Chain of Portable Health Folders: A Systematic Literature Review

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Abstract. The rise of Information Technologies' influence during the 3rd industrial revolution led to the development of Digital Health Records, with Electronic Health Records (EHRs) and Personal Health Records (PHRs) beginning patient empowerment. Today, Health Wallets (HWs), leveraging technologies like Fast Healthcare Interoperability Resources (FHIR) and Blockchain, represent the next step in this evolution, focusing on patient-centric health management, and the growing need for availability, transparency, privacy, and reliability. The paper, henceforth, will conduct a Systematic Literature Review, following the PRISMA framework, with the aim of exploring the characteristics of existing patient information platforms, the advantages and limitations of their use, and gaps in the current solutions. An initial search yielded 850 articles, of which 36 were included in the analysis. The results show that healthcare professionals generally support the integration of HWs into practice, with accelerated research and implementation following the COVID-19 pandemic. These platforms aim for secure data management, although challenges persist, particularly in terms of interoperability, and data protection. Benefits include Patient empowerment, better treatment, and cost reduction as well as operational efficiency. Despite some resistance due to established routines and patient eHealth literacy, key issues are mitigated by key technologies such as FHIR, Blockchain, Role Based Access Control (RBAC), and Bidirectional Communication. Research should focus on the ability of Health Wallets to integrate seamlessly with existing systems to avoid additional complexity, enhance privacy, enhance user experience, and improve healthcare efficiency.

Keywords: Digital Wallet · Healthcare Folder · Systematic Literature Review

1 Introduction

Since the 1950s, the 3rd industrial revolution paved the way for an economy driven by information technology. The healthcare sector was first impacted by the development of both Electronic Medical Records (EMRs) and Electronic Health Records (EHRs) [8], which manifested in a shift from paper-based documentation to digital records,

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revolutionizing how healthcare data is accessed and stored. These early digital systems helped not only to simplify processes in hospitals and clinics, but also assist in the prevention of the loss of information while aiding with both communication of data and information and efficiency in the access of data.

These investments were primarily provider-centric, focusing on the needs of healthcare providers rather than the patients. However, as these naturally developed, technologies such as the Personal Health Records (PHRs) [9] appeared, allowing for the beginning of patient empowerment, and facilitating a more active role in managing their own health data. This empowerment was further guaranteed by the expansion of Wearable [10] technologies and Over-the-counter (OTC) [11] health records, generating vast amounts of data and emphasizing the need for systems that provide patients access and control. This growth in patient participation saw its rhythm accelerated from the Covid-19 pandemic, requiring an increase in health literacy [12, 13] (with prophylactic measures put into practice). Social distancing also put an emphasis on technological literacy. eHealth literacy grew in importance as patients grew in awareness.

Despite these advancements, significant challenges remain in how health data is managed and shared across different platforms and made visible to its users and owners. The growth in data visibility and availability was not accompanied by management capabilities and operation efficiency or standardization methods, hence the pressing issue of data fragmentation. Interoperability problems not only persist but increase exponentially with the growing amount of information available, as well as, with different healthcare systems using incompatible formats and standards, a hurdle in data exchange, affecting the continuity of care [14]. Additionally, with the continuous usage of informatic means [15, 16], concerns about privacy and security have grown.

In response to these challenges, Health Wallets (HWs) have emerged as a promising solution. These are portable health record management systems, similar to folders but that allow for information transactions, representing the next step in the evolution of digital health records, as a parallel to the wallets increasingly used for payments [17]. HWs are secure, portable digital tools that allow individuals to manage, access, and share their health data across various healthcare settings. Unlike traditional health records, HWs are user-centric, giving patients full control over their data alongside the possibility for value co-creation, a bigger intervention, and cooperation in the processes [18].

With its ability to leverage modern technologies like Blockchain and Fast Healthcare Interoperability Resources (FHIR), health wallets aim to address issues related to data privacy, interoperability, and patient empowerment. While Blockchain ensures that sensitive data remains secure and immutable, allowing for Access Control and Selective Parameter Sharing, FHIR facilitates the smooth exchange of information across different healthcare systems, creating formalized methods of exchanging information and guaranteeing a reduction of constant manual handling [2, 17, 18].

The importance of Health Wallets (HWs) has only grown in recent years due to several key trends in healthcare: the continuous shift towards a patient-centered care model, the rise of telemedicine, and remote healthcare services —accelerated by the COVID-19 pandemic—which emphasized the critical need for secure, accessible health data management [19, 20]. In this evolving landscape, HWs are uniquely positioned to bridge significant gaps in digital health systems, aiming to offer a secure way to integrate

and manage the vast amounts of health data generated by wearables, mobile apps, and healthcare providers—data that remains vulnerable in current systems.

Despite their potential, research on HWs remains limited and fragmented. There is a critical lack of consolidated investigations into the specific benefits, challenges, and adoption of these technologies. Crucially, the diminishing marginal returns of introducing yet another tool in an already crowded healthcare technology landscape have not been explored, nor have the effects of eHealth literacy on adoption and continuous usage. Additionally, the essential requirements for effectively integrating HWs into existing healthcare processes are still unclear.

Today, several studies are addressing Health Wallets, their technicalities, benefits and limitations however, none was found that consolidates and compares them. This research aims to address this gap by comparing the current Health Wallet solutions. In doing so, it will answer the following research questions (RQ): 1) Are current developments and solutions in Health Wallet technologies sufficient to overcome existing challenges in healthcare?; 2) What are the key requirements for sustainable usage of a Health Wallet?; and 3) Are all requirements linked with a technology?;

This study resorts to a Systematic Literature Review, examining the state of technology integration in healthcare, identifying key benefits and challenges, and analyzing the conditions that influence HW adoption and sustained use.

The remainder of the article is organized as follows: it will begin by disclosing the Systematic Literature Review (SLR) pathway; then it will address the findings from the SLR and discuss them, leading to the identification of gaps in the current knowledge.

2 Systematic Literature Review

2.1 Search Strategy

To identify relevant articles, a Systematic Literature Review was conducted. Following the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) framework, searches were conducted in 3 Databases – IEEE Xplore, Scopus (main collection), and PubMed, and 5 distinct keywords ("Health Wallet", "Digital Health Wallet", "Personal Health Wallet", "Healthcare Wallet", "Medical Wallet") were used, joined by closely related words and/or synonyms. The closely related words used next to "Wallet" were "Folder" and "App", since these may approach the matter at hand from different perspectives.

The search relied on Boolean operators (AND, OR, NOT) in all databases – "Health Wallet" OR "Digital Health Wallet" OR "Personal Health Wallet" OR "Medical Wallet" AND "Healthcare Wallet" NOT "Financial Wallet". Filters were applied in relation to the used language, allowing English or Portuguese.

2.2 Selection Process

The selection process was conducted systematically and in alignment with the PRISMA framework and guidelines (see Fig. 1). The selection process was carried out independently by the researchers and the compared. Whenever the classification (inclusion

or not) was different, discussion followed until a consensus was reached. This input was instrumental in ensuring a holistic and comprehensive review. The studies were selected through content analysis, i.e., excluding papers that did not showcase either of the intervenient perspectives (Physician or Patient side). Topics such as Management, Technology Management or Innovation Management were also prioritized.

