

Global infodemiological trends in Parkinson's disease-associated sleep disorders: Long-term digital impact of the COVID-19 pandemic

Esra Demir Ünal¹, Selim Selçuk Çomoğlu²

¹Department of Neurology, Ankara Yıldırım Beyazıt University Faculty of Medicine, Ankara, Türkiye

²Department of Neurology, Gülhane Faculty of Medicine University of Health Sciences, Ankara, Türkiye

ABSTRACT

Objectives: This study aimed to characterize global and regional information-seeking patterns for common Parkinson's disease (PD)-related sleep disorders (SDs) and to assess whether the COVID-19 (coronavirus disease 2019) pandemic caused a permanent structural change in these patterns using interrupted time series analysis.

Materials and methods: In this retrospective, multi-country infodemiological study, Google Trends monthly relative search volume data for 10 PD-related SDs was analyzed across nine countries and globally between 2015 and 2025. Relative search volumes were deseasonalized, and prepandemic (March 1, 2015–February 29, 2020) and postpandemic (March 1, 2020–February 28, 2025) periods were compared using a t-test or Mann-Whitney U test, as appropriate, and 95% confidence intervals were estimated by bootstrap. Data extraction used Python pytrends. Interrupted time series regression modeled level (β_2) and slope (β_3) changes, with Newey-West corrections for autocorrelation when required.

Results: Globally, insomnia relative search volume increased from 42.5 ± 5.2 to 68.2 ± 8.4 ($p < 0.001$). Rapid eye movement sleep behavior disorder (RBD) searches rose by 52.1% (mean difference: +6.3; 95% confidence interval, 4.8-7.9). Interrupted time series showed immediate level increases for insomnia ($\beta_2 = +12.4$, $p < 0.001$) and excessive daytime sleepiness ($\beta_2 = +4.2$, $p = 0.021$), and a significant positive slope acceleration in RBD ($\beta_3 = +0.08$, $p = 0.045$). Türkiye demonstrated an accelerated restless leg syndrome slope ($\beta_3 = +0.45$, $p < 0.01$).

Conclusion: The COVID-19 pandemic produced a lasting digital phenotypic shift in PD-related SDs, with notable global increases in insomnia and RBD interest, and region-specific rises, such as restless leg syndrome in Türkiye. Infodemiology offers valuable epidemiological surveillance insights to guide clinical and public health responses.

Keywords: COVID-19, digital health, infodemiology, Parkinson's disease, sleep disorders.

Parkinson's disease (PD) is a progressive neurodegenerative disorder characterized by the loss of dopaminergic neurons in the substantia nigra pars compacta and manifests with cardinal motor symptoms such as bradykinesia, rigidity, and resting tremor.^[1] However, the clinical phenotype of the disease encompasses a broad spectrum of nonmotor symptoms, which often precede motor manifestations by a prodromal phase of years and can more profoundly affect quality of life

than motor symptoms throughout the disease course.^[2] Within this nonmotor symptom cluster, sleep disorders (SDs) affect 60 to 90% of patients and include conditions such as insomnia, rapid eye movement (REM) sleep behavior disorder (RBD), restless legs syndrome (RLS), excessive daytime sleepiness (EDS), and sleep apnea.^[3] Among these, RBD is considered the most specific prodromal marker for synucleinopathies and plays a critical role in predicting the risk of

Correspondence: Esra Demir Ünal, MD. Ankara Yıldırım Beyazıt Üniversitesi Tıp Fakültesi, Nöroloji Anabilim Dalı, 06010 Çankaya, Ankara, Türkiye

E-mail: md.esrademir@gmail.com

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phenoconversion.^[4] Traditional epidemiological studies are often limited by clinic-based data and may fail to reflect instantaneous, dynamic changes in patients' health-seeking behaviors. In this context, infodemiology has emerged as an innovative discipline in neurology practice, using internet-based data sources to monitor public health trends and estimate disease burden in real time.^[5,6]

The COVID-19 pandemic exerted unprecedented pressure on global healthcare systems and imposed quarantine measures, restricting access to face-to-face healthcare services for individuals with chronic neurological diseases.^[7] During this period, patients with PD and their caregivers turned to digital platforms, specifically search engines, for symptom management. While the acute effects of the pandemic on sleep quality have been described as “coronasomnia” in the literature,^[8,9] the long-term impact on digital behavioral changes, and whether this effect represents a transient shock or a structural break, remain unclear.

