Review Article Pol J Public Health, Vol. 136 (2026): 135-140

Digital health tools in epidemiology and public health in Poland: Effectiveness, availability, and implementation barriers – a narrative review

Karolina Wziątek[1,A-B,D-I,K] ✉, Jakub Fiegler-Rudol[1,A-B,D-I], Karolina Lau[1,G,L], Janusz Kasperczyk[1,G,L]

[1] *Department of Environmental Medicine and Epidemiology, Medical University of Silesia, Poland*

A – Development of the concept and methodology of the study; B – Query – a review and analysis of the literature; C – Submission of the application to the appropriate Bioethics Committee; D – Collection of research material; E – Analysis of the research material; F – Preparation of draft version of manuscript; G – Critical analysis of manuscript draft version; H – Statistical analysis of the research material; I – Interpretation of the performed statistical analysis; K – Technical preparation of manuscript in accordance with the journal regulations; L – Supervision of the research and preparation of the manuscript

Abstract

Introduction and aim. The synthesis of current scientific evidence on the effectiveness, implementation and barriers associated with digital health interventions, with particular focus on health outcomes, system efficiency, user engagement and digital inequalities, with emphasis on the Polish public health and epidemiological context.

Methods of review. A structured narrative literature review was conducted based on peer-reviewed scientific articles from the PubMed, Google Scholar, Scopus, and Embase databases (publications from 2021-2026), including systematic reviews, meta-analyses, observational studies and policy analyses. Data were subjected to narrative synthesis within thematic areas.

Brief summary of current knowledge. Out of the 1,247 identified records, 34 publications were included in the analysis. Digital health interventions show moderate to high effectiveness in improving selected clinical outcomes, screening rates, and patient engagement. Patient portals and mHealth tools are associated with improved self-management and system efficiency. Persistent barriers include limited interoperability, regulatory fragmentation, data privacy concerns and digital inequalities disproportionately affecting older adults and populations with low digital literacy.

Summary. Digital health technologies offer measurable benefits, but their full utilisation requires a systemic resolution of interoperability, standardisation and digital literacy problems. Evidence-based implementation is needed to support their effective and equitable use.

Keywords: digital health, eHealth, mHealth, patient portals, digital inequalities, interoperability.

DOI: 10.12923/2083-4829/2026-0024

INTRODUCTION

The concepts of eHealth and mHealth describe a growing area of application of information and communication technologies in healthcare. The term eHealth refers to the broad use of digital technologies – including the Internet, digital games, virtual reality, and robotics – in health promotion, prevention, treatment, and maintenance. While the term mHealth constitutes a subcategory of eHealth encompassing the use of mobile devices: smartphones, applications, wearable devices (wearables), and SMS in the delivery of health services [1]. The World Health Organization (WHO) uses the term digital health as an umbrella term encompassing both eHealth and mHealth, as well as new areas: artificial intelligence, big data and genomics.

The COVID-19 pandemic constituted an unprecedented catalyst for digital transformation in healthcare. In the United States, telehealth use among Medicare fee-for-service beneficiaries peaked in the second quarter of 2020 (47% of Medicare users with a telehealth service) and, although it subsequently levelled off (15% by the end of 2022), remained substantially higher than before the pandemic [2].

In Poland, the digitalisation of healthcare gained particular momentum during the same period. Internetowe Konto Pacjenta (IKP- translated as "Online Patient Account" by the authors), enabling access to e-prescriptions, test results and referrals, has become a central element of the Polish eHealth ecosystem. Nevertheless, challenges related to interoperability [3,4], standardisation [5] and reimbursement [6] of digital health solutions remain important barriers to the effective implementation of digital health technologies in Poland.

Given the heterogeneity of digital health interventions, target populations, outcomes and implementation settings, a narrative review approach was considered appropriate for synthesising the available evidence. The literature search was conducted in PubMed, Google Scholar, Scopus and Embase databases, using predefined combinations of controlled vocabulary and keywords related to digital health, public health,

© 2026 Author(s). This is an open access article distributed under the Creative Commons Attribution CC-BY 4.0 licence (https://creativecommons.org/licenses/by/4.0/)

epidemiology, prevention, accessibility, and health inequalities. Publications were selected according to predefined inclusion and exclusion criteria, with particular emphasis on peer-reviewed studies addressing the use, effectiveness, accessibility and implementation of digital health technologies in public health and epidemiology.