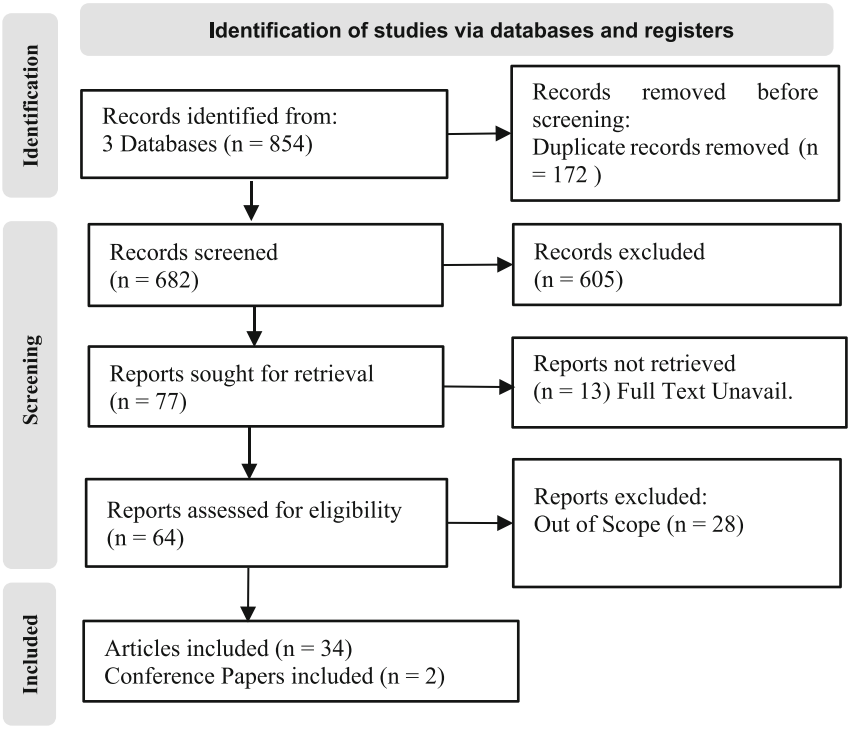

Fig. 1. PRISMA Diagram

2.3 Search Results

Out of 854 records identified from three databases (122 from IEEE Xplore, 391 from PubMed, and 342 from Scopus), 173 duplicates were removed through the usage of Mendeley, ensuring 682 distinct records for screening. From the title and abstract, 605 were excluded since they were irrelevant to this research. 77 records were sought for full-text retrieval. 64 were obtained, since 13 reports were excluded due to the unavailability of their full documents. Post retrieval, upon fully analysing the reports, 28 records were excluded as they were out of scope. Decision made from the apparent lack of attention to the medical professional's side of the interchange required in a Wallet, with ultimately their input being disregarded.

Consequentially, 36 studies were included in the systematic review for analysis. Of these 34 were peer-reviewed academic journal articles, and 2 were conference papers. This inclusion was deemed necessary to capture the rapid developments in the field.

Of the identified studies, only 4 were published before 2017, and since then, there has been a clear tendency to increase the number of publications on the topic per year (See Fig. 2). The final selection of 36 studies encompasses research from various regions across the globe, reflecting the growth of health folders, wallets, and apps. The studies originated mostly from the USA, Australia, and India (See Appendix 1).

2.4 Study Categorization

Groups. After a first content analysis of the collected literature, five distinct groups of articles emerged, based on recurring themes, objectives, and focus areas found across the papers. The group creation process identified patterns in how the articles approached the integration of technology in healthcare, as well as how they tackled related benefits, challenges, and specific features.

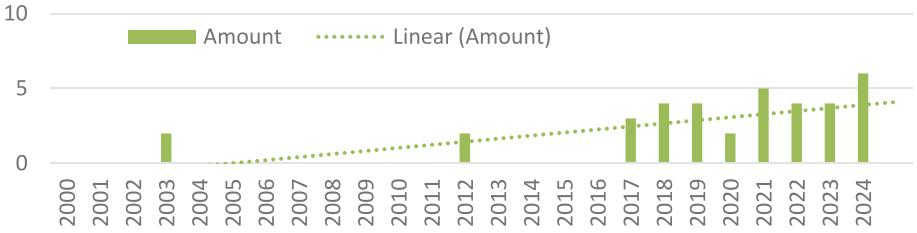

Fig. 2. Studies per Year of Publication

Many studies took a broader view of how digital tools are used and integrated into healthcare systems, forming a category that connected health wallets to overall technology adoption in healthcare. Conversely, several studies balanced advantages and challenges specific to HW/PHR introduction into the sector. There were however others that focused on narrower, more specific aspects, such as requirements from HWs and issues with eHealth literacy. While most studies focus on introducing a technology, there were some, that analyzed post-implementation usage, i.e., continuous intention to use a tool.

Accordingly, the articles were split into five: "Benefits and Challenges in a Health Wallet", "Continuous Intention to Use a Health Wallet", "eHealth Literacy", "Requirements from the Health Wallet", and "Technology Integration in Healthcare Systems" (See Tables 1, 2, 3, 4, and 5).

– Benefits and Challenges in a Health Wallet: This category includes studies that examine both the advantages and obstacles of implementing health wallets or similar technologies. Key topics include data security, user reluctance (both from medical professionals and patients), interoperability, and innovation culture/resistance to change.

- Continuous Intention to Use a Health Wallet: This category focuses on studies that explore post-implementation usage, examining what is most important for users and exploring both ongoing use and long-term retention.
- eHealth Literacy: Studies in this category address not only users' ability to use technology but also how literacy impacts adoption and effective use. These studies look at the influence of users' familiarity with health-related technologies.
- Requirements from technologies: This category encompasses studies that focus on essential features, technologies, and functionalities that users need from a wallet.
- Technology Integration in Healthcare Systems: Studies under this category assess the broader landscape of technology in healthcare, how the system has adapted to these changes, and how previous technologies were implemented.

Categories. The groups built above showcase the topics approached by the paper when discussing HWs' implementation. However, there can be a parallel categorization made from the major conclusions achieved, i.e., if the paper relies on specific technologies, benefits, challenges, or requirements to justify the addition (or not) of the tool - what technologies should be used, what benefits should be sought after, what challenges should a possible implementation prepare to face and what users require from the tool for it to add value to their value-creation.

The Technology Integration category became vital to understand what previous technologies have been used in the healthcare systems, how they were implemented, what can be built upon them, and what challenges they have faced. From this need, all papers will be divided into 4 key research concerns, according to which they address:

- Technologies either used or with the intent to use;
- Benefits either felt or foreseen;
- Challenges felt after the introduction of the technology or foreseen, and;
- Requirements from a tool, for it to add value to its users.

Table 1. Categories per Group - Benefits & Challenges in a HW

	Technology	Benefits	Challenges	Requirements
Equey et al. (2024)	x	x	✓	x
Galetsi et al. (2023)	✓	x	✓	✓
Khodadad-Saryazdi (2021)	✓	✓	✓	✓
Zhang et al. (2024)	✓	✓	✓	✓
Zhou et al. (2019)	✓	x	✓	✓

Table 2. Categories per Group - Continuous Intention to Use a HW

	Technology	Benefits	Challenges	Requirements
Chiu et al. (2020)	x	x	✓	x
Daragmeh et al. (2021)	x	x	✓	✓
Yadav et al. (2022)	x	x	✓	x

Table 3. Categories per Group - eHealth Literacy

	Technology	Benefits	Challenges	Requirements
Elgamal (2024)	x	x	✓	✓
Estrela et al. (2023)	x	x	✓	✓

Table 4. Categories per Group - Requirements from Technologies

	Technology	Benefits	Challenges	Requirements
Baek et al. (2018)	✓	✓	✓	✓
Birkmeyer et al. (2021)	✓	✓	✓	✓
Esmaeilzadeh & Sambasivan (2017)	✓	✓	✓	✓
Keshta & Odeh (2021)	✓	✓	✓	✓
Martínez-Pérez et al. (2015)	✓	✓	✓	✓
Schroeder et al. (2024)	✓	✓	✓	✓
Sengupta et al. (2024)	✓	✓	✓	✓
Sreejith & Senthil (2023)	✓	✓	✓	✓

3 Results

3.1 Group Analysis

Requirements. For a successful implementation and continuous usage of the Health Wallet (See Table 7), Interoperability (n = 15), Access Control mechanisms (n = 13), User-friendly (n = 13), having Patient Management systems (n = 13), allowing for Parameter Sharing (n = 12), maintaining a Privacy Policy (n = 12) and a Connection with Medical Professionals (n = 12) are seen as vital for at least a third of all papers.

