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Analysis of barriers and benefits associated with e-health technology applications

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Abstract

People's interest in health issues has stimulated the development of healthcare-oriented technology products. For the process of developing and using e-health technologies, it is necessary to know the challenges and facilitators for their implementation and wide acceptance. this research aims to identify, among the e-health technologies that are already available in the literature, what are the barriers for implementation/adoption of these technologies, as well as the main benefits arising from their use. In order to identify research opportunities on the subject of e-health, the method of systematic literature review was performed using the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) methodological approach. 130 records are considered for the review. The results obtained about barriers and benefits were structured from the sociotechnical (social - people/society; technical - machines/technology) systems approach. As a result, we expect to identify perspectives for the direction of new products development and opportunities for future research.

Keywords: e-health; sociotechnical systems; innovation; information technology

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1. Introduction

Information technologies are increasingly part of the corporate environment of institutions and are gaining more and more importance in the health sector as well (Correia *et al.*, 2013; Calegari & Fettermann, 2022). People's interest in health issues has stimulated the development of healthcare-oriented technology products. In general, among the objectives of these technologies is providing universal accessibility to health services for society (Hixson & Braverman, 2020). Part of this goal is achieved by incorporating the Internet into healthcare systems, through information and communication management to improve patient care (Greiwe & Nyenhuis, 2020).

For the process of developing and using e-health technologies, it is necessary to know the challenges and facilitators for their implementation and wide acceptance (Reeder & David, 2016). Thus, this research aims to identify, among the e-health technologies that are already available in the literature, what are the barriers for implementation/adoption of these technologies, as well as the main benefits arising from their use. As a result, we expect to identify perspectives for the direction of new products development and opportunities for future research.

However, this study proposes a focus only on healthcare 4.0 systems that feed the e-health systems of Telehealth and health self-monitoring. The combination of IoT technologies with cloud computing technologies allows for greater connectivity of devices that enables the concept of ubiquitous computing (U-health). The wide use of these devices for Telehealth and Self-monitoring services fosters the process of complex data generation. Big Data Analytics, in turn, transforms the load of complex data into information and supplies e-health systems with the purpose of guiding/reorienting computational tasks and decision-making.

2. Research method

To conduct the systematic review, the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) methodological approach was adopted, originally used in the field of medicine and expanded to other fields such as social sciences and engineering. Based on the procedures recommended by the PRISMA method and applied in studies that relate health and technology, five steps were considered for the systematization of the review, as detailed in Figure 1:

Figure 1: PRISMA application steps (Author, 2022)

Three fields of research were included: the first field corresponds to technological applications in health care, especially applications of information and communication technologies in an e-health context; the second field of research refers to ways of monitoring health; the third field refers to consumer acceptability. The search was conducted in the period between the months of December 2020 and January 2021. The search was restricted to the fields "title", "abstract" and "keywords" of the articles.

