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From Neurorehabilitation to Robotics and Artificial Intelligence: A Decade of Global Public Interest Assessed by Google Trends

Nörorehabilitasyondan Robotik ve Yapay Zekaya: Google Trends ile Değerlendirilen Küresel Kamu İlginin On Yıllık Analizi

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Abstract

Objective: Rapid advances in digital health technologies have increased public interest in robotic and technology-assisted rehabilitation approaches. Internet search engines reflect individuals' health-related information-seeking behaviors and enable the assessment of this interest. The aim of this study was to evaluate global public interest in key terms related to neurological, robotic, and technology-assisted rehabilitation over the past decade using Google trends data and to compare interest levels between two consecutive five-year periods.

Materials and Methods: In this retrospective, observational infodemiology study, relative search volume data from January 1, 2016 to December 31, 2025 were analyzed. The study period was divided into two equal intervals: 2016-2020 and 2021-2025. Keywords were selected in accordance with the priorities of the World Federation for NeuroRehabilitation and the European Federation of NeuroRehabilitation Societies. Inter-period comparisons were performed using the Mann-Whitney U test.

Results: A significant increase in public interest was observed for the majority of the analyzed keywords during the 2021-2025 period ($p<0.001$ for most terms). Notable increases were identified for the terms robotic rehabilitation, robotic gait training, exoskeleton rehabilitation, stroke robotic rehabilitation, artificial intelligence rehabilitation, and virtual reality rehabilitation. In contrast, no significant difference was observed for the term neurorehabilitation, while the brand-specific term Lokomat demonstrated a high but stable level of public interest.

Conclusion: Global public interest in robotic and technology-assisted neurological rehabilitation has increased markedly over the past decade. This trend indicates growing societal awareness of the digital transformation within the field of rehabilitation.

Keywords: Neurorehabilitation, robotic rehabilitation, technology-assisted rehabilitation, Google trends

Öz

Amaç: Dijital sağlık teknolojilerindeki hızlı gelişmeler, robotik ve teknoloji destekli rehabilitasyon yaklaşımlarına yönelik kamu ilgisini artırmaktadır. İnternet arama motorları, bireylerin sağlıkla ilgili bilgi arama davranışlarını yansıtarak bu ilginin değerlendirilmesine olanak sağlar. Bu çalışmanın amacı, Google trends verileri kullanılarak son on yılda nörolojik, robotik ve teknoloji destekli rehabilitasyonla ilişkili anahtar terimlere yönelik küresel kamu ilgisini değerlendirmek ve iki ardışık beş yıllık dönem arasında karşılaştırmaktır.

Gereç ve Yöntem: Bu retrospektif gözlemsel infodemiyoloji çalışmasında, 1 Ocak 2016-31 Aralık 2025 dönemine ait göreceli arama hacmi verileri analiz edilmiştir. Çalışma dönemi 2016-2020 ve 2021-2025 olmak üzere iki eşit periyoda ayrılmıştır. Anahtar terimler, World Federation for NeuroRehabilitation ve European Federation of NeuroRehabilitation Societies öncelikleri doğrultusunda seçilmiştir. Dönemler arası karşılaştırmalar Mann-Whitney U testi ile yapılmıştır.

Bulgular: Anahtar kelimelerin büyük çoğunluğunda 2021-2025 döneminde kamu ilgisinin anlamlı düzeyde arttığı saptanmıştır (çoğu terim için $p<0,001$). Robotic rehabilitation, robotic gait training, exoskeleton rehabilitation, stroke robotic rehabilitation, AI rehabilitation ve virtual reality rehabilitation terimleri belirgin artış göstermiştir. Neurorehabilitation teriminde anlamlı fark izlenmezken, Lokomat yüksek ancak stabil bir ilgi düzeyi sergilemiştir.