These requirements were consistently identified as essential for ensuring correct integration and usability, not just for HWs but for most technology integration in healthcare - allowing for improved coordination, enhanced outcomes, and greater efficiency in healthcare delivery. By meeting these requirements, HWs can facilitate data sharing

Table 5. Categories per Group - Technology Integration into Healthcare

	Technol-ogy	Benefits	Chal-lenges	Require-ments
Alamri et al. (2021)	✓	✓	✓	✓
Ali et al. (2021)	✓	✓	✓	✓
Belfiore et al. (2022)	✓	✓	x	x
Beratarrechea et al. (2014)	✓	✓	x	✓
Fotiadis et al. (2018)	✓	✓	✓	✓
ICACCS (2019)	✓	✓	✓	✓
I*CTAS* (2019)	✓	✓	✓	✓
Karadas et al. (2023)	✓	✓	x	✓
Kebodeaux (2019)	✓	✓	✓	✓
Kharrazi et al. (2012)	✓	✓	✓	✓
Morton et al. (2021)	✓	✓	✓	✓
Motta & Furuie (2003)	✓	✓	✓	✓
Patel (2017)	✓	✓	✓	✓
Ranjan et al. (2018)	✓	✓	✓	✓
Tully et al. (2020)	✓	✓	x	x
Ueckert et al. (2003)	✓	✓	✓	✓
Utsha & Morshed (2024)	✓	✓	✓	✓
Van Der Storm et al. (2023)	✓	✓	✓	✓

between users with the correct authentication, making them easier, more secure, accessible, and able to cooperate with multiple organizations without human intervention. Still relevant and shown in several studies, Health Data collection, Authentication, and Minimizing time and Cost, which should also be prioritized in HW design. Not all features developed in the studies are associated with HWs, video calls, and feedback mechanisms (only referenced in 4 studies), e.g., indicate that, while useful, there is no apparent need to prioritize them in the design of HWs.

Technologies. Across the studies, a diverse range of technologies were discussed as an integral part of both the development and the operation of HWs. EHR/EMR (n = 22) and Cloud-based solutions (n = 14), emerged as the most frequently mentioned technologies for their key roles in data storage and accessibility. Equally important, PHRs, Role Based Access Control (RBAC), and Telemedicine were also highlighted, usually approached given their importance in security, patient management, and remote care. It becomes clear that any tool introduced in healthcare must assure the correct management and transmission of information, reducing dissemination, and preventing loss, while aiming to increase patient participation in the process.

Lesser-known technologies such as Selective Sharing (n = 7), Wearable Devices (n = 7), FHIR (n = 5), and Blockchain (n = 5) were shown in some of the most recent

Table 6. Categories: Topics Approached per Study

	Technology	Benefits	Challenges	Requirements
Alamri et al. (2021) [2]	✓	✓	✓	✓
Ali et al. (2021) [21]	✓	✓	✓	✓
Baek et al. (2018) [22]	✓	✓	✓	✓
Belfiore et al. (2022) [19]	✓	✓	x	x
Beratarrechea et al. (2014) [23]	✓	✓	x	✓
Birkmeyer et al. (2021) [24]	✓	✓	✓	✓
Chiu et al. (2020) [25]	x	x	✓	x
Daragmeh et al. (2021) [15]	x	x	✓	✓
Elgamal (2024) [12]	x	x	✓	✓
Equey et al. (2024) [2626]	x	x	✓	x
Esmaeilzadeh & Sambasivan (2017) [1]	✓	✓	✓	✓
Estrela et al. (2023) [13]	x	x	✓	✓
Fotiadis et al. (2018) [27]	✓	✓	✓	✓
Galetsi et al. (2023) [28]	✓	x	✓	✓
ICACCS (2019) [2929]	✓	✓	✓	✓
I*CTAS* (2019) [30]	✓	✓	✓	✓
Karadas et al. (2023) [31]	✓	✓	x	✓
Kebodeaux (2019) [11]	✓	✓	✓	✓
Keshta & Odeh (2021) [5]	✓	✓	✓	✓
Kharrazi et al. (2012) [32]	✓	✓	✓	✓
Khodadad-Saryazdi (2021) [33]	✓	✓	✓	✓
Martínez-Pérez et al. (2015) [34]	✓	✓	✓	✓
Morton et al. (2021) [35]	✓	✓	✓	✓
Motta & Furuie (2003) [36]	✓	✓	✓	✓
Patel (2017) [18]	✓	✓	✓	✓
Ranjan et al. (2018) [17]	✓	✓	✓	✓
Schroeder et al. (2024) [37]	✓	✓	✓	✓
Sreejith & Senthil (2023) [14]	✓	✓	✓	✓
Sengupta et al. (2024) [4]	✓	✓	✓	✓
Tully et al. (2020) [10]	✓	✓	x	x
Ueckert et al. (2003) [9]	✓	✓	✓	✓
Utsha & Morshed (2024) [38]	✓	✓	✓	✓
Van Der Storm et al. (2023) [39]	✓	✓	✓	✓
Yadav et al. (2022) [16]	x	x	✓	x
Zhang et al. (2024) [40]	✓	✓	✓	✓
Zhou et al. (2019) [41]	✓	x	✓	✓

Table 7. Number of references per Category of Requirements

	Main Groups	Categories	Nº	References
Main Requirements	Data Management & Sharing (R1)	Interoperability	15	[1, 2, 5, 17, 18, 22, 24, 27–29, 32, 33, 37–39]
		Parameter Sharing	12	[5, 9, 11, 18, 21, 22, 24, 27, 29, 32, 37, 38]
		Health Data Collection	11	[1, 5, 11, 14, 24, 27, 28, 32, 34, 38, 41]
		Real-time Data Updates	7	[1, 2, 9, 18, 28, 35, 38]
		Limited Data Retention	8	[1, 5, 28, 30, 36, 38, 39, 41]
	Access & Privacy Control (R2)	Access Control	13	[1, 2, 5, 11, 17, 18, 28–30, 32, 36, 38, 41]
		Privacy Policy	12	[1, 2, 5, 17, 18, 28, 30, 32, 35, 36, 39, 41]
		Authentication	10	[1, 2, 5, 17, 18, 28, 32, 35, 39, 41]
	User Experience & Efficiency (R3)	User-Friendly	15	[9, 11–15, 17, 22, 24, 27, 32, 34, 35, 38, 40]
		Minimize Time & Cost	10	[2, 4, 5, 9, 15, 17, 24, 28, 38, 39]
		Digitaliz. of Processes	9	[1, 5, 14, 18, 27, 29, 30, 32, 33]
		Feedback Mechanisms	4	[14, 22, 32, 33]
		Diagnostic Assisting	8	[1, 4, 11, 24, 28, 31, 32, 37]
	Patient Physician Interaction (R4)	Patient Management	13	[2, 4, 5, 11, 18, 24, 28, 32–35, 37, 41]
		Connect. w. Physicians	12	[1, 5, 18, 21, 24, 28, 31–33, 37–39]
		Video Call	1	[28]
		Remote Monitoring	9	[4, 9, 21, 23, 24, 31, 32, 38]

studies and highlighted for their enhancements on interoperability, data security, and patient engagement, i.e., following the same thought process, increasing the difficulty for non-cleared access of records and doubling down on patient intervention.