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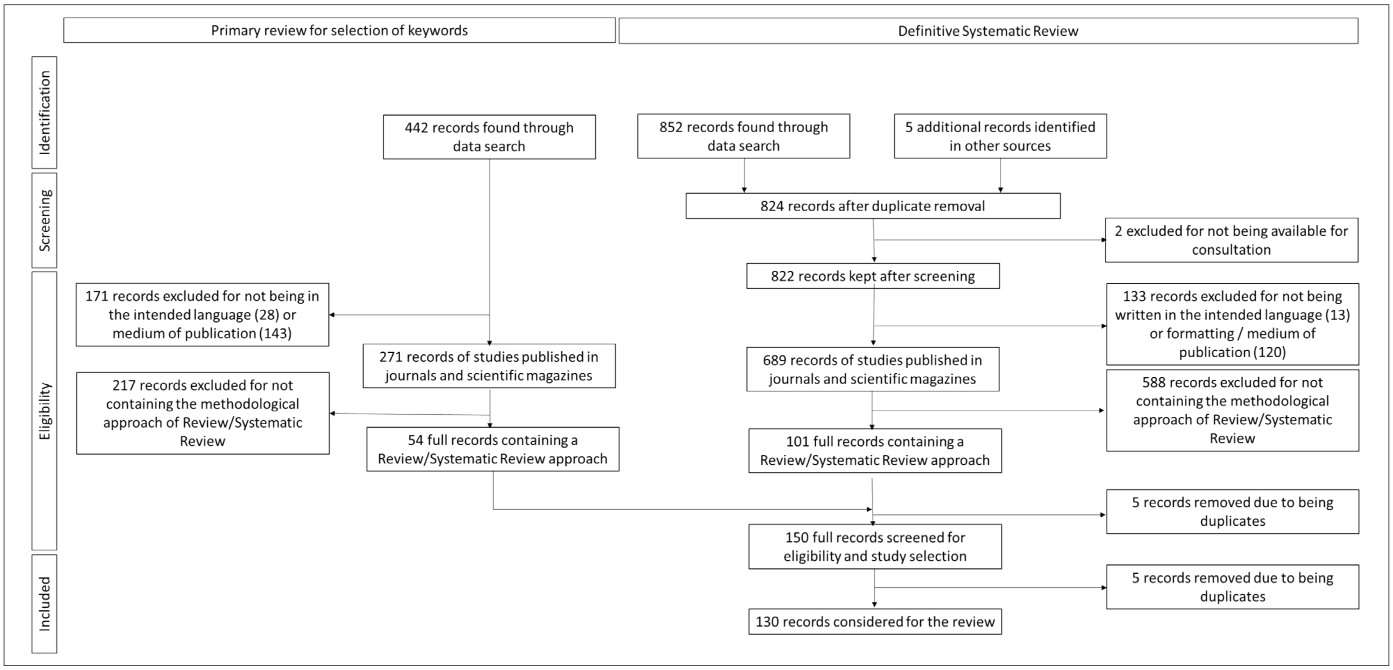
For this research, we only selected studies that presented applications of information and communication technologies for health monitoring from the "Scopus", "Web of Science", "Pub Med", "Science Direct", "Emerald Insight" and "IEEE" databases. Besides, only literature review studies published in journals and written in the English language were considered. The strategy of selecting only reviews cohesively synthesizes the gathering of relevant information on the topic of e-health and is widely adopted in the healthcare literature. The filters considered for the selection of studies are detailed in Figure 2.

Figure 2: Flow of information processed by PRISMA (Author, 2022)



The results obtained were structured from the sociotechnical (social - people/society; technical - machines/technology) systems approach, which have good results when supporting the environmental complexity of the scenarios related to dynamism, new technologies and competitiveness. As widely disseminated in the literature, for this study, we considered the division of the sociotechnical approach into four interrelated subsystems: (i) personnel subsystem, which comprises social and psychological aspects of the technology user; (ii) technological subsystem, which comprises aspects related to the characteristics of available technologies; (iii) work design subsystem, which comprises characteristics related to the organizational structure of work; and (iv) external environment subsystem, which comprises socioeconomic, legal, cultural, political, etc. factors.

3. Results and discussion

3. Benefits and barriers to e-health technology

The benefits and barriers resulting from this review were organized based on the structure of the following sociotechnical subsystems: personnel, technological, work design, and external environment. According to Fettermann et al., (2017), the personnel subsystem is defined by the characteristics and qualifications relevant to the participants in the analyzed system. The technological subsystem is defined by identifying how the available technologies and infrastructure can influence the analyzed system. The external environment subsystem is characterized by external factors that influence the analyzed system, such as governmental, regulatory, environmental and commercial factors. The work design subsystem is characterized by the way work is designed into the system.