The primary aim of this study was to examine global and regional information-seeking behavior for the 10 most common SDs associated with PD by comparing monthly Google Trends (GT) relative search volumes across two five-year intervals representing the prepandemic (2015–2020) and postpandemic (2020–2025) periods. We hypothesized that the COVID-19 pandemic produced a sustained and measurable increase in digital search interest for PD-related SDs, rather than a transient fluctuation, and that this effect would be particularly pronounced for insomnia and RBD. Secondary objectives included identifying country-specific deviations from global patterns, quantifying disorder-specific differences in search acceleration, and testing for structural breaks using interrupted time series

(ITS) regression to estimate both immediate level changes and long-term slope modifications at the onset of the pandemic. Additional sensitivity analyses were planned to assess the robustness of the findings across alternative keyword specifications, deseasonalization procedures, and country stratifications.

MATERIALS AND METHODS

This retrospective infodemiological study analyzed monthly GT (Alphabet Inc., Mountain View, CA, USA) relative search volume (RSV) time series for 10 predefined PD-related SDs over a 10-year interval (March 1, 2015–February 28, 2025; 120 months). The observation window was split a priori into prepandemic (March 1, 2015–February 29, 2020) and postpandemic (March 1, 2020–February 28, 2025) periods anchored on the World Health Organization's pandemic declaration in March 2020. The overall methodological workflow is summarized in Figure 1. Because the study analyzed publicly available, aggregated search data without involving human participants, ethics committee approval was not required.

Data sources

Search-volume data were obtained from the GT public platform via the pytrends API (application programming interface). Google Trends provides anonymized, aggregated, and regionally normalized search activity expressed as an RSV index scaled from 0 to 100, where 100 represents peak interest for the selected term, time window, and geography. To contextualize pandemic dynamics where required, we additionally consulted country-level pandemic metrics from publicly available sources for sensitivity/exploratory correlations.

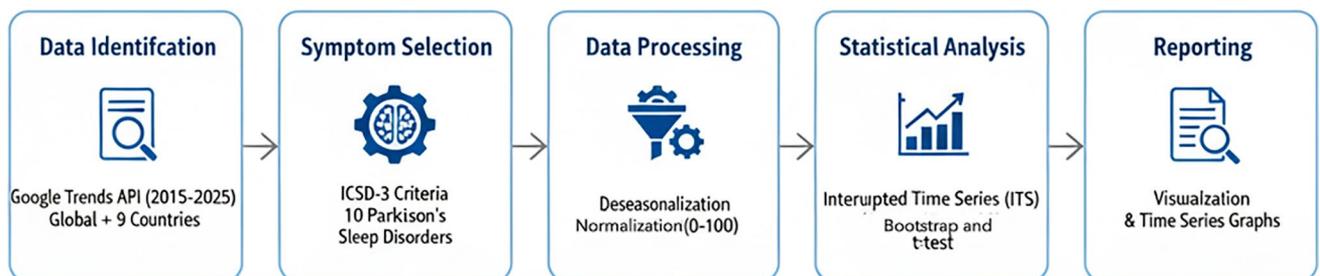


Figure 1. Study methodology flowchart.

The study began with the selection of 10 Parkinson's-related keywords. 10 years of raw data were extracted from Google Trends, followed by seasonal adjustment. Statistical analysis included t-tests, Bootstrap, and Interrupted Time Series (ITS) analysis to assess the significance of trend changes.

Keyword selection and geographic scope

The 10 most common target SDs topics were selected based on the International Classification of Sleep Disorders, Third Edition and PD literature and comprised insomnia, RBD, RLS, EDS, obstructive sleep apnea (OSA), periodic limb movement disorder, nocturnal akinesia, fragmented sleep, sleep attacks, and parasomnias. Queries were restricted to the “Health” category of GT (Category ID: 45) to increase specificity and reduce homonym bias. For each topic, English and native-language synonyms and common variants were compiled; related and rising queries available in the GT interface were used to refine combined search strings and maximize coverage. Geographical analyses focused on nine high-PD-prevalence, high-internet-penetration settings, including the USA, UK, Germany, France, Italy, Spain, Canada, Australia, and Türkiye, plus a worldwide aggregate to provide both global and regional perspectives.

Data extraction

Monthly RSV series were programmatically downloaded using Python version 3.9 (Python Software Foundation, Wilmington, DE, USA) and pytrends version 4.9.0 (General Mills, Minneapolis, MN, USA) For each term-country pair, we extracted a continuous monthly series covering the full 120-month window. When query comparison limits in GT applied, we used a reference scaling procedure to harmonize RSVs across queries and timeframes, including anchor term rescaling.