AIM OF THE STUDY

The aim of this work is to synthesise current scientific evidence on the effectiveness and availability of digital health tools – mobile applications, patient portals, electronic health record (EHR) systems and epidemiological databases – with particular focus on their role in health prevention, epidemiological surveillance, and patient engagement. The analysis also includes identification of systemic implementation barriers and consideration of the Polish healthcare context in relation to selected European countries.

MATERIALS AND METHODS

Type of Review

This work is a narrative literature review conducted in accordance with guidelines for narrative reviews. A narrative approach was applied due to the heterogeneity of the interventions and populations analysed, which precluded a meta-analysis covering all thematic areas.

Search Strategy

The literature search was conducted in May 2026 across four databases: PubMed, Google Scholar, Scopus and Embase. In the PubMed database, the following search strategy based on MeSH terms was applied:

("Telemedicine"[MeSH] OR "Mobile Applications"[MeSH] OR "Internet"[MeSH] OR "Medical Informatics Applications"[MeSH] OR "Patient Portals"[MeSH]) AND ("Health Services Accessibility"[MeSH] OR "Preventive Health Services"[MeSH] OR "Mass Screening"[MeSH] OR "Health Promotion"[MeSH]) AND ("Public Health"[MeSH] OR "Epidemiology"[MeSH]) AND ("COVID-19"[MeSH] OR "Data Collection"[MeSH] OR "Healthcare Disparities"[MeSH])

In the remaining databases, analogous combinations of keywords with AND/OR logical operators, adapted to the specifics of each database, were applied. Only English-language publications published between 2021 and 2026 were included.

Eligibility Criteria

Inclusion criteria:

- publications concerning the application of eHealth technologies (telemedicine, mobile applications, medical informatics systems, patient portals, EHR systems)
- studies in the field of health prevention, health promotion and screening
- articles in the field of public health and epidemiology
- studies relating to service accessibility, health inequalities and health data collection, including in the context of the COVID-19 pandemic
- systematic reviews, meta-analyses, observational studies, and policy analyses

Exclusion criteria:

- publications older than 5 years (before 2021), with the exception of key methodological works
- non-medical articles or those unrelated to eHealth topics
- reports not meeting scientific standards (e.g., opinions without research backing)
- conference reports without full text

Selection and Data Extraction

The selection process proceeded in two stages: (1) independent assessment of titles and abstracts by two reviewers with subsequent reconciliation of discrepancies, (2) full-text assessment applying the above eligibility criteria. Data were extracted into a structured form covering: author, year of publication, study type, population, digital intervention/tool, health area and main results. The data were subjected to narrative synthesis within five thematic areas: (1) epidemiological surveillance, (2) prevention and screening, (3) patient engagement and portals, (4) implementation barriers, (5) digital inequalities.

Publication Selection Flow (PRISMA-like)

TABLE 1. Publication selection process.

Stage	Number of records
Records identified in databases	1,247
Records after removal of duplicates	891
Records after title and abstract screening	112
Full texts assessed for eligibility	58
Publications included in the review	34

RESULTS

The narrative synthesis included 34 publications, comprising 18 systematic reviews or meta-analyses, 9 observational studies and 7 policy analyses or conceptual frameworks. The characteristics of the included publications are presented in Table 2. The categories of digital tools identified in the analysed publications, along with their main applications and level of availability in Poland, are presented in Table 3.

Digital Tools in Epidemiological Surveillance

Digital epidemiological surveillance systems – based on social media, internet search engines, EHR and data from wearable devices – enable the collection and analysis of health information in near real time [15,16]. Hybrid systems combining traditional epidemiological data with digital data can provide a time lead of several days to several weeks compared to traditional reporting systems [16].

In the European context, Tornero Costa et al. showed that the implementation of EHR systems in the WHO European Region is advanced, although outcomes and challenges differ significantly between subregions – Western European countries face the fewest barriers, while Central Asian countries report the greatest difficulties [3]. Bogaert et al. identified five key barriers common to European health information systems: fragmentation of data sources, EHR implementation barriers, unclear division of responsibility, legal gaps (including the misinterpretation of GDPR) and shortages of qualified personnel [4].