3.1.1 Personal subsystem

In this review, the personnel subsystem consists of nine benefits (Table 1):

Table 1. Benefits of e-health adoption related to the sociotechnical subsystem of influence caused by users' personal factors

Personnel subsystem elements that influence knowledge transfer		
Code	**Element Detail**	**Number of References**
PB1	Network for sharing information among users	25
PB2	Anonymity	04
PB3	Better control of the patients' anxiety about the treatment	12
PB4	Personalized and continuous feedback	48
PB5	Reduction of the burden to the patient's routine and exposure to risks from hospital environments	58
PB6	Increased accessibility of patients to health care	78
PB7	Increased patient involvement in self-care	75
PB8	Increased knowledge/basis for decision making about medical procedures	41
PB9	Increased information sharing between users and health professionals	70

Although there are still obstacles to the use of digital health, e-health technologies have the potential to promote greater accessibility to health services for diverse social groups (PB6). Remote interventions enable access to medical services by people who have onerous conditions that limit their ability to go to face-to-face appointments, for reasons of disease limitation (PB5), age or living in locations distant from medical centers. In addition, digital health through smartphones, increasingly widespread among the low-income public, is an alternative for meeting the needs of low-income people, who do not always have access to health information and quality medical care (Muiruri *et al*., 2019). Still referring to the low-income population, remote interventions would avoid having to take time off work for in-person consultations, an option not always feasible for this public (Kelso & Feagins, 2018).

The presence of patients in the medical environment, especially the more vulnerable ones, can have risks to their health due to unnecessary exposure to contagious diseases. E-health systems allow the reduction of risks from unnecessary exposure for both patients and healthcare professionals. In this context, remote interventions contribute to reducing the need for face-to-face appointments that burden the patient's routine and place them in a position of insecurity (PB5). However, it is common for patients to go through anxiety episodes as they feel insecure when away from medical care (Shin *et al*., 2019; Weerdmeester *et al*., 2020). E-health technologies can enable the control of patient anxiety (PB3), from the continuous process of remote monitoring and information sharing with health professionals (PB9). Despite the lack of trust in the content present on the Internet, sharing information with other Internet users also proved to be significant in improving the patients' anxiety control (PB1 and PB3). In this context, anonymity, usually seen in a negative way in the digital environment, is an ally for people who feel embarrassed or uncomfortable regarding their disease. Thus, the use of digital health services anonymously to obtain medical clarifications and guidance consists in an alternative for improving the population's health care (PB2).

Other benefits coming from e-health technologies are related to motivational matters, capable of promoting greater awareness of their users about health care (Qian *et al.*, 2019). Considering the large amount of unqualified information present in the network and the indispensable intervention of medical professionals, the health knowledge/self-knowledge acquired by the user promotes improvements in his treatment. Thus, e-health devices enable greater user involvement in monitoring physiological signs and controlling treatment (PB7). In line with this, personalized and continuous feedback (PB4) helps professionals and the patient himself to make more assertive decisions (PB8). In addition to the benefits, the personnel subsystem is made up of ten barriers (Table 2):

Table 2. Barriers to e-health ado
ption related to the sociotechnical subsystem of influence caused by users' personal factors

Personnel subsystem elements that influence e-health adoption		
Code	**Element Detail**	**Number of References**
P1	Discomfort with the volume/material of the device	14
P2	Physical (motor coordination)/psychological inability to use the technology	9
P3	Lack of reliability of the efficiency and low perceived usefulness by users of the technological resource	45
P4	Avoidance in the use of technologies for the intervention/disinterest	21
P5	Perception of usefulness/effectiveness/adherence	14
P6	Invasiveness of the device	5
P7	Need for customization of the intervention/Variety of specialized areas	30
P8	Difficulty in using the system (usability) - may be related to digital inclusion - health illiteracy	21
P9	Treatment self-adjustment/ self-diagnosis/ self-medication	4
P10	Embarrassment when using the visible device	3