Finally, there were also niche solutions like Facial Recognition, Chatbots, Natural Language Processing, and Image Matching that, while less frequently highlighted, showcase a standardization of AI and growing interest in introducing AI-driven tools to support patient care. This trend may also indicate the beginnings of automation in the sector, introducing more advanced tools with minimum human intervention, therefore allowing for more time put into treatment and patient relations (Table 8).

Benefits. The studies revealed several key benefits associated with the implementation of HWs (Fig. 6). The most frequently mentioned advantages included Higher Efficiency (n = 19), Patient-centric Approaches & Empowerment (n = 18), and Better Treatment (n = 12). By Centralizing data, HWs enhance treatment quality, empower patients, and optimize workflows.

Table 8. Number of references per Category of Technology

	Main Groups	Categories	Nº	References
Main Technologies	Health Data Management & Systems (T1)	EHR/EMR/HIE/OTC	22	[1, 2, 4, 5, 9–11, 17, 18, 21, 22, 24, 27–29, 31–33, 36, 38, 39, 41]
		PHR	11	[1, 2, 5, 9, 10, 18, 30–32, 36, 38]
		Cloud-based	14	[5, 9, 18, 19, 21, 23, 24, 28–31, 34, 40, 41]
	Security & Access Control (T2)	RBAC	9	[1, 5, 11, 17, 18, 29, 30, 36, 39]
		Selective Sharing	7	[1, 5, 10, 11, 18, 31, 38]
		Electronic Consent	3	[1, 17, 39]
		Blockchain	5	[2, 17, 18, 29, 40]
		Facial Recognition	1	[28]
	Patient Monitoring & Interaction (T3)	Wearable Devices	7	[5, 10, 14, 21, 22, 24, 39]
		Patient Monitor. Devices	4	[14, 31, 34, 35]
		Chat-bot	1	[28]
		Telemedicine	9	[4, 5, 10, 19, 24, 28, 33, 34, 40]
	Data Analytics & Processing (T4)	Machine Learning	5	[19, 27, 28, 34, 38]
		AI	4	[19, 28, 38, 40]
		Natural Lang. Processing	1	[28]
		Image Matching	1	[28]

Cost Reduction (n = 13) and Easier Access to Care (n = 10) are closely linked, as HWs reduce administrative burdens and accelerate access to patient records, leading to faster, more affordable care. This also supports Faster Orientation (n = 4) for healthcare providers who benefit from having readily available patient information, guaranteeing the possibility for a holistic analysis and therefore, better treatment – showcasing how most of the shown benefits are, in fact, interconnected.

Security-related benefits, such as Safety and Security of Information (n = 6), Transparency (n = 4), and Completeness & Accuracy of Data (n = 4), ensure HWs foster greater confidence in digital systems. It should be pointed out that Security is seen as a hurdle, a challenge, in older studies, with more recent analyses considering these tools trustworthy enough to publicize it as a benefit. However, this is not so black-and-white, as the overall research is still split on the ability to protect users.

Benefits such as Promoting Process Flow (n = 9) and Lower Manual Handling (n = 5) emphasize the reduction of administrative tasks, while Scalability (n = 3) and Fewer Hardware Components (n = 3) highlight the long-term sustainability and flexibility of HWs in Healthcare as well as featuring the importance of interoperability in a system (Table 9).

Challenges. Out of the 4 Groups, there are distinctively more joint mentions for Requirements (167) and Challenges (164) than the remaining categories, with Benefits (115) and technologies (109) being less prominent. This, however, only validates the need of the sector to maintain order, standardize, mitigate current problems, and prevent future issues related to a possible introduction of a tool, i.e., confirming the rigidness of the sector.

Table 9. Number of references per Category of Benefits

	Main Groups	Categories	Nº	References
Main Benefits	Operational Efficiency (B1)	Higher Efficiency	19	[1, 5, 10, 11, 18–24, 29, 30, 32–34, 36–38, 40]
		Promote Flow of Process	9	[4, 17–19, 23, 32–34, 40]
		Lower Manual Handling	5	[22, 27, 33, 37, 40]
		Faster Orientation	4	[4, 17, 32, 33]
	Scalability & Resource Optimization (B2)	High Scalability	3	[21, 23, 27]
		Less Hardware Comp	3	[17, 23, 27]
		Cost Effective	13	[1, 10, 17, 21–24, 31–34, 45]
	Patient-centric & Empowerment (B3)	Patient-centric & Empower	18	[1, 2, 5, 9, 11, 14, 17, 18, 22–24, 26, 31–33, 37, 38, 40]
		Easier Access to Care	10	[1, 4, 5, 22, 23, 31–33, 35, 38]
		Better Treatment	12	[1, 10, 11, 18, 24, 31–35, 38, 40]
		Better Communication	5	[1, , 2414, 32, 38]
	Patient – Physician Interaction (B4)	Completeness of Records	4	[1, 21, 38, 39]
		Transparency	4	[1, 18, 26, 27]
		Security of Information	6	[1, 18, 24, 27, 29, 36]

The main challenges identified are not unique to HWs, but reflect broader issues related to the use of technology in healthcare (See Fig. 7). Challenges were discussed in 32 of the 36 studies, with the most prominent being Privacy and Confidentiality (n = 22) and Security and Encryption (n = 21), both critical concerns in managing sensitive data. Other significant challenges include Trust and Reliability (n = 15), Interoperability (n = 14), and Literacy and Health Consciousness among users (n = 12).

While other categories are more focused, the 'Challenges' section is notably more dispersed, with 18 distinct challenges identified. This diversity highlights the complexity of integrating HWs into healthcare systems. Rather than diminishing the value of HWs, these challenges underscore the need for further research to address these issues as the technology becomes gradually more well-known (Table 10).

Standards and Regulations. To introduce the technology into existing European healthcare systems, the HW must ensure compliance with current regulatory frameworks and must adhere to various legal and technical standards, such as the General Data Protection Regulation (GDPR), ISO 13485 for medical devices, ENISA guidelines on cybersecurity, and the Cyber Resilience Act. These standards provide guidelines for data protection, security, and overall resilience in health technologies. The table (See Table 2) presents a mapping of these regulatory requirements, outlining how each set of standards applies to the development and deployment of health wallets (Table 11).

Table 10. Number of references per Category of Challenges

Main Challenges	Main Groups	Categories	Nº	References
	Data Security & Privacy (C1)	Privacy & Confidentiality	22	[1,2,5,9,11,14,15,17,18,22,24,28,30,32,34-39,41]
		Security & Encryption	21	[1,2,5,9,11,14,15,17,18,22,24,28,30,32,34,35,37-39,41]
		Ethical Issues & Consent	8	[1,5,11,26,28,29,36,39,41]
		Trust & Reliability	15	[1,2,5,14,18,25,28,30,32-34,37,39-41]
	Interoperability & Information Sharing (C2)	Interoperability	14	[1,2,11,17,18,21,23,26,28,31,32,36,37,40]
		Sharing Restrictions	10	[1,5,9,11,17,18,21,26,36,37]
		Incomp./Incorrect Storing	8	[1,5,9,11,17,18,27,39]
		Cooperation	7	[1,11,13,22,26,33,39]
	Adoption & User Engagement (C3)	Literacy & Health Consc.	12	[1,12,1113,22,24-26,33,39]
		User At. & Self-efficacy	8	[1111,13,15,18,22,24,33,40]
		Resistance from Profess.	9	[1,4,5,26,33,35,37,39,40]
		Innovation Culture	2	[33,40]
	System Usability & Impact on Care (C4)	Depersonalize of Care	6	[1,4,33,35,39,40]
		Intrusiveness	6	[1,5,11,14,36,41]
		Staff Overloading	1	[33]
		Accessibility	5	[1,11,13,24,30]
	Cost & Policy Constraints (C5)	High Cost of Health IT	5	[25,35,37,40,41]
		Policies	4	[11,26,33,39]

3.2 Result Grouping

The shown data (See Table 2, 3, 4, 5 and Table 6), as mentioned in each article, is further grouped into 4 or 5 main topics. 2 dimensions should be evaluated. Firstly, not all technologies are implemented in today's healthcare landscape so, which ones were implemented, which ones are required, and what's the degree of adoption? Secondly, it becomes clear that several of these groups are related, with technologies often overlapping in purpose, addressing common challenges, or complementing each other to fulfill broader service needs.

