-pandemic to 53.19 (SD = 5.39) during the pandemic, followed by a slight decrease to 51.65 (SD = 5.16) post-pandemic. This overall difference was significant ($p < 0.001$), with significant increases from pre-pandemic to pandemic ($p < 0.001$) and from pre- to post-pandemic ($p = 0.027$).

Across all Saudi provinces, Sildenafil was the most commonly searched ED medication, followed closely by Tadalafil, as represented in Fig. 2.

4. Discussion

Google Trends analysis indicated significant shifts in ED-related online search trends in Saudi Arabia during the pandemic, and sustained significant interest in the post-pandemic period.

The sustained interest in ED-related searches suggests a potential long-term impact of the pandemic on sexual health and psychological well-being. Several factors have likely contributed to this surge in interest during the pandemic period. For instance, one study reported that during the first lockdown, sexually active people experienced a lower frequency of sexual interactions and sexual satisfaction with decreased levels of libido [13]. These findings are likely due to the devastating impact of the pandemic on the well-being of individuals worldwide, with men in particular suffering from the impact of the disease itself, including mental health challenges, economic burden or the broader consequences of the pandemic [14–16].

Our findings are consistent with a global study by (Mattiuzzi, C), which demonstrated an 8.1% increase in online searches for ED during the Covid-19 pandemic compared to pre-pandemic levels [17]. To our knowledge, no study has compared post-pandemic to pandemic trends.

Sildenafil remained the most searched ED medication in Saudi Arabia. This aligns with a study conducted by Değer, MD, which examined global search trends for phosphodiesterase type 5 inhibitors (PDE5 inhibitors) during the same period, who reported that sildenafil was the most searched medication [5]. The predominance of sildenafil can be attributed to it being the first drug approved by the FDA for ED use in 1998 [18], making it the most familiar and recognizable option for many individuals seeking information about ED medications.

Additionally, cultural and religious factors in Saudi Arabia may affect individuals' willingness to seek medical advice for sexual health concerns [7], which may lead to an increase in online searches for information about ED treatments. The pandemic has also led to a marked increase in online health information-seeking behaviors, making it easier for individuals to research medical issues online [4]. However, a disadvantage of this trend is the risk of accessing misleading or non-evidence-based information. For instance, Alzahrani *et al.* [19] evaluated Arabic-language content on YouTube related to ED and found that 84% of videos were based on non-

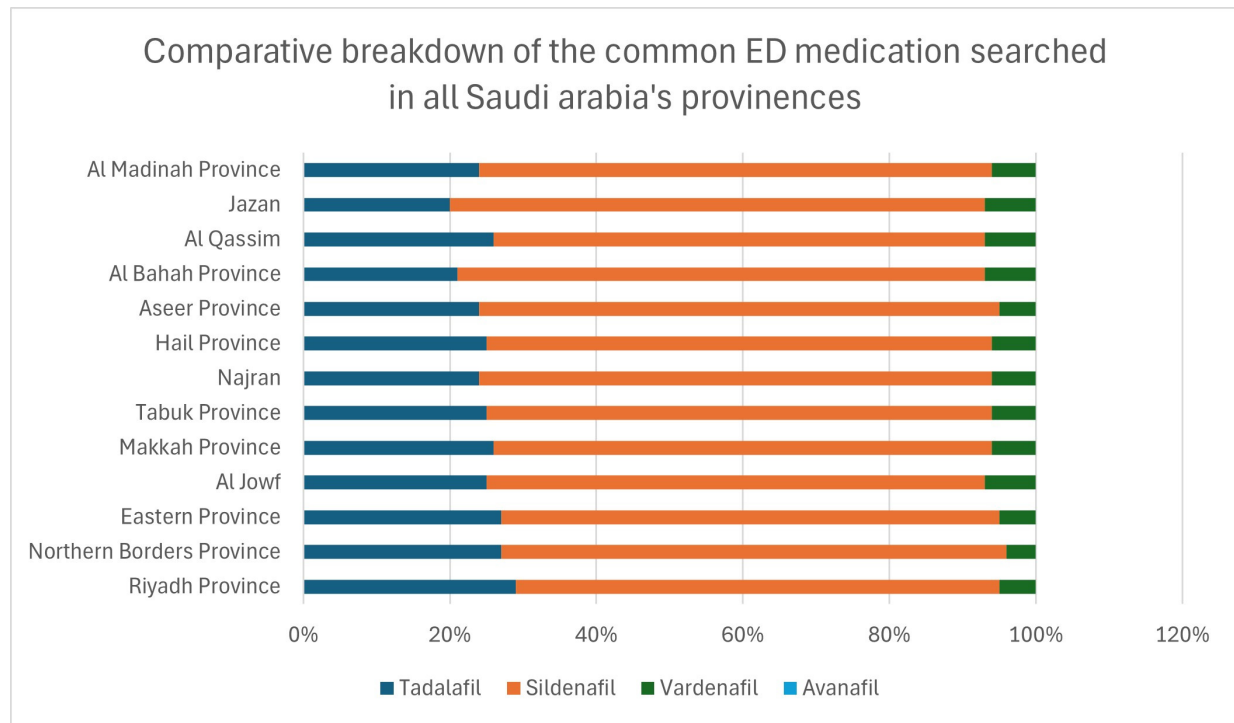


FIGURE 2. Comparative breakdown of the most common search term in Saudi Arabia pre and post-Covid-19 pandemic. ED: Erectile dysfunction.

evidence-based information, which may harm viewers or lead to incorrect treatment and management of the condition.

Although Google Trends offers insights into search behaviors, it is important to acknowledge its limitations. Google Trends data are anonymous, and age, race and gender cannot be assessed individually. Additionally, Google Trends cannot provide information on the motivation behind searches, users' actions after searching, or the accuracy of the information given, nor does it provide a specific number of online searches.

5. Conclusions

Trends analysis results demonstrated that public interest in ED-related search behaviors surged during the pandemic and was sustained in the post-pandemic period. These findings can be attributed to an increase in health awareness or behavioral changes caused by the pandemic. Sildenafil was the most commonly searched medication across all Saudi provinces, indicating a growing awareness of ED and its treatments, thus rising concerns of potential self-medication or diagnoses without consulting a physician. These findings suggest the need for increased public health efforts to increase the awareness and treatment of ED in the region.

AVAILABILITY OF DATA AND MATERIALS

Data is available online at <https://trends.google.com/trends/>.

AUTHOR CONTRIBUTIONS

RMA and YAA—designed the research study. YAA—performed the research. HA and MAA—provided help and

advice on analyzing the data. YAA and MIA—wrote the manuscript. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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