TABLE 2. Characteristics of selected included publications.

Author (year)	Study type	Tool/area	Key findings
Monasterio et al. (2026) [7]	Systematic review (18 studies)	eHealth – digital inequalities	Social gradients in the use of telemedicine and patient portals in Europe
Yang et al. (2025) [8]	Meta-analysis	mHealth – adoption	Older age negatively associated with mHealth adoption (OR=0.47); women and physically active individuals use it more often
Duplaga, Zimny-Zając (2025) [9]	Cross-sectional study (n=120,000)	eHealth – Poland	~50% used a teleconsultation; determinants: age, education, urban residence, chronic diseases
Grady et al. (2023) [10]	Meta-analysis	mHealth /digital interventions – engagement (nutrition, physical activity, obesity)	Engagement strategies show a small to moderate effect (SMD=0.33)
Lau et al. (2022) [11]	Meta-analysis (RCT)	mHealth – CRC screening	Digital decision-support tools increase colorectal cancer screening uptake (OR=1.42)
Tornero Costa et al. (2025) [3]	Regional analysis (WHO Europe)	EHR /interoperability	Advanced EHR implementation, but large differences between subregions
Shrivastava et al. (2021) [12]	Cross-sectional study (773 hospitals)	EHR interoperability	A unified EHR system reduces interoperability problems by 43-53%
Jakob et al. (2022) [13]	Systematic review	mHealth – adherence	Mean adherence 56%; key role of personalisation and personal support
Zych et al. (2024) [5]	Umbrella review (15 reviews)	Health app quality	Lack of consistent evaluation frameworks; MARS most common but not universal
van Kessel et al. (2023) [6]	Scoping review (9 countries)	Health app reimbursement	Germany is the only country with a DiGA system; among the countries analysed, Poland was the only country without reimbursement mechanisms for health applications
Tangari et al. (2021) [14]	Cross-sectional study (20,991 apps)	mHealth data privacy	88% of apps contained data-collecting code; 28.1% had no privacy policy

TABLE 3. Categories of digital tools used in public health.

Tool category	Examples	Main applications	Availability in Poland
Mobile applications (mHealth)	Apps for monitoring blood pressure, glucose, physical activity, mental health	Primary and secondary prevention, self-management, screening	Widely available; lack of reimbursement and standardisation [5,6]
Patient portals /IKP	Online Patient Account, hospital portals	Access to documentation, e-prescriptions, appointment reminders	IKP implemented; growing use after COVID-19
Electronic Health Records (EHR)	Hospital systems, primary care systems	Epidemiological surveillance, continuity of care, data exchange	Fragmentary implementation; limited interoperability
Telemedicine	Physician teleconsultations, e-visits	Access to care, continuation of treatment	Dynamic growth after 2020; reimbursement regulations in progress
Digital epidemiological surveillance	Social media platforms, Google Trends, wearable data	Early detection of disease outbreaks, monitoring of health trends [15,16]	Used by the National Institute of Public Health–PZH; lack of systemic integration
Epidemiological databases	WHO, ECDC, national disease registries	Population health surveillance, health policy	ECDC, WHO available; national registries variably interoperable

Effectiveness of Digital Interventions in Prevention and Screening

Digital health interventions show moderate to high effectiveness in selected prevention areas. A meta-analysis by Lau et al. (22 RCTs) confirmed that digital decision-support tools significantly increase participation in colorectal cancer screening (OR = 1.42; 95% CI: 1.24-1.63) [11]. Electronic patient-generated health data (PGHD) collected via mobile applications and wearable devices constitute a growing source of health information in multicomponent preventive interventions [17]. A scoping review by Stark et al. indicated that the most frequently addressed areas in digital health promotion are physical activity (40.5%), nutrition (22.5%), and sexual health (17%) [18].

Patient Portals and User Engagement

Patient portals can improve health status monitoring, strengthen the physician–patient relationship, and increase adherence to therapeutic recommendations, as confirmed in the systematic review by Carini et al. [19]. Although 90% of healthcare systems in the United States offer patient portals, only 15-30% of patients actively use them [20]. Scheckel et al. confirmed a noticeable decline in patient portal use over time, with the most frequent users are younger individuals with higher education [21].