In the healthcare system, there are a number of individual, organizational, community, and political barriers that must be overcome for digital technologies to become a therapeutic reality (Shegog *et al*., 2020). Starting with the barriers related to personal issues, we can observe there is resistance on the part of consumers, related to devices with apparent volume that can cause embarrassment to the user in the face of public exposure or discomfort in its use (P1, P6 and P10). In addition to the physical aspect, users may also feel discomfort from psychological aspects associated with the insecurity of handling technological devices (P8). Such insecurity may be related to the unfamiliarity of certain social groups with the use of technology. Among these groups, the literature points out that insecurity in the use of technology is associated mainly with the elderly group and social groups that are less economically favored or that live in remote areas of urban centers (Penedo *et al*., 2020). In this sense, it is important to point out that both groups require greater health care when compared to other social groups: the elderly, due to their more vulnerable health (Vinciguerra & Vinciguerra, 2019); and the disadvantaged social groups, due to precarious infrastructural resources and lack of efficient means of information (Franklin, Lavie, & Arena, 2015).

Thus, it is necessary to develop strategies that enable the application of e-health through digital inclusion. E-health applications should be customized to the needs of different social groups (P7), in order to

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make healthcare services more accessible. To achieve broad accessibility to e-health systems for the various social groups, it is also necessary to overcome the technological barriers discussed in the following section, such as: the development of devices that can be used by people with physical or mental limitations (P2); user's dependence on Internet access to use e-health systems (T4); and the need for qualified instruction and guidance for the correct use of the system (T13).

It is also important to highlight consumer resistance to the use of e-health technologies, related to barriers arising from the lack of reliability of results generated and perceived usefulness (P3 and P5). These factors constitute, among others, the main influencers for the adoption of new technologies (Bostrom *et al*., 2020). Not overcoming these barriers may not only cause consumers to become disinterested in using these technologies, but also cause patients to avoid remote treatments (P4).

3.1.2 Technological subsystem

In this review, the technological subsystem is composed of six benefits (Table 3):

Table 3. Benefits of e-health adoption related to the sociotechnical subsystem of influence caused by available technologies

Technological subsystem elements that influence knowledge transfer		
Code	**Element Detail**	**Number of References**
TB1	Patient Tracking	2
TB2	Making use of devices familiar to the population, already widespread in society	25
TB3	Portability	6
TB4	Continuous monitoring	63
TB5	Improved treatment efficiency	22
TB6	Increased control of physiological signs/diseases	30

It is possible to verify the growing use of mobile technological devices in society, such as smartphones and wearables. These technologies have consolidated and advanced structures that enable a ubiquitous digital environment for their users (Hwang, 2016). Thus, developers of e-health systems have been searching for technological alternatives with which they can take advantage of technological devices already available and familiar to the consumer market (TB2). In addition to the diversity of health computational applications (in software format) already available to the population, hardware resources such as sensors, accelerometers, and cameras have been incrementally exploited in health care activities (Lee *et al*., 2019). Furthermore, as these technologies spread throughout society, enabling more information sharing, there is the possibility of making health campaigns more effective (Franklin, Lavie, & Arena, 2015).

The evaluation of the patient by health care professionals is usually limited to what the patient reports (Reeder & David, 2016). With continuous monitoring (TB4), e-health technologies promote greater control of their users' physiological signals (TB6). Although the traceability of electronic devices (TB1) is seen as a weakness to users' security and privacy, tracking technologies become relevant for patient monitoring activities (Bostrom *et al*., 2020). Continuously generated data can be stored to build a patient history to complement the patient's self-report (Greiwe & Nyenhuis, 2020; Hixson & Braverman, 2020). Data captured instantaneously from the patient's routine allows for more accurate diagnoses, as it makes it possible to analyze physiological changes in a real-life context (Greiwe & Nyenhuis, 2020; Weerdmeester *et al*., 2020). Thus, e-health devices are indicated as a way to improve the efficiency and quality of medical care through more assertive decision-making regarding disease prevention, early diagnosis and treatment improvement (TB5). In addition to the benefits, the sociotechnical technological subsystem is also composed of 13 barriers (Table 4):

