EXTENDED ABSTRACT

Healthcare Digitalization in Europe: A Cross-Country Analysis of Access Disparities

The digitalization of healthcare systems presents a transformative opportunity to mitigate inequalities in healthcare access across the European Union (EU). The COVID-19 pandemic underscored the urgency of digital health adoption, as various technologies were swiftly integrated to address disruptions in medical service delivery. However, despite the apparent benefits of digital solutions, there remain substantial disparities among EU countries in terms of their readiness to embrace digital healthcare. This study investigates these disparities and explores how digitalization can contribute to improving healthcare access across member states.

To systematically analyze the relationship between digitalization and healthcare access, we constructed a comprehensive database incorporating data from the European Health Interview Survey (EHIS), the Digital Economy and Society Index (DESI), and other Eurostat databases. Employing k-means cluster analysis, we classified EU countries based on two dimensions: the level of digitalization and inequalities in access to medical services.

Table 1 Description of main cluster characteristics used in performing k-means algorithm

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
General government expenditure on health as % of GDP	7,6%	5,8%	8,9%	5,9%	6,9%
number of health personnel (excluding nursing and caring professionals) per 100,000 inhabitants	411,6	289,3	406,1	375,9	387,9
number of hospital beds per 100,000 inhabitants	285,8	539,0	661,8	685,3	432,8
Self-reported unmet needs for healthcare due to long waiting list	17,9%	22,6%	17,3%	5,2%	23,1%
% of inhabitants aged 15 or older using smartphones for private purpose	90,1%	79,1%	82,3%	67,6%	74,1%
% of inhabitants using Internet to seeking health information	72,3%	53,1%	53,0%	37,0%	58,0%
Digital Economy and Society Index (DESI)	63,4	46,4	52,1	37,2	54,2

Source: Authors' elaboration : https://doi.org/10.1016/j.healthpol.2023.104950.

Table 2 Differences among five clusters of European Union countries in access to healthcare and digitalization

Cluster	Countries	Unmet need for healthcare due to long waiting list	Digitalization of society and industry
1	Denmark, Finland, Netherlands, Spain, Sweden, Cyprus	Moderate	High
3	Austria, Belgium, Czech Republic, Germany, France	Moderate	Moderate
5	Croatia, Estonia, Lithuania, Slovenia, Ireland, Italy, Malta, Portugal	High	Moderate
2	Hungary, Latvia, Poland, Greece, Luxembourg	High	Low
4	Bulgaria, Romania, Slovakia	Low	Low

Source: Authors' elaboration : https://doi.org/10.1016/j.healthpol.2023.104950.

Our findings reveal five distinct clusters: two clusters exhibiting high levels of unmet medical need, two clusters with moderate levels, and one with relatively low levels of unmet need. With regard to digitalization, only a single cluster—comprising the Nordic countries, Spain, and Cyprus—demonstrates high digital readiness. Meanwhile, Western European countries with advanced healthcare systems fall into a category characterized by moderate levels of both digitalization and unmet need for healthcare. The remaining EU member states display varying degrees of digital infrastructure deficits, underscoring the need for substantial investment in healthcare digitalization.

Our study is the first to systematically examine the link between unmet healthcare needs—particularly due to long waiting times—and the level of digitalization across EU member states. The clustering approach provides valuable insights into potential opportunities for digital transformation in healthcare and expands on existing research that addresses digitalization in Europe. The results emphasize the need for a nuanced, localized approach to digital health policy rather than a one-size-fits-all strategy across the EU. Countries with lower digitalization levels require targeted interventions that account for their specific economic, technological, and healthcare system characteristics.

Despite the theoretical benefits of digital healthcare, integrating mobile health (mHealth) and other digital solutions into clinical and public health initiatives remains a significant challenge, particularly in countries with constrained economic resources. From a technological standpoint, the development of robust public infrastructure is crucial to ensure seamless integration of digital healthcare into everyday medical practice. These innovations should be embedded within the framework of "integrated healthcare services," which refers to healthcare systems that deliver a continuum of services—including health promotion, disease prevention, diagnosis, treatment, rehabilitation, and palliative care—across different levels and sites of care, ensuring coordinated and patient-centered care delivery.

Addressing healthcare disparities through digitalization requires a multidimensional strategy that accounts for both institutional and systemic factors influencing the adoption and accessibility of digital health technologies. Our research highlights that unmet healthcare needs in different EU regions are driven by various determinants, including macroeconomic factors (such as healthcare expenditures as a percentage of GDP), resource allocation (e.g., availability of healthcare personnel and infrastructure), and technological accessibility (e.g., Internet penetration rates and smartphone usage). The interplay of these factors underscores the complexity of digital transformation in healthcare and the necessity of tailored policy responses that align with country-specific conditions.

Post-pandemic research indicates that healthcare delivery has increasingly shifted towards remote consultations, and general practitioners (GPs) across Europe acknowledge the advantages of digital health solutions. However, the full potential of digital healthcare can only be realized through adequate financing of healthcare systems, workforce training, the integration of digital platforms, and patient readiness. Simply expanding digitalization efforts without addressing these foundational challenges may exacerbate existing inequalities rather than resolve them.

The findings of this study offer a foundation for future research aimed at exploring how differences in digital readiness and healthcare access across the EU can inform local policy development. Policymakers must consider country-specific conditions when designing digital

health strategies to maximize their effectiveness. In addition, targeted healthcare campaigns should be developed to address the unique needs of different clusters of EU countries, ensuring that digital health solutions contribute to reducing—not widening—healthcare disparities.

In conclusion, while healthcare digitalization offers a promising pathway for addressing access inequalities in the EU, achieving its full potential requires a strategic and context-sensitive approach. Investing in digital infrastructure, training healthcare professionals, integrating digital solutions into existing medical workflows, and ensuring patient engagement are essential steps in this process. Policymakers must move beyond a generalized digital health agenda and adopt targeted, evidence-based strategies that address the specific challenges faced by different EU countries. By doing so, digital health technologies can serve as a powerful tool for enhancing healthcare accessibility and improving health outcomes across the region.