A meta-analysis by Grady et al. showed that strategies increasing user engagement with digital health interventions have a small to moderate positive effect on both usage (SMD = 0.33; 95% CI: 0.20-0.46) and user experience (SMD = 0.29; 95% CI: 0.07-0.52) [10]. Among the most effective techniques were social support, individualised push notifications, and email/SMS reminders. The mean adherence rate for mHealth applications was only 56% (SD 24.4%), highlighting the scale of the long-term engagement problem [13].

DISCUSSION

Digital Inequalities

Despite the growing availability of digital tools, digital exclusion (the digital divide) remains one of the most serious challenges to the equitable use of health technologies [22]. A systematic review by Monasterio et al., covering 18 observational studies from European public healthcare systems, showed consistent social gradients: older individuals, those with lower education or socioeconomic status, ethnic minorities, and individuals with limited digital competencies used telemedicine, patient portals, and EHR less frequently [7]. A meta-analysis by Yang et al. confirmed that older age negatively correlates with mHealth tool adoption (OR = 0.47; 95% CI: 0.23-0.93), while higher education and income positively correlate with both access and adoption [8]. In the Polish context, the study by Duplaga and Zimny-Zając confirmed that 5% to 9% of respondents still use paid online medical advice, indicating persistent barriers to access to public digital services [9].

Sim highlighted digital literacy as an important factor influencing the effective use of mobile health technologies [1]. A meta-analysis by Kizilkilic et al. showed that educational interventions – particularly those delivered in person – significantly improve digital health literacy (eHEALS) both in the short and long term [23,24].

Lack of Standardisation of Health Applications

The lack of uniform quality standards for health applications constitutes a significant threat to patient safety. An umbrella review by Zych et al. showed a lack of consistency among existing quality assessment frameworks – none met all identified quality criteria. The Mobile App Rating Scale (MARS) remains the most common tool, but its use is neither universal nor mandatory [5,25]. Akbar et al. identified 80 safety concerns across 74 studies, of which 67 concerned the quality of the information presented, and five reports indicated a risk of direct harm to the patient [26].

In the European context, Germany has implemented a systemic reimbursement pathway for health applications within statutory health insurance (DiGA – Digitale Gesundheitsanwendungen), which involves mandatory quality and safety assessment. As of August 2023, digital health solutions were reimbursable to some extent in all countries analysed by van Kessel et al. except Poland. Poland – unlike Germany, France or the United Kingdom – therefore did not, as of 2023, possess reimbursement mechanisms for digital health solutions, which may limit the incentive for standardisation and validation of applications [6].

Challenges of Interoperability and System Integration

The integration of health information systems remains a key technical and organisational challenge. A study by Shrivastava et al., based on data from 773 European hospitals, showed that hospitals with a unified EHR system had a 43-53% lower probability of technical and semantic interoperability problems compared to hospitals with multiple systems [12]. Paradoxically, privacy regulations at the regional and organisational level increased the probability of semantic interoperability problems by 85% and organisational interoperability problems by 76% [12].

The European Health Data Space (EHDS), proposed by the European Commission in 2022, represents an attempt to address these problems by establishing a European format for the electronic exchange of health records; however, further specification and harmonisation of concrete semantic and syntactic interoperability standards are still required [27].

Data Protection and Privacy

The protection of personal and health data constitutes a fundamental challenge in the era of healthcare digitalisation. A review by Gökçe İşcan and Oğulcan Çöme, covering 52 studies, identified the most common threats: data breaches, insufficient encryption, ambiguities regarding patient consent, and difficulties in securing virtual consultations [28]. A study by Tangari et al., based on a sample of nearly 21,000 applications from Google Play, showed that 88% contained code enabling potential collection of user data, 28.1% had no privacy policy whatsoever, and 23% of data transmissions occurred over unsecured protocols [14].

Poland compared to Europe

An analysis by Majcherek et al. confirmed that the Nordic countries and Spain are characterised by the highest digital readiness in the health domain, while many Central and Eastern European countries, including Poland, require further investment in digital infrastructure [29]. Despite the dynamic development of the IKP and telemedicine in Poland, the system is still characterised by limited interoperability between healthcare providers, a lack of reimbursement mechanisms for health applications, and persistent digital inequalities related to age, place of residence and level of education [6,9]. A summary of the main implementation barriers identified in this review, together with their corresponding sources, is presented in Table 4.