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Sonuç: Son on yılda robotik ve teknoloji destekli nörolojik rehabilitasyona yönelik küresel kamu ilgisi belirgin biçimde artmıştır. Bu eğilim, rehabilitasyon alanındaki dijital dönüşüme yönelik toplumsal farkındalığın güçlendiğini göstermektedir.
Anahtar kelimeler: Nörorehabilitasyon, robotik rehabilitasyon, teknoloji destekli rehabilitasyon, Google trends

Introduction

Health-related information seeking has increasingly shifted to online environments in recent years, with search engines becoming one of the primary sources for patients and their caregivers to obtain information about symptoms, diagnoses, and treatment options. Indeed, analyses based on European data report that approximately half of individuals searched the internet for health-related information and symptoms in 2022, and that this trend continues to increase (1). This behavioral shift enhances the value of "digital traces" for understanding societal awareness and expectations regarding specific diseases and therapeutic approaches.

In this context, infodemiology/infoveillance has been defined as an approach aimed at examining the distribution and determinants of information in online environments and generating insights for the health domain based on these data (2). The analysis of digital traces such as internet search queries allows the investigation of which clinical topics attract public interest and how this interest changes over time. Google trends (GT) is one of the most widely used open-access tools for measuring public interest in a time-series format by providing relative search volume (RSV) data for specific keywords.

The use of GT in health research has increased steadily, and methodological evaluations and reviews have shown that GT has been applied in various ways to characterize, monitor, and, in some scenarios, predict online interest in health-related phenomena (3). However, it is emphasized that GT data do not directly represent clinical prevalence or actual healthcare utilization; rather, they primarily reflect information-seeking behavior and public interest (3). Accordingly, GT-based studies are particularly valuable for tracking changes in societal awareness, curiosity, and perceptions rather than clinical outcomes.

Research on rehabilitation robotics has gained substantial momentum since the 1990s, a period that has been identified as a turning point during which the field began to develop in a systematic manner (4). Within the rehabilitation domain, robotic and advanced technologies—such as exoskeletons, robotic gait training systems, virtual reality applications, and artificial intelligence (AI)–based approaches—have attracted increasing attention due to the long-term and intensive rehabilitation requirements characteristic of neurological disorders. Scientific output related to these technologies has likewise increased, with bibliometric analyses covering the 2010-2020 period reporting steady growth in the rehabilitation robotics literature and a progressive concentration of research focus on themes such as exoskeletons, virtual reality, brain-computer interfaces, and intelligent control systems (5).

Despite this expansion in the scientific literature, infodemiological studies evaluating how these developments are reflected at the societal level—specifically, the temporal evolution of global public interest in robotic and technology-assisted rehabilitation approaches—remain relatively limited.

The aim of this study was to examine changes in global public interest in selected keywords related to neurological, robotic, and technology-assisted rehabilitation during the 2016-2025 period using GT data, and to compare RSV levels between two consecutive five-year intervals (2016-2020 and 2021-2025). By doing so, the study sought to provide a data-driven framework illustrating how technology-oriented transformations within the rehabilitation ecosystem are reflected in societal information-seeking behavior.

Materials and Methods

Study Design

This study was designed as a retrospective, observational infodemiology study based on GT data. Global public interest was assessed using online search behaviors related to neurological and technology-assisted rehabilitation.

Data Source and Search Strategy

Data were obtained from the GT platform (https://trends.google.com). Searches were conducted using the web search option, across all categories, and on a worldwide scale. The study period was defined as January 1, 2016 to December 31, 2025, and monthly RSV data provided by GT were used for the analyses.

Selection of Keywords

Keywords were determined by a physical medicine and rehabilitation specialist with clinical experience in neurological rehabilitation, robotic rehabilitation, and technology-assisted rehabilitation. During the selection process, the research and clinical priorities of international neurorehabilitation organizations—the World Federation for NeuroRehabilitation and the European Federation of NeuroRehabilitation Societies—were taken into consideration. To ensure suitability for GT analysis, commonly used, concise, and English-language terms were selected.

The keywords included in the analysis were as follows:

- Neurorehabilitation
- Stroke rehabilitation
- Robotic rehabilitation
- Robotic therapy
- Robotic gait training
- Exoskeleton rehabilitation

- Lokomat
- Stroke robotic rehabilitation
- Spinal cord injury robot therapy
- AI rehabilitation
- Virtual reality rehabilitation
- Rehabilitation technology
- Rehabilitation technologies
- Technology-based rehabilitation.

Definition of Study Periods

The ten-year study duration was divided into two equal five-year periods:

- **Period 1 (P1):** January 1, 2016-December 31, 2020
- **Period 2 (P2):** January 1, 2021-December 31, 2025.