4 Discussion

4.1 Relationship Between Groups

Through the analysis of the results, it becomes possible to create a few propositions:

The proposition suggests that obstacles encountered in healthcare can be directly mapped to certain requirements, i.e., manifest as requirements in technologies. *P1*

Table 11. Standards & Regulatory Requirements for HW Compliance

Regulation/ Standard	Category	Requirement	Description/Objective	Relevant Section
GDPR [4244]	Data Privacy & Protection	Content & Data Processing	Requires explicit user consent for Data Collection and Processing	Article 6, 7, 9
	Data Security	Encryption	Protects data through anonym. And encryption	Article 32
ISO 13485 [45]	Medical Device Quality	Quality Management System	Requires a quality management system for medical device manufacturers	Section 4.1, 4.2
	Risk Management	Risk assessment and Hazard Analysis	Focuses on evaluating risks related to the usage of devices	Section 7.1
ENISA [46]	Cybersecurity	Network & Information Security	Establishes security measures for network and information systems	Section 3, ENISA Guidelines
	Incident Response	Incident Notification & Breach Response	Requires creation of breach response procedures	Section 6
Cyber Resilience Act [47]	Security of Digital Products	Security by design	Digital products must integrate security measures from the outset	Section 5.1, 5.2
	Market Surveillance	Continuous Monitoring	Manufacturers must maintain and update Security measures	Section 6.3

implies that understanding present challenges allows for the development of requirements necessary to successfully integrate technologies.

$$P1 = \textit{Challenges}\,(C)\ \textit{can be translated into specific Requirements}\,(R) \quad (1)$$

Once the requirements are identified, they can be addressed through the application of appropriate Technologies. For instance, access control requirements can be met with RBAC, while interoperability issues can be mitigated with standards like FHIR and OpenEHR. P2 showcases the role that the right solutions play in addressing defined

requirements, bridging challenges, and the solution.

$$P2 = \textit{Requirements}(R)\ \textit{can be fulfilled using appropriate Technologies}\ (T) \quad (2)$$

The third proposition, P3, supports the ability to achieve significant benefits once the proper technologies are implemented to meet established requirements.

$$P3 = \textit{Using Appropriate Technologies}\ (T)\ \textit{leads to significant Benefits}\ (B) \quad (3)$$

Building upon the previous propositions, the final one combines all elements to suggest a comprehensive framework. It proposes that challenges arising from healthcare processes can be systematically targeted by translating them into actionable requirements. These, when met with the appropriate solutions, ultimately yield meaningful benefits. The interconnection between these categories ensures a link between problem identification to problem resolution.

$$\begin{aligned} P4 = {} & \textit{Challenges}\ (C),\ \textit{identified in healthcare settings are effectively} \\ & \textit{addressed through their translation into specific requirements}\ (R), \\ & \textit{which, when fulfilled using appropriate technologies}\ (T), \\ & \textit{lead to significant Benefits}\ (B) \end{aligned} \quad (4)$$

This shows a connection between groups and between categories - that technology usage in healthcare follows a similar path to other sectors. The alignment of these elements suggests that the integration of Health Wallets into healthcare is not only feasible but could follow a clear and structured approach that mirrors successful technology adoption in other fields.

There are also links more complete than this first linear connection. For instance, using new technologies can originate new challenges, which themselves would require new technologies to fix. Since achieving benefits may restart the process of redefining requirements, we are therefore debating continuous improvement, where the evolving needs of healthcare and technological advancement demand an ongoing process of refinement and adaptation, rather than a static solution.

These categories are therefore not only related but interdependent. Technology will not be introduced without a requirement, or it will not add value. Value is the difference between benefits and challenges, which can both come from the usage of a new technology.

The Venn Diagram (See Fig. 4) showcases how all groups interact with each other.

The combined efforts of all groups create an ecosystem, i.e., state-of-the-art, how everything works in a living organization, in this case, in the healthcare sector. The development and future introduction of a HW should aim to seamlessly enter this system. Introducing technology, answering challenges, creating benefits, and working efficiently and effectively, like a cogwheel in a machine.

The introduction of the Wallet itself will bring new challenges in need of defining into requirements, will involve technologies within the processes for it to function as intended, and will take x amount of time until showcasing its benefits (depending on the learning curve and inertia to learning, e.g.) (Fig. 3).

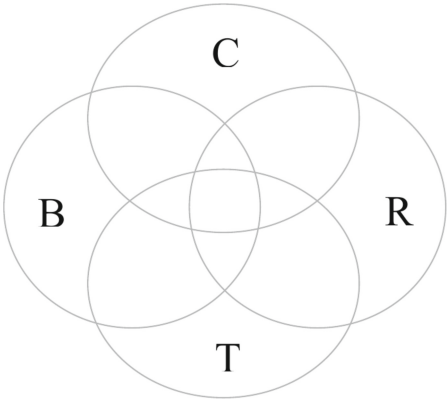

Fig. 3. Links between Categories

This required fluidity aims for future scalability and adaptation to new challenges and requirements that will appear. Tools such as FHIR make the HW scalable and ready to integrate emerging tools, guaranteeing its long-term value and viability. From this knowledge, an iterative approach should be preferred, i.e., the process should position itself as agile development, where improvements are based on real usage and require regular feedback from all stakeholders.

4.2 Technologies Implemented in the Healthcare Sector

In addition to exploring requirements and challenges, the level of adoption of key technologies, such as Blockchain, FHIR, and RBAC, has been analyzed to understand the feasibility of implementing Health Wallets; these have different levels of value-added, ease of usage, and standardization.

Their introduction differs in the time of attempted implementation and in the challenges it created. Equally, their evaluation is vital since it is from past introductions that a future one should be based, i.e., understanding what worked and what did not. From content analysis as well as the number of papers mentioning each one, it is also possible to evaluate the adoption and the life cycle stage at which each technology finds itself (Table 12).

While technologies such as EHRs or Cloud-based systems, showcase widespread adoption in healthcare, Blockchain is still in the early stages of integration. As a parallel, PHR, FHIR, OTC, and Blockchain are still in their early stages of market introduction which makes it difficult to confidently predict issues during implementation.

These technologies' value requires their joint effort, interdisciplinary, i.e., the more of these technologies the healthcare system uses the bigger their benefit, with each one promoting a certain requirement and building on top of the others. Combining them would grant the tool interoperability (from FHIR), between Information Systems (EHR), protected and confidential (Blockchain), with selective and minimum access to the tools (from Selective Sharing and RBAC), available for the patient (PHR, OTC), empowering them to access, store and manage their healthcare data.

Table 12. Implementation Status and Challenges from Technology

Technology	Level of Adoption	Technology Lifecycle Stage
AI	Low	Growth
Blockchain	Low	Growth
Cloud-based	High	Maturity
EHR/EMR/HIE	High	Maturity
FHIR	High	Growth
OTC	Low	Growth
PHR	Moderate	Early Growth
RBAC	High	Maturity
Selective Sharing	High	Maturity
Telemedicine	High	Maturity
ZKP	Pilot-Stage Use	Early Growth

It is only thanks to this coordination that the Health Wallet would be able to be correctly and efficiently implemented into today's healthcare sector.