TABLE 4. Main barriers to the implementation of digital health tools.

Barrier category	Description	Source
Digital exclusion	Older age, low education and income, limited digital competencies; disproportionate burden on vulnerable groups	Monasterio (2026) [7], Yang (2025) [8], Sim (2019) [1], Wilson (2024) [22]
Lack of application standardisation	Heterogeneous quality, lack of universally accepted assessment frameworks (MARS not mandatory), risk of direct harm	Zych (2024) [5], Woulfe (2021) [25], Akbar (2020) [26]
Limited interoperability	Fragmentation of EHR systems, lack of data exchange standards, paradox of privacy regulations increasing barriers	Shrivastava (2021) [12], Tornero Costa (2025) [3], Bogaert (2021) [4], Nalin (2019) [30]
Data protection and privacy	Data breaches, lack of privacy policy in applications, mixing of health and non-health data in the cloud	Tangari (2021) [14], İşcan (2026) [28], Alhammad (2024) [31]
Inconsistent reimbursement	Germany the only country with a DiGA system; among the countries analysed, only Poland without reimbursement mechanisms for health applications	van Kessel (2023) [6]
Low adherence to applications	Mean adherence only 56%; lack of personalisation, support, and a user-friendly interface as key drivers of user drop-off	Jakob (2022) [13], Figueiredo (2025) [32], Giebel (2023) [33]
Low credibility of content	Erroneous or incomplete information, lack of involvement of medical experts in app development, lack of clinical validation	Akbar (2020) [26], Wyatt (2018) [34], Li (2021) [17]

LIMITATIONS OF THE STUDY

This work has a number of limitations that should be taken into account when interpreting the results.

First, as a narrative literature review, this work does not meet the methodological rigour of a systematic review. Although the assessment of titles and abstracts was conducted independently by two reviewers, full texts were assessed by a single reviewer for practical reasons, which should be regarded as a limitation increasing the risk of selection bias.

Second, only English-language publications were included. This may lead to the omission of important studies published in Polish or other European languages, particularly those concerning the national context of digital health technology implementation.

Third, the methodological heterogeneity of the included studies – variation in populations, digital tools and endpoints – precludes direct quantitative comparison of results across thematic areas. Narrative synthesis, while appropriate for this scope, remains more susceptible to subjective interpretation than meta-analysis.

Fourth, the dynamic nature of the digital health field means that some data may become outdated shortly after the review is published. This applies particularly to regulatory, reimbursement and technological data.

Fifth, the data concerning Poland are based largely on a single large cross-sectional study (Duplaga and Zimny-Zając, 2025), which limits the generalisability to the entire Polish population and hinders the formulation of policy recommendations.

Sixth, no formal risk of bias assessment was conducted for the individual included studies, which constitutes a standard element of systematic reviews but falls outside the methodological scope of a narrative review.

The results of this work should be treated as a starting point for formulating research questions requiring verification in studies with a higher level of evidence.

CONCLUSIONS

Based on the literature review conducted, the following conclusions were formulated:

- Digital health tools – mobile applications, patient portals, EHR systems and telemedicine platforms – have demonstrated documented effectiveness in improving selected clinical outcomes, increasing participation in screening and patient engagement, particularly when integrated with existing healthcare systems.
- Digital exclusion remains the main barrier to equal access: older individuals, those with lower education and socioeconomic status and those with limited digital competencies use eHealth tools less frequently and less effectively. Educational interventions delivered in person significantly improve digital health literacy.
- The lack of standardisation of health applications and reimbursement mechanisms – combined with the absence of universally accepted quality assessment frameworks – poses a risk to patient safety and limits trust in digital interventions. The DiGA system implemented in Germany provides an example of a structured reimbursement and quality-assessment approach that may be relevant when considering future digital health policies in Poland.
- Limited interoperability of health information systems, particularly in the area of semantic data exchange between providers, remains a key technical challenge. The realisation of the European Health Data Space requires the development of concrete semantic and syntactic interoperability standards.
- Poland requires targeted investment in the interoperability of health information systems, a regulatory and reimbursement frameworks for health applications and programmes to increase digital competencies, particularly among older people and residents of rural areas.
- Future research should focus on high-quality comparative effectiveness studies of digital interventions across different populations, and implementation policies should be based on the principles of equitable access, algorithmic transparency and personal data protection.