This division was applied to evaluate changes in interest in digital and robotic health technologies during the post-pandemic period.

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics software (version 29.0; IBM Corp., Armonk, NY, USA). RSV data obtained from the GT platform were analyzed on a monthly basis. Descriptive statistics were presented as mean, median, standard deviation, and minimum-maximum values for each keyword and study period.

As the RSV data did not meet the assumption of normal distribution, as confirmed by the Shapiro-Wilk test and visual inspection of distribution plots, non-parametric Mann-Whitney U tests were used to compare the two periods (2016-2020 and 2021-2025). Analyses were conducted separately for each keyword to evaluate inter-period differences.

All statistical tests were two-sided, and a p-value of <0.05 was considered statistically significant.

In addition to period-based comparisons, annual mean RSV values were calculated to visualize temporal trends between 2016 and 2025, and line graphs were generated to illustrate longitudinal changes.

Results

For all keywords included in the GT analysis, notable changes in global public interest were observed between the 2016-2020 and 2021-2025 periods. For the majority of terms related to robotic and technology-assisted rehabilitation, RSV increased significantly during the second five-year period (Table 1).

Annual trend analysis demonstrated a gradual increase beginning in 2019, followed by a steeper acceleration after 2021 for several technology-oriented keywords (Figure 1).

In particular, public interest in the terms robotic rehabilitation, robotic therapy, robotic gait training, exoskeleton rehabilitation, stroke robotic rehabilitation, AI rehabilitation, and virtual reality rehabilitation was significantly higher in the 2021-2025 period compared with the 2016-2020 period (all p<0.001). For most of these terms, low or near-zero search volumes were observed during the first period, followed by sharp increases in the second period.

Table 1. Comparison of global public interest in neurological and technology-assisted rehabilitation terms according to Google trends (2016-2020 vs. 2021-2025)

Keyword	P1 Mean ± SD	P1 Median	P1 Min-max	P2 Mean ± SD	P2 Median	P2 Min-max	p-value
Robotic rehabilitation	9.30±1.67	9.0	5-13	23.48±22.04	18.0	4-100	**<0.001**
Robotic therapy	7.70±1.81	8.0	4-12	17.82±22.23	10.0	3-100	**<0.001**
Robotic gait training	0.00±0.00	0.0	0-0	10.10±23.84	0.0	0-100	**<0.001**
Exoskeleton rehabilitation	3.03±2.84	4.0	0-8	13.30±22.30	7.0	0-100	**<0.001**
Lokomat	35.28±5.97	36.0	22-55	33.93±14.52	30.5	23-100	**<0.001**
Neurorehabilitation	27.42±3.39	27.0	19-34	33.05±18.64	28.0	17-100	0.61
Stroke rehabilitation	17.37±1.55	17.0	15-21	25.27±17.40	20.0	15-100	**<0.001**
Stroke robotic rehabilitation	0.38±2.97	0.0	0-23	12.50±22.27	0.0	0-100	**<0.001**
Spinal cord injury robot therapy	0.00±0.00	0.0	0-0	1.67±12.91	0.0	0-100	0.33
AI rehabilitation	0.00±0.00	0.0	0-0	9.82±24.62	1.0	0-100	**<0.001**
Virtual reality rehabilitation	8.08±2.92	8.0	0-18	17.45±21.40	10.5	5-100	**<0.001**
Rehabilitation technology	7.45±0.93	7.0	6-10	16.25±21.18	10.0	5-100	**<0.001**
Rehabilitation technologies	6.63±1.83	6.0	0-12	15.75±21.53	9.0	0-100	**<0.001**
Technology-based rehabilitation	0.00±0.00	0.0	0-0	11.72±22.44	0.0	0-100	**<0.001**

P1: 01.01.2016-31.12.2020. P2: 01.01.2021-31.12.2025, RSV: Relative search volume, SD: Standard deviation, Mann-Whitney U test, AI: Artificial intelligence