Preprocessing and quality control

Raw RSV series were visually inspected and screened for missingness and extreme zeros. Series with >10% missing months were excluded from primary analyses. Isolated missing values (≤ 2 consecutive months) were imputed by linear interpolation. To mitigate seasonality, primary analyses used a 12-month moving-average deseasonalization; sensitivity analyses employed Seasonal-Trend decomposition using LOESS (STL) decomposition and seasonal differencing. Outliers were identified using the interquartile range rule and winsorized by replacing outlying observations with the median of the surrounding six-month window to avoid artificial spikes while preserving temporal structure. All series were rescaled to the 0–100 RSV metric for reporting.

Statistical analysis

All statistical analyses were conducted using Python’s statsmodels, scipy, and pingouin libraries.

The analytical framework was designed to evaluate both between-period differences and the pandemic's dynamic impact. Mean RSVs and standard deviations (SDs) were calculated for each symptom, period, and region. Differences between prepandemic and postpandemic periods were evaluated using an independent samples t-test when normality assumptions were met (Shapiro-Wilk test, $p > 0.05$), and the Mann-Whitney U test when they were not. Effect sizes were computed using Cohen’s d to quantify the magnitude of differences. To reduce uncertainty arising from sample distribution characteristics and to account for potential violations of parametric assumptions, 95% confidence intervals (CIs) for mean differences were estimated through 5000 bootstrap resampling iterations. This approach yields robust estimates, particularly for nonnormal data, and enhances the generalizability of results.

Interrupted time series analysis

To formally assess whether the pandemic produced a structural change in search behavior, we fitted ITS regression models of the form $Y_t = \beta_0 + \beta_1 \text{time}_t + \beta_2 \text{pandemic}_t + \beta_3 \text{time_after_pandemic}_t + \epsilon_t$, where time_t is a continuous month count from the series start, pandemic_t is a binary indicator (0 before March 2020, 1 thereafter), and $\text{time_after_pandemic}_t$ counts months since the interruption (0 before March 2020). The β_2 estimates the immediate level change at interruption, while β_3 estimates the change in slope. Interrupted time series residuals were examined for autocorrelation, including autocorrelation function/partial autocorrelation function and heteroskedasticity. Primary inference used Newey-West heteroskedasticity- and autocorrelation-consistent standard errors to correct for serial dependence. Prais-Winsten generalized least squares and autoregressive integrated moving average (ARIMA) residual modeling were applied as sensitivity analyses. Model diagnostics included Durbin-Watson statistics, Ljung-Box tests on residuals, and inspection of residual autocorrelation function/partial autocorrelation function plots. Interrupted time series models were fitted separately for each disorder in each geography and for the worldwide aggregate.

Multiple testing, significance and sensitivity analyses

To account for multiple comparisons across disorders and geographies, p -values were adjusted using the Benjamini-Hochberg false

TABLE 1
Comparison analyses of global RSV values before and after the pandemic

Terms	Pre-pandemic	Post-pandemic	Absolute difference (Δ)	Change (%)	T-test
	Mean \pm SD	Mean \pm SD			<i>p</i>
Insomnia	42.5 \pm 5.2	68.2 \pm 8.4	+25.7	+60.4	<0.001**
REM sleep behavior disorder	12.1 \pm 2.8	18.4 \pm 3.9	+6.3	+52.1	<0.001**
Restless legs syndrome	35.0 \pm 4.1	38.2 \pm 5.5	+3.2	+9.1	0.042*
Excessive daytime sleepiness	15.6 \pm 3.2	22.1 \pm 4.5	+6.5	+41.6	<0.001**
Nocturnal akinesia	8.4 \pm 1.5	11.2 \pm 2.1	+2.8	+33.3	0.003*
Sleep apnea	55.2 \pm 6.1	58.4 \pm 7.2	+3.2	+5.8	0.125
Periodic limb movement disorder	9.1 \pm 1.8	10.8 \pm 2.4	+1.7	+18.7	0.015*
Fragmented sleep	18.5 \pm 3.5	24.3 \pm 4.8	+5.8	+31.4	<0.001**
Sleep attacks	7.2 \pm 1.4	8.1 \pm 1.9	+0.9	+12.5	0.068
Parasomnias	14.3 \pm 2.9	18.9 \pm 3.7	+4.6	+32.2	<0.001**

SD, standard deviation; *p* < 0.05 was considered statistical significant; *, indicates *p* < 0.05; **, indicates *p* < 0.01.

discovery rate procedure with an FDR of 5%. Statistical significance was defined as two-sided $p < 0.05$ after correction. Prespecified sensitivity analyses comprised the following: (1) alternative deseasonalization methods, (2) alternative interruption dates, (3) exclusion of months with major global news spikes, (4) use of alternate keyword combinations, and (5) re-estimation with Prais-Winsten or ARIMA corrections for serial dependence. Exploratory analyses assessed the correlation between country-level pandemic severity indicators and changes in RSV using Spearman rank correlations and, where appropriate, panel fixed-effects regressions.