REFERENCES

1. Sim I. Mobile devices and health. N Engl J Med. 2019;381(10):956-968. https://doi.org/10.1056/NEJMra1806949
2. Saharkhiz M, Rao T, Parker-Lue S, et al. Telehealth expansion and Medicare beneficiaries' care quality and access. JAMA Netw Open. 2024;7(5):e2411006. https://doi.org/10.1001/jamanetworkopen.2024.11006
3. Tornero Costa R, Adib K, Salama N, et al. Electronic health records and data exchange in the WHO European Region: a subregional analysis. Int J Med Inform. 2025;194:105687. https://doi.org/10.1016/j.ijmedinf.2024.105687
4. Bogaert P, Verschuuren M, Van Oyen H, et al. Identifying common enablers and barriers in European health information systems. Health Policy. 2021;125(12):1517-1526. https://doi.org/10.1016/j.healthpol.2021.09.006
5. Zych MM, Bond R, Mulvenna M, et al. Quality assessment of digital health apps: umbrella review. J Med Internet Res. 2024;26:e58616. https://doi.org/10.2196/58616
6. van Kessel R, Srivastava D, Kyriopoulos I, et al. Digital health reimbursement strategies of 8 European countries and Israel: scoping review and policy mapping. JMIR Mhealth Uhealth. 2023;11:e49003. https://doi.org/10.2196/49003
7. Monasterio G, Fernandez-Lopez MJ, Valero E, et al. Digital inequalities in the use of eHealth services in European public health care systems: systematic review of observational studies. J Med Internet Res. 2026;28:e81841. https://doi.org/10.2196/81841
8. Yang S, Cha MJ, van Kessel R, et al. Understanding inequalities in mobile health utilization across phases: systematic review and meta-analysis. J Med Internet Res. 2025;27:e71349. https://doi.org/10.2196/71349
9. Duplaga M, Zimny-Zając A. The assessment of the use of e-health services in Polish society in the post-pandemic era: the results of a large-scale cross-sectional study. Stud Health Technol Inform. 2025;329:1337-1341. https://doi.org/10.3233/SHTI251056
10. Grady A, Pearson N, Lamont H, et al. The effectiveness of strategies to improve user engagement with digital health interventions targeting nutrition, physical activity, and overweight and obesity: systematic review and meta-analysis. J Med Internet Res. 2023;25:e47987. https://doi.org/10.2196/47987
11. Lau J, Ng A, Wong GJ, et al. How effective are digital technology-based interventions at promoting colorectal cancer screening uptake? A systematic review and meta-analysis of RCTs. Prev Med. 2022;164:107343. https://doi.org/10.1016/j.ypmed.2022.107343
12. Shrivastava U, Song J, Han BT, et al. Do data security measures, privacy regulations, and communication standards impact the interoperability of patient health information? A cross-country investigation. Int J Med Inform. 2021;148:104401. https://doi.org/10.1016/j.ijmedinf.2021.104401
13. Jakob R, Harperink S, Rudolf AM, et al. Factors influencing adherence to mHealth apps for prevention or management of noncommunicable diseases: systematic review. J Med Internet Res. 2022;24(5):e35371. https://doi.org/10.2196/35371
14. Tangari G, Ikram M, Ijaz K, et al. Mobile health and privacy: cross sectional study. BMJ. 2021;373:n1248. https://doi.org/10.1136/bmj.n1248
15. Aiello AE, Renson A, Zivich PN. Social media- and internet-based disease surveillance for public health. Annu Rev Public Health. 2020;41:101-118. https://doi.org/10.1146/annurev-publhealth-040119-094402
16. Liscano Y, Anillo Arrieta LA, Montenegro JF, et al. Early warning of infectious disease outbreaks using social media and digital data: a scoping review. Int J Environ Res Public Health. 2025;22(7):1104. https://doi.org/10.3390/ijerph22071104
17. Li L, Novillo-Ortiz D, Azzopardi-Muscat N, et al. Digital data sources and their impact on people's health: a systematic review of systematic reviews. Front Public Health. 2021;9:645260. https://doi.org/10.3389/fpubh.2021.645260
18. Stark AL, Geukes C, Dockweiler C. Digital health promotion and prevention in settings: scoping review. J Med Internet Res. 2022;24(1):e21063. https://doi.org/10.2196/21063
19. Carini E, Villani L, Pezzullo AM, et al. The impact of digital patient portals on health outcomes, system efficiency, and patient attitudes: updated systematic literature review. J Med Internet Res. 2021;23(9):e26189. https://doi.org/10.2196/26189
20. Lyles CR, Nelson EC, Frampton S, et al. Using electronic health record portals to improve patient engagement: research priorities and best practices. Ann Intern Med. 2020;172(Suppl 11):S123-S129. https://doi.org/10.7326/M19-0876
21. Scheckel B, Schmidt K, Stock S, et al. Patient portals as facilitators of engagement in patients with diabetes and chronic heart disease: scoping review. J Med Internet Res. 2023;25:e38447. https://doi.org/10.2196/38447
22. Wilson S, Tolley C, Mc Ardle R, et al. Recommendations to advance digital health equity: a systematic review of qualitative studies. npj Digit Med. 2024;7(1):173. https://doi.org/10.1038/s41746-024-01177-7