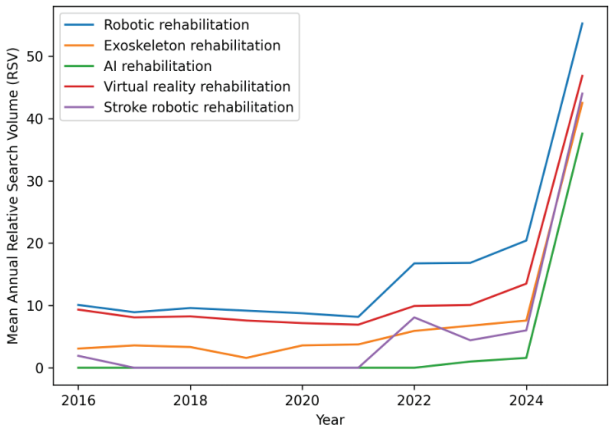

Figure 1. Annual mean relative search volume trends for selected technology-oriented rehabilitation keywords between 2016 and 2025
AI: Artificial intelligence

In contrast, no statistically significant difference was observed between the two periods for the more general term neurorehabilitation (p=0.61). Similarly, although an upward trend was noted for the term spinal cord injury robot therapy during the second period, this difference did not reach statistical significance (p=0.33).

The brand-specific keyword Lokomat exhibited a relatively high level of public interest across both periods but did not demonstrate a significant increase between periods. Collectively, these findings indicate that public interest has shifted particularly toward emerging robotic and digital rehabilitation technologies, while more established and general concepts have remained relatively stable.

Discussion

This study examined changes in global public interest in neurological, robotic, and technology-assisted rehabilitation approaches over the past decade using GT data and revealed a marked increase, particularly during the 2021-2025 period. The findings indicate that society's health information–seeking behavior in the field of rehabilitation has evolved over time, with a pronounced shift toward innovative, technology-based, and practice-oriented rehabilitation approaches.

The acceleration observed during the 2021-2025 period may also be interpreted within the broader context of the global digital health transformation that intensified following the coronavirus disease-2019 (COVID-19) pandemic. The pandemic substantially accelerated the integration of telemedicine, remote assessment tools, and technology-enhanced therapeutic platforms into routine healthcare delivery. In rehabilitation medicine, this digital momentum likely increased both professional and public awareness of robotic, AI-supported, and virtual reality-based interventions, which align with emerging trends toward data-driven, intensive, and technology-integrated therapy models.

Within rehabilitation sciences, the rapid expansion of digital health technologies likely increased scientific output, media visibility, and professional discourse surrounding robotic, AI-assisted, and immersive rehabilitation systems, thereby contributing to heightened societal awareness.

Robotic and technology-assisted rehabilitation approaches have attracted growing research and clinical interest because they move beyond classical rehabilitation paradigms by offering intensive, repeatable, and quantifiable exercise capacity. Systematic reviews have demonstrated that robotic motor rehabilitation systems have the potential to improve both upper and lower extremity function and that these technologies may also reduce therapist workload while making rehabilitation interventions more standardized and reproducible (6).

Some neurological diseases are characterized by the need for long-term rehabilitation and slow, gradual recovery processes (7,8). This situation creates a trajectory shaped not only by the experiences of patients but also by those of their families and caregivers, involving uncertainty, expectations, and a continual search for hope (9). In this context, the increasing public interest in robotic and technology-assisted rehabilitation approaches may be associated not only with the availability of technological advances but also with societal expectations that these methods can accelerate recovery, enhance functional outcomes, and render the rehabilitation process more predictable (10).

The pronounced increase observed in terms such as robotic rehabilitation, exoskeleton rehabilitation, stroke robotic rehabilitation, and robotic gait training suggests that public interest has shifted away from abstract technological concepts toward applications directly associated with functional recovery and perceived tangible clinical benefits. Given the time-consuming nature of conventional rehabilitation approaches in neurological disorders, the intensive, repeatable, and quantifiable treatment characteristics offered by robotic systems are likely perceived by patients and their families as an attractive alternative. Furthermore, the increasing integration of these technologies into routine clinical practice across a growing number of centers, along with their greater visibility in patient education and informational materials, may have contributed to the perception of robotic rehabilitation as an accessible and viable option within the community.