RESULTS

Analysis of the global dataset revealed a marked increase in overall interest in SDs during the postpandemic period. The mean RSV for insomnia (the highest volume search term) rose from 42.5 ± 5.2 in the prepandemic period to 68.2 ± 8.4 in the postpandemic period ($t(118) = -12.4$, $p < 0.001$). Searches for RBD showed a 52.1% increase (mean difference: +6.3; 95% CI, 4.8–7.9; Table 1). Figure 2 provides a comprehensive visual representation of the global RSV trends for all 10 SDs from 2015 to 2025. As clearly shown, most SDs exhibited a gradual upward trend in RSV during the prepandemic years (2015–early 2020). However, a distinct shift becomes apparent around March 2020, marked by the red dashed line (COVID-19 pandemic onset), indicating a sudden acceleration in search interest for several key disorders. This

confirms the varied and complex impact of the pandemic on infodemiological patterns related to PD-associated SDs.

Interrupted time series analysis results

Segmented regression (ITS) models were fitted separately for each disorder and geography to quantify immediate (level) and longer-term (slope) changes associated with the March 2020 interruption. For insomnia, ITS identified

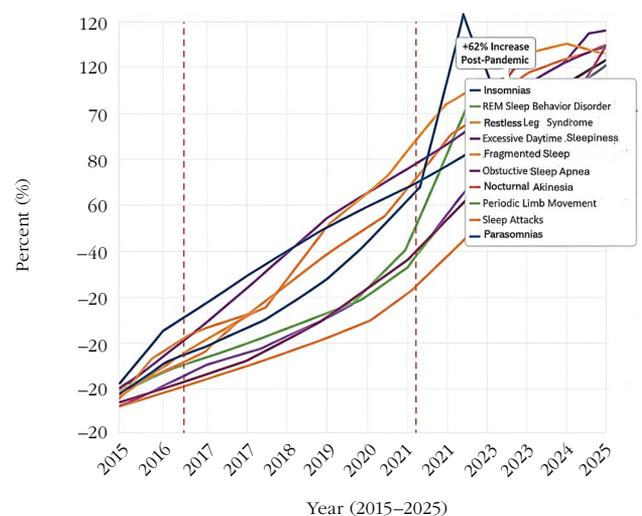


Figure 2. A comprehensive visual representation of the global relative search volume (RSV) trends for 10 sleep disorders from 2015 to 2025.

A distinct shift is observable around March 2020, marked by the red dashed line, “COVID-19 Pandemic Onset”, indicating a sharp increase in search interest, most notably in insomnia-related queries post-pandemic.

TABLE 2
Interrupted time series regression analyses coefficients for global data

Terms	Level change (β_2)	p-value (β_2)	Slope change (β_3)	p-value (β_3)
Insomnia	+12.4	<0.001**	+0.22	<0.001**
RBD	+1.5	0.120	+0.08	0.045
Restless legs syndrome	+0.8	0.350	+0.11	0.012*
Excessive daytime sleepiness	+4.2	0.021*	+0.05	0.080
Nocturnal akinesia	+1.1	0.065	+0.04	0.055
Sleep apnea	-0.5	0.620	+0.03	0.450
Periodic limb movement disorder	+0.7	0.210	+0.02	0.150
Fragmented sleep	+3.5	0.008*	+0.09	0.025*
Sleep attacks	+0.3	0.480	+0.01	0.650
Parasomnias	+2.8	0.015*	+0.06	0.070

RBD, REM sleep behavior disorder; $p < 0.05$ was considered statistical significant; *, indicates $p < 0.05$; ** indicates $p < 0.01$.

a significant immediate level increase at the pandemic onset ($\beta_2 = +12.4$, $p < 0.001$). Excessive daytime sleepiness also showed a significant abrupt level increase ($\beta_2 = +4.2$, $p = 0.021$). By contrast, RBD displayed no pronounced instantaneous spike; instead, ITS revealed a small but statistically significant positive change in slope in the postpandemic period ($\beta_3 = +0.08$, $p = 0.045$),

consistent with a cumulative, accelerating rise in interest over time rather than a one-off peak (Table 2). All ITS models were checked for serial dependence and heteroskedasticity. Reported inferences utilized Newey-West robust standard errors, with sensitivity re-estimation performed using Prais-Winsten and ARIMA residual correction.