Table 4. Barriers to e-health adoption related to the sociotechnical subsystem of influence caused by available technologies

Technological subsystem elements that influence e-health adoption		
Code	**Element Detail**	**Number of References**
T1	Sensor position may cause under- or overestimation	2
T2	Signal interference that impairs the quality of data collection	3
T3	Technical failures / standardization of maintenance procedures / latency / bugs/ incomplete apps / wrong information	16
T4	Dependence on internet/ limited packages/ compatible device/ need for digital inclusion	31
T5	Power requirements / low battery lifespan	11
T6	Dependence on energy source (lack of device autonomy/battery lifespan)	6
T7	Transformation of subjective questions into objective data	1
T8	Integration - Compatibility between IoT structures/technologies and medical structures/technologies/ Technological limitations/ interoperability between systems/ different speeds of evolution/ systems must be customized for different institutions or areas/ impossibility of having some medical equipment at home/ Need for in-person medical exams that cannot be done at home	39
T9	Lack of confidentiality regarding data security and privacy	44
T10	Choosing the right and reliable application/device/technology	4
T11	Presentation format (design) of the results to the user (small screen / difficulties with interpretation-clarity)	17
T12	Quick outdating / Lifespan / obsolescence	5
T13	Need for qualified instruction/orientation and motivation - wrong, inaccurate, untruthful information	43

Although e-health systems translate into benefits for healthcare users, the literature still points out a number of barriers to their widespread adoption in the face of technological innovations (George *et al*., 2020). As mentioned earlier, in convergence with the discomfort caused by the bulkiness of e-health devices, body sensors may have the accuracy of their functions impaired due to the neglect of developing an anatomical design (T1). For example, incorrect positioning of e-health sensors can lead to overestimated measurements in patients with Parkinson's disease, and underestimated measurements in patients with limitations in their arms (Reeder & David, 2016). In addition, e-health devices are subject to external interferences that also impair data collection (T2). Such barriers, among others, contribute to a lack of user trust in the efficiency of these technological resources (Hixson & Braverman, 2020; Weerdmeester *et al*., 2020).

The unreliability of the efficiency of e-health devices is also substantiated by technical failures due to bugs, incomplete or low quality software (T3). Technical failures become even more harmful in cases where patient monitoring cannot be discontinued. The short response time to a change indicative of disease would allow a wider window for preventive intervention (Rosner *et al*., 2017). In some cases, the response time to these changes should be further reduced, such as in cardiac and epileptic patients. Therefore, the efficient and accurate operation of e-health devices is not just about eliminating technical failure or developing more precise measurements. It is also necessary to develop technologies that enable a reduction in the latency of these devices (e.g., Hosseini *et al*., 2020)standards are highly complex and require a large amount of interpretation, deployments are currently scarce, and performance evaluations simplistic or speculative. In this paper, we focus on the experimental evaluation of latency in IoT service composition with mobile gateways (GWs.

Also with regard to monitoring continuity, mobility is an important factor in e-health systems. However, mobile devices have design limitations as they should be small, lightweight, wireless, and low power consumption (T4). Although mobile devices are already widespread among consumers (Franklin, Lavie, & Arena, 2015; Franssen, *et al*., 2020), portability must not prevent the use of these technologies by people with limited sight (T11). In addition, the high energy requirement of the mobile device (T6), as well as its dependence on batteries with generally low lifespan (T5), signal the need for technologies that enable a higher degree of energy autonomy of IoT systems in general, above all e-health systems.

Among other technological limitations found in the literature, the need for technological development to enable interoperability of IoT technologies with medical structures and healthcare protocols is highlighted (T8). In this context, there are still limitations to remote care, related to medical interventions that need to be performed in person (Lew *et al*., 2021). Besides, since health needs are very specific, it is also necessary that technologies are able to direct treatment in a personalized way for each individual. However, even with the personalization of care, there are still limitations regarding the patient's diagnosis. Medical diagnoses must consider subjective factors that are not always easily translated into objective data and information by computer processing (T7).