FHIR and Blockchain in Achieving Interoperability. Both FHIR and Blockchain are transformative for interoperability in healthcare, as each focuses on unique secure, and seamless data exchange. FHIR creates standardized protocols that allow health records to be easily exchanged between EHR systems, reducing redundant data entry, improving data accuracy, and enabling real-time data sharing. This interoperability is crucial for data sharing without manual handling of information and, therefore, the risk of data mismanagement, loss, or manipulation.

Blockchain enhances this data exchange by providing a decentralized, secure ledger where patient information is stored in immutable blocks. Each time data is updated or accessed, a new block is added to the ledger, allowing for the creation of a secure trail that ensures data integrity and prevents tampering. This distributed structure also allows patients to control data access directly, aligning e.g. with patient-centred care models.

In Estonia, a comprehensive eHealth system integrates FHIR and Blockchain to facilitate secure data exchanges within the healthcare sector. Patients access their medical records through a patient portal, enhancing data transparency, accessibility, and continuity of care. Similar initiatives are underway in several other countries. In Australia, Blockchain is used to ensure data integrity across healthcare systems, supported by FHIR for compatibility between these systems.

Blockchain's Role in Privacy. Blockchain's distributed architecture is particularly suited for safeguarding patient privacy [2]. Its cryptographic techniques ensure that once data is entered, it can be neither deleted nor tampered with, providing a secure and transparent record. However, the public nature of Blockchain networks, if not managed carefully, could expose patient data to unauthorized access, making not only robust encryption but also access management essential for any health-related applications.

Regulatory Compliance Frameworks. Any development of the HW should, firstly, acknowledge the need to fulfill any legal requirements, such as the GDPR [42–44] (or HIPAA in the U.S.), ENISA [46], Cyber Resilience Act [47], as well as the ISO 13485 [44, 45]. If its definition does fall into the Medical Device spectrum, it must also follow the Medical Device Regulation (MDR) [48].

HWs that use technologies such as Blockchain must comply with these standards. GDPR mandates explicit consent for data processing, stringent encryption, and data anonymization – requiring only the minimum data to be stored, the least amount of people to access it, and for the shortest time possible - while HIPAA focuses on protecting identifiable health information. To meet these regulatory demands, Blockchain systems can incorporate Zero-Knowledge Proofs (ZKPs), enabling the verification of data without revealing its contents. With ZKPs, e.g., patients could be granted limited access to parts of their records without exposing the full content. These techniques, alongside end-to-end encryption, key management, and advanced access controls.

A notable example of ZKPs in Europe is in the European Self-Sovereign Identity Framework (ESSIF), an initiative under the European Blockchain Services Infrastructure (EBSI)[49], aimed at providing a cross-border blockchain infrastructure to enhance the efficiency and trustworthiness of public services across EU member states. This approach allows individuals to authenticate aspects of their identity to access government or private services without exposing their entire identity, e.g., confirming residency without sharing an address. Although this usage aligns with GDPR's emphasis on data exposure minimization, its widespread implementation is limited.

4.3 The Health Wallet

All of the suggested requirements and technologies, uncovered through content analysis, will work together to achieve the objective of this paper: present a consolidated review of the state of technology integration in healthcare as well as being able to confidently showcase, from their combined efforts, an ideal Health Wallet.

Firstly, any aim at technology introduction in healthcare should have a seamless integration into already existing processes as one of the major outcomes of the development process [17, 44]. This emphasis is vital to the implementation and usage of the Health Wallet to not add to the already present issues in the sector, overcrowding systems, and unnecessarily complicated processes.

The uncovered requirements were introduced following these necessary legal compliances, being a vital part of a Privacy Policy [41]. This Policy also requires an Access Control, which, could be secured, through the usage of RBAC [36], for both minimum dissemination of information and maximum privacy and confidentiality. For additional security, recent studies mention the importance of Blockchain.

Interoperability [22, 29], through the usage of both FHIR (for information transactions between organizations) [6, 14] and OpenEHR (for information transactions within the organization) [9, 21], aims for efficiency from the reduction in manual handling of information, which directly impacts the loss of information as well as requiring additional time and effort on the behalf of the physicians [27].

Patient's trust should be fostered, with their willingness to adopt and consistently use such a tool depending on their trust in data security and the sense of control it provides

over their health information, even more so for users with lower digital know-how, hence why user-friendliness should also be prioritized by the developers [12]. UI/UX mechanisms should be put into place, given the existing lack of eHealth literacy [12, 13], easing the learning curve for both medical professionals and patients, aiding in their collaborative value creation, with better Health Data Collection and Parameter Sharing [39].

Continuous Intention to use HWs and other similar tools depends on the users' self-efficacy as well as perceived usefulness, improved by more accessible architectures [15, 16, 25]. Patient-facing features must be designed with inclusivity in mind, considering various demographics, including older adults, those with disabilities, and individuals with limited eHealth literacy.

Varying degrees of eHealth literacy on both patients and healthcare providers will surely hinder adoption and effective use. To overcome this, HW developers should prioritize intuitive, accessible user interfaces (UIs) designed for diverse digital fluency levels. Simplified interfaces with guided onboarding can help ease patients into the systems.

Other than the developers, management has a role in adoption, through which educational initiatives are key. These could include interactive workshops or tutorials that explain the functionalities and usage of HWs. Another approach is integrating HWs with telehealth services, where healthcare professionals can actively engage with patients and directly help them in using it for data sharing and their own health management.

The way to guarantee real value creation and usage is through co-designing for end-users, creating feedback loops, and introducing their input in product development. Studies show that co-designing health platforms during development phases significantly improves usability, accessibility, effectiveness, and overall user satisfaction.

HWs face several implementation barriers, especially in real-world settings where healthcare infrastructure varies significantly. A central limitation lies in their effectiveness which itself is strained by data fragmentation and lack of a standardized approach for data management.

Maintaining a connection with physicians should therefore be central to the tool's implementation. Telemedicine practices help achieve this objective with their focus on accessibility [33]. It should be noted that establishing this connection requires more than the correct tool implementation; it requires time and effort, being vital to the well-being and correct treatment of the patient. Although technologies help with physical proximity, they're not substitutes for the physician-patient relationship and should not be treated as such [28].

Although medical personnel are open to the introduction of these technologies, inertia to change always occurs and, as it seems to be the case with physicians, may be higher for this sector, where older ways of processing information still come about, even with the digitalization of processes [24]. Henceforth, all potential added value depends on the effective involvement of both management and physicians. While Management plays a crucial role in supporting the strategic implementation of the HW, ensuring both the necessary resources and infrastructure, Physicians, will have a profound impact on the day-to-day use of HWs – making their endorsement critical to any and all introductions

[4044]. Catering to its users, and conditioned by Physician's perceptions, feedback loops should be created between developers, management, and medical professionals.

Ultimately, the added value of the Health Wallet lies not only in its architecture and legal frameworks it adheres to, but research also makes it viable to ensure it creates a system that genuinely enhances the delivery of care, aiming to maintain and encourage trust in information technology in healthcare, with the collaboration of medical staff and patients alike, the joint value creation empowers both parties. Hence the ultimate goal, patient empowerment and improved healthcare outcomes, is achieved through a combination of technology, legal frameworks, and the collaboration of all stakeholders.

4.4 Limitations and Future Research

Other than limitations and future research ideas mentioned afterward, the paper may showcase the limitations usual to a Systematic Literature Review, with other possible words or manners of research leading to other articles. The sudden growth in articles around the topic may lead to a surge of new papers not included. Health Wallets can be named or categorized differently which might consist of another limitation.