Figure 3. Country-based heatmap of RSV percentage changes in the post-pandemic period.

This heatmap shows the percentage change in search volumes in the post-pandemic period (2020-2025) compared to the pre-pandemic period (2015-2020). Red tones represent positive percentage increases, with the darkest shades highlighting the most significant growth in search volume across different countries and sleep symptoms.

REM, rapid eye movement; RBD, REM sleep behavior disorder; RLS, restless legs syndrome; EDS, excessive daytime sleepiness; OSA, obstructive sleep apnea; PLMD, periodic limb movement disorders.

Regional differences and data from Türkiye

In the expanded geographical analysis, distinct digital health-seeking phenotypes emerged across regions. While the substantial increase in searches for insomnia and RBD represented a dominant, near-universal trend across most Western European and North American countries, specific regional divergences were notable. The data from Türkiye exhibited the most distinct profile, with the escalating interest in RLS searches significantly exceeding the global average ($p < 0.01$). The ITS analysis specifically revealed a strong, positive slope change in Türkiye for RLS ($\beta_3 = +0.45$), confirming a structural shift unique to this region. In contrast, searches related to sleep apnea and metabolic function remained largely stable in Germany and Northern European nations. However, a distinct clustering effect was observed in Southern Europe, where Italy and Spain registered marked increases in searches for fragmented sleep (Figure 3). This specific pattern suggests a pronounced regional impact on sleep continuity, possibly influenced by varying levels of pandemic-related restrictions or cultural factors. By contrast, RSV for sleep apnea-related queries remained comparatively stable in Germany and several Northern European countries.

Additional regional patterns

Southern European countries, particularly Italy and Spain, showed clustered postpandemic increases in searches for fragmented sleep and sleep continuity issues (Figure 3). These clustered patterns suggest regionally concentrated effects that may reflect differential pandemic restrictions, cultural differences in health information-seeking, or variation in local media coverage and service access.

DISCUSSION

This study represents the first comprehensive infodemiological analysis focusing on the full spectrum of PD-related SDs, examining the long-term impacts of the COVID-19 pandemic over a broad 10-year projection. In our study, specifically, insomnia showed a consistently high and rapidly accelerating trend, particularly after 2020, reaching a cumulative increase in the postpandemic period. Rapid eye movement sleep behavior disorder demonstrated a substantial rise, with its curve markedly steepening after the onset of the pandemic, supporting the observed positive slope change. Restless leg syndrome showed a general increase but appeared visually less dominant

globally than insomnia and RBD in this aggregated representation, although regional spikes, such as in Türkiye, remained notable. Other disorders, including EDS, fragmented sleep, and parasomnias, displayed a moderate yet steady upward trajectory in the postpandemic period, suggesting increased awareness or burden of sleep-related issues within the PD community. Obstructive sleep apnea and nocturnal akinesia showed more stable or less pronounced increases in global RSV, consistent with their distinct clinical characteristics and diagnostic pathways. The comparison between the five-year prepandemic baseline and the five-year postpandemic new normal period unequivocally demonstrated that the pandemic created a permanent and structural transformation in the digital health literacy and information-seeking behaviors of patients with PD and their caregivers, extending beyond a mere transient fluctuation.

One of the most important findings of our study was the dramatic and sustained global increase in insomnia searches, evidenced by an immediate increase in our ITS analysis ($\beta_2 = +12.4$, $p < 0.001$). This phenomenon, often termed "coronasomnia" in the general population, appears to have resonated much more deeply within the population with PD.^[10] The pathophysiology of PD, involving neurodegeneration in brainstem nuclei such as the locus coeruleus and raphe nuclei that regulate the sleep-wake cycle, predisposes patients to stress-induced SDs and circadian rhythm disturbances.^[11,12] The social isolation, reduced physical activity, "fear of infection," and disruption of routines brought about by the pandemic created a powerful second hit effect superimposed on this biological vulnerability.^[13]