23. Kizilkilic SE, Xu L, Akinci B, et al. Educational methods to improve digital health literacy: a systematic review and meta-analysis for the EAPC Opti(MI)se initiative. Eur J Prev Cardiol. 2025;32(10):zwaf354. https://doi.org/10.1093/eurjpc/zwaf354
24. Barbati C, Maranesi E, Giammarchi C, et al. Effectiveness of eHealth literacy interventions: a systematic review and meta-analysis of experimental studies. BMC Public Health. 2025;25(1):288. https://doi.org/10.1186/s12889-025-21354-x
25. Woulfe F, Fadahunsi KP, Smith S, et al. Identification and evaluation of methodologies to assess the quality of mobile health apps: rapid review. JMIR Mhealth Uhealth. 2021;9(10):e28384. https://doi.org/10.2196/28384
26. Akbar S, Coiera E, Magrabi F. Safety concerns with consumer-facing mobile health applications and their consequences: a scoping review. J Am Med Inform Assoc. 2020;27(2):330-340. https://doi.org/10.1093/jamia/ocz175
27. Stellmach C, Muzoora MR, Thun S. Digitalization of health data: interoperability of the proposed European Health Data Space. Stud Health Technol Inform. 2022;298:132-136. https://doi.org/10.3233/SHTI220922
28. İşcan G, Çöme O. Security and privacy in e-health technologies: a scoping review of challenges and strategies in primary care. Fam Pract. 2026;43(2):cmag006. https://doi.org/10.1093/fampra/cmag006
29. Majcherek D, Hegerty SW, Kowalski AM, et al. Opportunities for healthcare digitalization in Europe: comparative analysis of inequalities in access to medical services. Health Policy. 2024;139:104950. https://doi.org/10.1016/j.healthpol.2023.104950
30. Nalin M, Baroni I, Faiella G, et al. The European cross-border health data exchange roadmap: case study in the Italian setting. J Biomed Inform. 2019;94:103183. https://doi.org/10.1016/j.jbi.2019.103183
31. Alhammad N, Alajlani M, Abd-Alrazaq A, et al. Patients' perspectives on the data confidentiality, privacy, and security of mHealth apps: systematic review. J Med Internet Res. 2024;26:e50715. https://doi.org/10.2196/50715
32. Figueiredo T, Alcantara L, Carrilho J, et al. Understanding adherence to digital health technologies: systematic review of predictive factors. J Med Internet Res. 2025;27:e77362. https://doi.org/10.2196/77362
33. Giebel GD, Speckemeier C, Abels C, et al. Problems and barriers related to the use of digital health applications: scoping review. J Med Internet Res. 2023;25:e43808. https://doi.org/10.2196/43808
34. Wyatt JC. How can clinicians, specialty societies and others evaluate and improve the quality of apps for patient use? BMC Med. 2018;16(1):225. https://doi.org/10.1186/s12916-018-1211-7

ORCID

Karolina Wziątek https://orcid.org/0009-0007-1655-0196

Corresponding author
Karolina Wziątek
Department of Environmental Medicine and Epidemiology,
Medical University of Silesia, Zabrze, Poland
e-mail: s96501@365.sum.edu.pl