Currently, as of the time of writing, there seem to be gaps in the literature, especially concerning the diminishing value of introducing another tool in the healthcare sector as well as the relationship between these added tools, the perceived challenges and benefits, and continuous improvement. There is, at this time, a diverse array of papers seeing technology as a stressor for both medical professionals and users with digital tools often leading to frustration, anxiety, and information overload, marking the importance of this future research.

Current solutions value privacy and patient empowerment while seeing value in technology introduction. However, there is not a joint solution, through a tool, using a selection of technologies, that consolidates the concerns and wishes of both patients and medical professionals. The existing Wallets and Folders are found to be lacking from either the medical or patient perspectives, inadequately ambitious, and/or without valued features.

These limitations suggest a need for focused efforts to integrate HWs seamlessly within diverse healthcare environments as well as an increase in education initiatives for improved results, and consequentially, better app usage. Future work should aim to assess the specific needs and pain points of the specific healthcare stakeholders catering to their needs and tailoring solutions. Furthermore, it will be important to find out what initiatives improve eHealth Literacy across different demographics and support higher adoption and engagement with health platforms and apps. Understanding these limitations and building specific solutions around them is crucial for the next stages of HW research.

5 Conclusion

This research highlights the potential of Health Wallets, as well as the status of healthcare technology introduction, persisting challenges, and difficulties against sought-after technologies and benefits. The key requirements for successful implementation, such as interoperability, privacy, user-friendliness, and secure data sharing, are supported by

emerging technologies and frameworks such as FHIR, Blockchain, and RBAC. Despite the significant benefits, challenges related to privacy, security, and user adoption and retention may persist. Addressing these challenges through targeted development solutions is critical to maximizing the impact of HWs and ensuring their seamless integration into existing healthcare systems. It has been shown that co-designing would be a possible way forward for the tool, catering to specific needs and aiming for as much value as possible for all stakeholders.

The sought-after objective was achieved with some difficulties arising from the novelty of the topic, given the existence of multiple gaps in research, even more so for a unified approach that balances both the needs of patients and healthcare professionals. Equally important to note are the relationships established during the creation of this paper. From the literature analysis, not only were HWs presented and debated, but the healthcare sector as a whole was evaluated. The trade-off of exploring yet another tool against the better usage of persisting tools remains underexplored.

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Appendixes

Appendix 1. Origin of Content

(See Table 13).

Table 13. Authors' Continent of Origin

Continent of Origin	N.º of different origins	Percentage
Africa	1	2,3%
Asia	10	22,6%
Europe	12	27,3%
Oceania	5	11,4%
North America	14	31,8%
South America	2	4,6%
TOTAL	44	100%

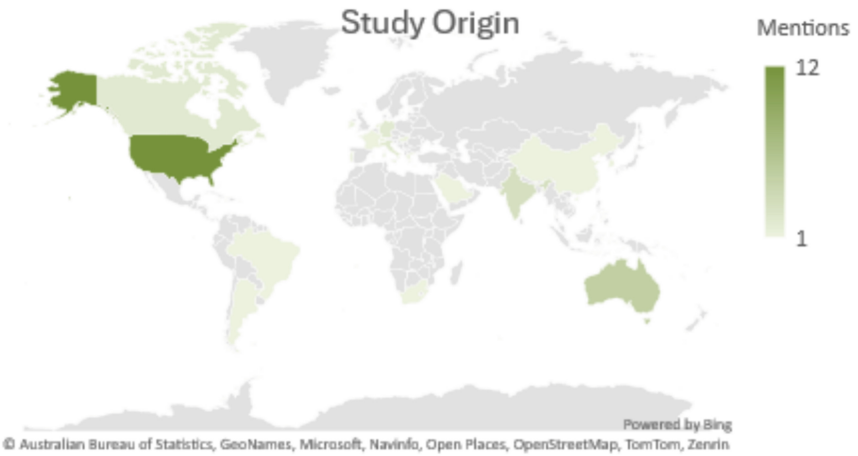

Fig. 4. Country of Origin for Publication

References

1. Esmaeilzadeh, P., Sambasivan, M.: Patients' support for health information exchange: a literature review and classification of key factors. BMC Med. Inform. Decis. Mak. **17**(1) (2017). https://doi.org/10.1186/s12911-017-0436-2
2. Alamri, B., Javed, I.T., Margaria, T.: A GDPR-compliant framework for IoT-based personal health records using blockchain. In: 2021 11th IFIP International Conference on New Technologies, Mobility and Security, NTMS 2021, 19 April 2021. https://doi.org/10.1109/NTMS49979.2021.9432661
3. PRISMA Diagram & Checklist - Systematic Reviews - Research Guides at University of Guelph-Humber (libguides.com). Accessed 06 June 2024
4. Sengupta, A., Sarkar, S., Bhattacherjee, A.: The relationship between telemedicine tools and physician satisfaction, quality of care, and patient visits during the COVID-19 pandemic. Int. J. Med. Inform. **190** (2024). https://doi.org/10.1016/j.ijmedinf.2024.105541
5. Keshta, I., Odeh, A.: Security and privacy of electronic health records: concerns and challenges. Egypt. Inform. J. **22**(2), 177–183. Elsevier B.V. (2021). https://doi.org/10.1016/j.eij.2020.07.003
6. Office of the National Coordinator for Health Information Technology, T. (n.d.). What Is FHIR®? http://www.hl7.org/fhir. Accessed 12 July 2024
7. BioGHP. (2024). Global Health Platform. Retrieved from BioGHP. Accessed 12 June 2024
8. Overview of openEHR. (2006). http://www.who.int/classifications/icd/en/.4.Primarycareclassificatoin http://www.globalfamilydoctor.com/. Accessed 12 June 2024
9. Ueckert, F., Goerz, M., Ataian, M., Tessmann, S., Prokosch, H.U.: Empowerment of patients and communication with health care professionals through an electronic health record. Int. J. Med. Inform. **70**(2–3), 99–108 (2003). https://doi.org/10.1016/S1386-5056(03)00052-2
10. Tully, J., Dameff, C., Longhurst, C.A.: Wave of wearables: clinical management of patients and the future of connected medicine. Clin. Lab. Med. **40**(1), 69–82 (2020). https://doi.org/10.1016/J.CLL.2019.11.004