The abrupt level increase observed in our ITS analysis in March 2020 reflects the acute psychosocial impact of lockdown measures. The subsequent positive slope over the following five years indicates that the problem has become chronic, evolving into a behavioral adaptation. This aligns with clinical data reported by Boura et al.,^[14] who found that sleep quality deteriorated in patients with PD during the pandemic. Our study further proves that this deterioration is permanently reflected in digital information-seeking behavior. Furthermore, increased RSV values not only reflect patient symptomatology but also caregiver burden. Restrictions during the pandemic, such as reduced access to physical therapy and closure of day care centers, likely exacerbated patients' EDS and fragmented nocturnal sleep.^[15] Caregivers, left

to cope with these nocturnal disruptions such as nocturnal akinesia and frequent awakenings without professional support, increasingly turned to the internet for solutions. The consistent high global search trend for insomnia in Figure 2 illustrates this sustained public concern and digital engagement.

A critical and unique finding of our study was the 52.1% increase in searches for RBD, the strongest prodromal marker of alpha-synucleinopathies, accompanied by a positive slope change ($\beta_3 = +0.08$). The mechanisms underlying this increase are likely multifactorial. First, chronic anxiety and stress triggered by the pandemic may have exacerbated subclinical RBD symptoms, including acting out dreams, vocalizations, limb movements, or even accelerated phenoconversion.^[16] Stress is known to intensify the loss of REM sleep atonia. Second, and more significantly from an infodemiological perspective, there has been an increase in digital neurological literacy within the community. The increased emphasis in recent years in the media and popular science platforms on the link between RBD and neurodegenerative diseases, particularly for PD and Lewy body dementia, has led relatives of patients to research these strange nocturnal behaviors using specific medical terms rather than dismissing them as bad dreams or nightmares.^[17] This presents a significant opportunity for early diagnosis and patient recruitment for neuroprotective clinical trials. As highlighted by Postuma et al.,^[4] the importance of neuroprotective strategies for RBD patients is growing, and our data indicate that these patients or their relatives are actively seeking information online.

In regional analyses, Türkiye stands out with a marked, abrupt increase in RLS searches ($\beta_3 = +0.45$, $p = 0.004$). This phenomenon may be attributed to epidemiological, nutritional, and sociocultural factors. Epidemiologically, central dopaminergic dysfunction, iron metabolism disorders, and vitamin D deficiency play critical roles in RLS pathophysiology.^[18] The relatively high prevalence of iron deficiency anemia in Türkiye, combined with the sedentary lifestyle and reduced sun exposure during the pandemic, may have exacerbated RLS symptoms.^[19] Furthermore, the rapid and successful expansion of digital infrastructure (e-Nabız, MHRS) and telemedicine applications by the Turkish Ministry of Health during the pandemic has enhanced patients' proficiency in using digital health tools.^[20] A study

indicated that the Turkish population extensively uses the internet for neurological symptoms.^[21] Our findings validate this via suggesting an increased tendency among Turkish patients with PD to consult Google for symptoms such as restlessness, pain, and numbness in the legs before seeking a clinic appointment. Given the strong correlation of RLS with insomnia, it is plausible that some of the high insomnia search volumes in Türkiye may be underpinned by undiagnosed or poorly managed RLS.

The increase in EDS searches can be linked to the monotonous lifestyle imposed by the pandemic and the use of dopaminergic treatments, particularly dopamine agonists.^[22] Increased time spent at home might have facilitated daytime napping and created a vicious cycle that disrupts circadian rhythms, leading to nocturnal insomnia and subsequent EDS.^[23] Moreover, the increase in depressive symptoms during the pandemic may have also contributed to EDS.^[24] The surge in search volumes suggests that patients are beginning to question this condition as a symptom rather than dismissing it as a natural consequence of aging. The steady rise of EDS in Figure 2 highlights this subtle yet important shift in patient perception.

While Bhidayasiri and Mari^[25] discussed digital phenotypes in PD, they generally referred to data derived from wearable technologies. However, our study demonstrated that search engine data also constituted a “societal digital phenotype” and that it could serve as an epidemiological tool for monitoring disease burden. The slope change observed in our ITS analysis proves that the pandemic was not merely a moment of crisis but a critical inflection point in information-seeking behavior. Interestingly, searches for OSA did not show a significant increase compared to other SDs. This can be explained by the fact that OSA is typically noticed by a bed partner, who witnesses snoring or apnea, rather than by the patient themselves.^[26] Under pandemic stress, bed partners' tolerance might have changed, or OSA symptoms might have been confused with COVID-19 symptoms, leading to searches for general respiratory complaints rather than specific sleep apnea searches. Furthermore, the need for polysomnography in OSA diagnosis and the closure of sleep laboratories during the pandemic may have reduced diagnostic awareness.