The observed increase in technology-oriented search terms may reflect broader structural transformations within the rehabilitation ecosystem, as reflected in patterns of public information-seeking behavior. The shift in search trends from broader umbrella terms such as robotic rehabilitation toward more specific, application-oriented terms—including exoskeleton rehabilitation, stroke robotic rehabilitation, virtual reality rehabilitation, and AI rehabilitation—indicates that public interest has moved from general concepts to concrete technologies and interventions. The fact that several technology-based keywords exhibited very low or near-zero search volumes during the first

period but demonstrated substantial growth in the second period suggests that these concepts have only relatively recently entered the public lexicon, with meaningful search activity emerging predominantly in recent years. However, as GT provides normalized relative search volumes rather than absolute counts, these findings should be interpreted as indicative of proportional changes in interest rather than exact magnitudes of public engagement. Conversely, the consistently high yet relatively stable interest observed for brand-specific terms such as Lokomat implies that public attention may be influenced not only by technological innovation but also by factors such as brand recognition and institutional visibility.

The increase in public interest identified in this study is also consistent with research trends reported in the scientific literature. Bibliometric analyses in the field of rehabilitation robotics have demonstrated a steady rise in scientific output over the past decade, with a progressive shift in research focus toward more sophisticated and technology-intensive topics (5,11). In particular, the emergence of exoskeletons, virtual reality, brain-computer interfaces, and AI-driven control systems as prominent research themes suggests that these technologies have gained visibility not only within academic communities but also within a broader societal context. When bibliometric findings are considered alongside GT data, the results indicate that growth in the field of robotic rehabilitation encompasses not only scientific production but also increasing societal awareness and expectations over time.

Recent analyses have highlighted the exponential growth of AI applications in healthcare, particularly in rehabilitation engineering, predictive analytics, and adaptive therapy systems (12-14). The integration of machine learning algorithms into robotic rehabilitation devices has enabled adaptive and personalized treatment modulation based on patient performance metrics. This technological evolution may have contributed not only to scientific expansion but also to increased media visibility, thereby influencing public search behavior.

These findings suggest that the future development of robotic and technology-assisted rehabilitation will be shaped not only by technical advancements but also by the expectations and perceptions of patients, caregivers, and clinical stakeholders. Accordingly, this shift in public interest indicates an increasing societal awareness of technology-based approaches within the field of rehabilitation.

From a clinical perspective, the increasing public interest in robotic and technology-assisted rehabilitation underscores the necessity for clinicians to be adequately informed about these modalities. As patients increasingly seek information about robotic systems, AI-based rehabilitation platforms, and virtual reality interventions, healthcare providers may encounter higher expectations regarding availability, accessibility, and outcomes of such technologies. This trend highlights the importance of evidence-based communication and realistic expectation management in clinical practice.

Study Limitations

This study has several limitations. First, GT data provide normalized RSV rather than absolute search counts. Consequently, the findings do not directly reflect the actual clinical utilization of rehabilitation technologies, disease prevalence, or healthcare demand; instead, they primarily represent public information-seeking behavior and levels of awareness.

Second, GT data are derived from the search behavior of users with internet access. Regions with limited internet availability or populations with lower socioeconomic status may therefore be underrepresented. This limitation may restrict the interpretation of the geographic distribution of global public interest.

Third, the keywords used in the analysis were selected in English. Searches conducted in languages other than English were not included, which may have resulted in an underrepresentation of search behaviors in non-English-speaking countries.

Finally, GT analyses do not establish causality. It is not possible to determine with certainty whether observed increases in public interest during specific periods are attributable to technological advancements, scientific publications, media influence, or external factors such as the COVID-19 pandemic. Accordingly, the results should be interpreted in terms of temporal trends and changes in awareness rather than causal relationships.

Conclusion

This study demonstrates a significant increase in global public interest in robotic and technology-assisted neurological rehabilitation approaches over the past decade, based on analyses of GT data. In particular, the marked rise in search trends related to robotic rehabilitation, exoskeleton systems, AI, and virtual reality–based rehabilitation applications during the 2021-2025 period highlights growing societal awareness of the technological transformation within the field of rehabilitation.

These findings may help inform future clinical, educational, and research priorities related to digital and robotic rehabilitation applications.

Ethics

Ethics Committee Approval: This study did not require ethics committee approval as it was based on publicly available data.

Informed Consent: Informed consent was not required for this study as it did not involve human participants or private medical information.

Footnotes

Financial Disclosure: The author declared that this study received no financial support.

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