11. Kebodeaux, C.D.: Prescription and over-the-counter medication record integration: a holistic patient-centered approach. J. Am. Pharm. Assoc. **59**(2), S13–S17. Elsevier B.V. (2019). https://doi.org/10.1016/j.japh.2018.10.002
12. Elgamal, R.: Meta-analysis: eHealth literacy and attitudes towards internet/computer technology. Patient Educ. Counsel. **123** (2024). https://doi.org/10.1016/j.pec.2024.108196
13. Estrela, M., Semedo, G., Roque, F., Ferreira, P.L., Herdeiro, M.T.: Sociodemographic determinants of digital health literacy: a systematic review and meta-analysis. Int. J. Med. Inform. **177**. Elsevier Ireland Ltd. (2023). https://doi.org/10.1016/j.ijmedinf.2023.105124
14. Sreejith, R., Senthil, S.: Smart Contract Authentication assisted GraphMap-Based HL7 FHIR architecture for interoperable e-healthcare system. Heliyon, **9**(4) (2023). https://doi.org/10.1016/j.heliyon.2023.e15180
15. Daragmeh, A., Sági, J., Zéman, Z.: Continuous intention to use e-wallet in the context of the covid-19 pandemic: Integrating the health belief model (hbm) and technology continuous theory (tct). J. Open Innov. Technol. Market Complex. **7**(2) (2021). https://doi.org/10.3390/joitmc7020132
16. Yadav, R., Giri, A., Chatterjee, S.: Understanding the users' motivation and barriers in adopting healthcare apps: A mixed-method approach using behavioral reasoning theory. Technol. Forecast. Soc. Change **183** (2022). https://doi.org/10.1016/j.techfore.2022.121932
17. Ranjan, P., Soman, S., Ateria, A.K., Srivastava, P.K.: Streamlining payment workflows using a patient wallet for hospital information systems. In: Proceedings - IEEE Symposium on Computer-Based Medical Systems, 2018-June, pp. 339–344 (2018). https://doi.org/10.1109/CBMS.2018.00066
18. Patel, M.: Blockchain approach for smart health wallet. IJARCCE **6**(10), 131–135 (2017). https://doi.org/10.17148/ijarcce.2017.61022
19. Belfiore, A., Cuccurullo, C., Aria, M.: IoT in healthcare: a scientometric analysis. Technol. Forecast. Soc. Chang. **184** (2022). https://doi.org/10.1016/j.techfore.2022.122001
20. Bhuyan, S., et al.: Privacy and security issues in mobile health: current research and future directions. Health Policy Technol. **6**(2), 188–191. Elsevier B.V. (2017). https://doi.org/10.1016/j.hlpt.2017.01.004
21. Ali, H., Naing, H. H., Yaqub, R.: An iot assisted real-time high cmrr wireless ambulatory ecg monitoring system with arrhythmia detection. Electronics (Switzerland) **10**(16) (2021). https://doi.org/10.3390/electronics10161871
22. Baek, H., et al.: Enhancing user experience through user study: design of an mHealth tool for self-management and care engagement of cardiovascular disease patients. JMIR Cardio **2**(1) (2018). https://doi.org/10.2196/cardio.9000
23. Beratarrechea, A., Lee, A.G., Willner, J.M., Jahangir, E., Ciapponi, A., Rubinstein, A.: The impact of mobile health interventions on chronic disease outcomes in developing countries: a systematic review. Telemedicine e-Health **20**(1), 75–82 (2014). https://doi.org/10.1089/tmj.2012.0328
24. Birkmeyer, S., Wirtz, B.W., Langer, P.F.: Determinants of mHealth success: an empirical investigation of the user perspective. Int. J. Inf. Manag. **59** (2021). https://doi.org/10.1016/j.ijinfomgt.2021.102351
25. Chiu, W., Cho, H., Chi, C.G.: Consumers' continuance intention to use fitness and health apps: an integration of the expectation–confirmation model and investment model. Inf. Technol. People **34**(3), 978–998 (2020). https://doi.org/10.1108/ITP-09-2019-0463
26. Equey, C., Priftis, A., Trabichet, J.P., Hutzli, V.: Designing a digital citizen-centered service. Technol. Forecast. Soc. Chang. **202** (2024). https://doi.org/10.1016/j.techfore.2024.123280
27. Fotiadis, D.I., Penders, J., Wang, M.D., Jafari, R.: Biomedical and Health Informatics and the Body Sensor Networks Conferences : 4-7 March 2018, Treasure Island Hotel - Las Vegas, Nevada, USA (2018). IEEE

28. Galetsi, P., Katsaliaki, K., Kumar, S.: Exploring benefits and ethical challenges in the rise of mHealth (mobile healthcare) technology for the common good: an analysis of mobile applications for health specialists. Technovation **121** (2023). https://doi.org/10.1016/j.technovation.2022.102598
29. ICACCS : 2019 5th International Conference on Advanced Computing & Communication Systems : 15–16 March 2019, Coimbatore, India. (2019). Institute of Electrical and Electronics Engineers
30. 2019 Conference on Information Communications Technology and Society (ICTAS): proceedings : Durban, South Africa, 6, 7 and 8 March 2019. (2019). IEEE
31. Karadas, B., et al.: Pregnancy outcomes following maternal favipiravir exposure: a case series. Neurotoxicol. Teratol. **98**, 107213 (2023). https://doi.org/10.1016/j.ntt.2023.107213
32. Kharrazi, H., Chisholm, R., VanNasdale, D., Thompson, B.: Mobile personal health records: an evaluation of features and functionality. Int. J. Med. Inform. **81**(9), 579–593 (2012). https://doi.org/10.1016/j.ijmedinf.2012.04.007
33. Khodadad-Saryazdi, A.: Exploring the telemedicine implementation challenges through the process innovation approach: a case study research in the French healthcare sector. Technovation **107** (2021). https://doi.org/10.1016/j.technovation.2021.102273
34. Martínez-Pérez, B., de la Torre-Díez, I., López-Coronado, M.: Privacy and security in mobile health apps: a review and recommendations. J. Med. Syst. **39**(1). Springer Science and Business Media, LLC (2015). https://doi.org/10.1007/s10916-014-0181-3
35. Morton, E., Torous, J., Murray, G., Michalak, E.E.: Using apps for bipolar disorder – an online survey of healthcare provider perspectives and practices. J. Psychiatr. Res. **137**, 22–28 (2021). https://doi.org/10.1016/j.jpsychires.2021.02.047
36. Motta, G.H.M.B., Furuie, S.S.: A contextual role-based access control authorization model for electronic patient record. IEEE Trans. Inf. Technol. Biomed. **7**(3), 202–207 (2003). https://doi.org/10.1109/TITB.2003.816562
37. Schroeder, T., et al.: Perception of middle-aged and older adults towards mHealth apps: a comparative factor analysis between Australia and Germany. Int. J. Med. Inform. **189** (2024). https://doi.org/10.1016/j.ijmedinf.2024.105502
38. Utsha, U.T., Morshed, B.I.: CardioHelp: a smartphone application for beat-by-beat ECG signal analysis for real-time cardiac disease detection using edge-computing AI classifiers. Smart Health **31** (2024). https://doi.org/10.1016/j.smhl.2024.100446
39. Van Der Storm, S.L., Jansen, M., Meijer, H.A.W., Barsom, E.Z., Schijven, M.P.: Apps in healthcare and medical research; European legislation and practical tips every healthcare provider should know. Int. J. Med. Inform. **177**, 1386–5056 (2023). https://doi.org/10.1016/j.ijmedinf.2023.105141
40. Zhang, X., Shen, K.N., Xu, B.: Double-edged sword of knowledge inertia: overcoming healthcare professionals' resistance in innovation adoption. Technovation **133** (2024). https://doi.org/10.1016/j.technovation.2024.103011
41. Zhou, L., Bao, J., Watzlaf, V., Parmanto, B.: Barriers to and facilitators of the use of mobile health apps from a security perspective: mixed-methods study. JMIR MHealth UHealth **7**(4) (2019). https://doi.org/10.2196/11223
42. 2019 IEEE International Conference on Healthcare Informatics (ICHI). (2019). IEEE. Accessed 23 July 2024
43. Council of the European Union. (s.d.). The general data protection regulation. Obtido de What is the GDPR: https://www.consilium.europa.eu/en/policies/data-protection/data-protection-regulation/#gdpr. Accessed 06 June 2024

44. I (Legislative acts) REGULATIONS REGULATION (EU) 2016/679 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation) (Text with EEA relevance). (n.d.). Accessed 22 July 2024
45. ISO. (2016). Obtido de ISO 13485 Medical Devices: https://www.iso.org/iso-13485-medical-devices.html. Accessed 16 Aug 2024
46. ENISA. (2023). European Union Agency for Cybersecurity. Retrieved from NIS Directive. https://www.enisa.europa.eu/topics/cybersecurity-policy/nis-directive-new. Accessed 24 July 2024
47. Cyber Resilience Act Requirements Standards Mapping. (n.d.). https://doi.org/10.2760/905934. Accessed 28 June 2024
48. Regulation - 2017/745 - EN - Medical Device Regulation - EUR-Lex (europa.eu). Accessed 12 Aug 2024
49. European Blockchain Services Infrastructure (EBSI) and the eSSIF | Verifiable Credentials and Self Sovereign Identity Web Directory. Accessed 11 Oct 2024