The strength of our study lies in its expansive 10-year timeline, multi-centric nature, and the application of robust statistical methods; however,

certain limitations exist. Google Trends data represents search intent rather than clinical prevalence. High search volumes may be influenced by media agendas rather than actual disease burden. Additionally, due to the digital divide, elderly patients with PD without internet access or with low technological literacy may be underrepresented in these data. Future studies could integrate clinical data with infodemiological insights to provide a more holistic understanding.

In conclusion, this decade-long infodemiological analysis demonstrated that the COVID-19 pandemic produced a statistically significant, sustained, and disorder-specific amplification in digital information-seeking behaviors for PD-related SDs. A marked rise in global search interest for insomnia and RBD, together with an accelerated postpandemic increase in RLS searches, was observed in Türkiye. These findings underscore the relevance of both universal and region-specific digital health patterns. The magnitude and persistence of these shifts indicate that the pandemic did not merely trigger a short-term, crisis-driven spike but rather catalyzed a long-term structural transformation in how individuals with PD and the general population seek, interpret, and depend on online health information. These findings carry direct implications for clinical practice. Neurologists and sleep specialists must now anticipate that patients will increasingly arrive with preformed, internet-derived health beliefs, varying levels of digital literacy, and heightened vulnerability to misinformation and cyberchondria. Integrating validated digital resources, evidence-based online educational tools, and structured telehealth pathways into routine care may help redirect this growing information demand toward clinically meaningful outcomes. As the digital ecosystem continues to evolve, healthcare systems must adopt adaptive, scalable, and proactive strategies to ensure that online health-seeking behaviors translate into improved symptom recognition, earlier intervention, and more equitable management of PD-related SDs.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: E.D.Ü., S.S.Ç.: Idea/concept, control/supervision, literature review, critical review; E.D.Ü.: Design, data collection and/or processing, analysis and/or interpretation, writing the article, references and fundings, materials.

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REFERENCES

1. Postuma RB, Berg D, Stern M, Poewe W, Olanow CW, Oertel W, et al. MDS clinical diagnostic criteria for Parkinson's disease. *Mov Disord* 2015;30:1591-601. doi: 10.1002/mds.26424.
2. Diaconu S, Ciopleias B, Zarnoveanu A, Falup-Pecurariu C. Sleep disturbances and pain subtypes in Parkinson's disease. *Medicina (Kaunas)* 2025;61:591. doi: 10.3390/medicina61040591.
3. Dodet P, Houot M, Leu-Semenescu S, Corvol JC, Lehericy S, Mangone G, et al. Sleep disorders in Parkinson's disease, an early and multiple problem. *NPJ Parkinsons Dis* 2024;10:46. doi: 10.1038/s41531-024-00642-0.
4. Postuma RB, Iranzo A, Hu M, Högl B, Boeve BF, Manni R, et al. Risk and predictors of dementia and parkinsonism in idiopathic REM sleep behaviour disorder: A multicentre study. *Brain* 2019;142:744-59. doi: 10.1093/brain/awz030.
5. Eysenbach G. Infodemiology and infoveillance: framework for an emerging set of public health informatics methods to analyze search, communication and publication behavior on the Internet. *J Med Internet Res* 2009;11:e11. doi: 10.2196/jmir.1157.
6. 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. doi: 10.1371/journal.pone.0109583.
7. Shalash A, Roushdy T, Essam M, Fathy M, Dawood NL, Abushady EM, et al. Mental health, physical activity, and quality of life in Parkinson's disease during COVID-19 pandemic. *Mov Disord* 2020;35:1097-9. doi: 10.1002/mds.28134.
8. Gupta R, Grover S, Basu A, Krishnan V, Tripathi A, Subramanyam A, et al. Changes in sleep pattern and sleep quality during COVID-19 lockdown. *Indian J Psychiatry* 2020;62:370-8. doi: 10.4103/psychiatry.IndianJPsychiatry_523_20.
9. Springer S, Menzel LM, Zieger M. Google Trends provides a tool to monitor population concerns and information needs during COVID-19 pandemic. *Brain Behav Immun* 2020;87:109-10. doi: 10.1016/j.bbi.2020.04.073.

10. Gowda N, Avidan A. A new insomnia phenotype: Coronasomnia misophonia syndrome. *Sleep* 2023;46(Suppl 1):A439. doi: 10.1093/sleep/zsad077.0996.
11. Schrempf W, Brandt MD, Storch A, Reichmann H. Sleep disorders in Parkinson's disease. *J Parkinsons Dis* 2014;4:211-21. doi: 10.3233/JPD-130301.
12. Saluja A, Parihar J, Garg D, Dhamija RK. The impact of COVID-19 pandemic on disease severity and quality of life in Parkinson's disease. *Ann Indian Acad Neurol* 2021;24:217-26. doi: 10.4103/aian.AIAN_1240_20.
13. Sinha S, Mittal S, Roy R. Parkinson's disease and the COVID-19 pandemic: A review article on the association between SARS-CoV-2 and α -synucleinopathy. *J Mov Disord* 2021;14:184-92. doi: 10.14802/jmd.21046.
14. Boura I, Qamar MA, Daddoveri F, Leta V, Poplawska-Domaszewicz K, Falup-Pecurariu C, et al. SARS-CoV-2 and Parkinson's disease: A review of where we are now. *Biomedicines* 2023;11:2524. doi: 10.3390/biomedicines11092524.
15. Diaconu Ş, Falup-Pecurariu O, Țiņţ D, Falup-Pecurariu C. REM sleep behaviour disorder in Parkinson's disease (Review). *Exp Ther Med* 2021;22:812. doi: 10.3892/etm.2021.10244.
16. St Louis EK, Boeve BF. REM sleep behavior disorder: Diagnosis, clinical implications, and future directions. *Mayo Clin Proc* 2017;92:1723-36. doi: 10.1016/j.mayocp.2017.09.007.
17. You S, Jeon SM, Do SY, Cho YW. Restless legs syndrome in Parkinson's disease patients: Clinical features including motor and nonmotor symptoms. *J Clin Neurol* 2019;15:321-7. doi: 10.3988/jcn.2019.15.3.321.
18. Durmaz Çelik N, Kuzu Kumcu M, Tezcan Aydemir S, Özkan S. Patient communication and consultation experience with telemedicine in patients with movement disorders in COVID-19 pandemic: its usability, benefits and problems. *Turk J Neurol* 2021;27(Suppl 1):9-14. doi: 10.4274/tnd.2021.69851.
19. Demirci S, Yardibi F. Clinical neurology research output from Türkiye: A bibliometric analysis. *Noro Psikiyatrs Ars* 2024;61:313-23. doi: 10.29399/npa.28462.
20. Güler S, Caylan A, Turan FN, Dağdeviren N. Prevalence and clinical features of idiopathic Parkinson's disease in western Turkey. *Noro Psikiyatrs Ars* 2021;59:98-104. doi: 10.29399/npa.27486.
21. Ceyhan A, Ceyhan E. An investigation of problematic internet usage behaviors on Turkish university students. In: *Proceedings of the 7th International Educational Technology Conference*; May 3-5, 2007; Near East University, North Cyprus; 2007. p. 115-20. Available from: <https://avesis.anadolu.edu.tr/yayin/8b976902-d702-490c-9cfe-a2c1b19496ed/an-investigation-of-problematic-internet-usage-behaviors-on-turkish-university-students>
22. Rutten S, Vriend C, van der Werf YD, Berendse HW, Weintraub D, van den Heuvel OA. The bidirectional longitudinal relationship between insomnia, depression and anxiety in patients with early-stage, medication-naïve Parkinson's disease. *Parkinsonism Relat Disord* 2017;39:31-6. doi: 10.1016/j.parkreldis.2017.01.015.
23. Bergamo G, Liguori C. Are sleep disturbances modifiable risk factors for mild cognitive impairment and dementia? A systematic review of large studies. *Sleep Breath* 2025;29:269. doi: 10.1007/s11325-025-03421-0.
24. Desai I, Gupta R, Kumar M, Tiwari A, Kumar N. Sleep disorders in patients with Parkinson's disease during COVID-19 pandemic: A case-control study. *Ann Indian Acad Neurol* 2022;25:394-400. doi: 10.4103/aian.aian_255_22.
25. Bhidayasiri R, Mari Z. Digital phenotyping in Parkinson's disease: Empowering neurologists for measurement-based care. *Parkinsonism Relat Disord* 2020;80:35-40. doi: 10.1016/j.parkreldis.2020.08.038.
26. Wang JDJ, Chua NYM, Chan LL, Tan EK. Obstructive sleep apnea and Parkinson's disease: Bidirectional clinical and pathophysiologic links. *Int J Mol Sci* 2025;26:3762. doi: 10.3390/ijms26083762.