As previously described, self-monitoring requires a certain amount of patient independence to keep track of his or her own results (Weerdmeester *et al*., 2020). Technological illiteracy, especially present in the low-income public, presents itself as one of the main barriers in the e-health systems adoption literature (T4). In addition, there are medical concerns regarding the quality of digital information (T13). Thus, guidance is needed in order to use e-health technologies in such a way as to avoid errors that can be harmful to the efficiency of treatment (Shin *et al*., 2019). Moreover, it would not be enough just to provide guidelines for the correct use of technology, since guidance for choosing a reliable and appropriate e-health to the user's needs is also essential to provide health benefits (T10).

Health policies that use technologies for identification and traceability of users for mapping disease transmission hotspots raise questions about the limits regarding exposure of the population's privacy (T9). The quest for complete integration between technological monitoring devices and health service structures involves the regular transmission of data from e-health technologies. However, current privacy laws do not adequately cover the digital health environment (George *et al*., 2020). In addition, due to patients' growing personal interest in e-health devices, concerns have arisen related to security factors and privacy of users' health-related data (T9). Although security and privacy requirements are high and well understood in the medical field, the unreliability of these factors still affects the acceptability of e-health technologies by users (Gao, Li, & Luo, 2015). There are recommendations for technology developers to consider users' personalities in order to customize privacy settings. While self-confident users do not tend to worry about privacy issues, those that are more distrustful tend to be more rigid about privacy issues (Shin *et al.,* 2019). The variation in the degree of concern with privacy may also be associated with the type of disease the user has, as publishing certain information could cause embarrassment (Shan *et al.,* 2019). Thus, it is necessary that projects and research on the use of e-health are carefully evaluated for legality, ethical considerations, feasibility, and the acceptability of potential users regarding privacy issues (Muiruri *et al*., 2019).

Despite the increase in the use of mobile technologies, especially regarding the low-income people (Franklin, Lavie, & Arena, 2015), the costs for continuous access to data services remain limiting (T4). The fact that e-health technologies depend on the Internet can be considered a barrier to people who cannot afford an adequate data plan to use the digital health service (Franklin, Lavie, & Arena, 2015). There are also difficulties to access the network by people who live in remote locations, far from urban centers (Lew *et al*., 2021). Technology dependence may prevent 30% of the rural population from accessing remote health care systems (Haulman *et al*., 2020). Internet access difficulties can be caused by the need for digital inclusion (T4) (Penedo *et al*., 2020) and for improving the compatible interoperability structure between technological and health systems (T8).

In the literature, it is possible to observe the rapid growth of consumer interest in e-health technologies (Vinciguerra & Vinciguerra, 2019; Weerdmeester *et al*., 2020). In contrast, one should note the short life cycle of technological innovations and their associated costs that represent obstacles to the development of e-health devices (T12). This presents an obstacle to the acceptance of e-health solutions by stakeholders in the healthcare sector, due to the need for high investments in technologies that are destined to become obsolete as soon as they are online. Besides, legislation on the subject of e-health needs to keep up with the continuous process of innovation, which can also be a problem for its implementation.

3.1.3 External environment subsystem

In this review, the external environment subsystem is composed of only four barriers (Table 5):

Table 5. Barriers to e-health adoption related to the sociotechnical subsystem of influence caused by the external environment

External environment subsystem elements that influence e-health adoption		
Code	**Element Detail**	**Number of References**
S1	Method of Reimbursement	12
S2	Environmental instability	2
S3	Cost / infeasibility of scaling e-health systems	16
S4	Licensing for practitioners / regulation for use	10

The lack and cost of well-defined strategies for patient underinsurance reimbursement policies for healthcare providers negatively influence the success of e-health device integration in the healthcare sector (S1). For the most part, reimbursements for digital health services are supported by third-party insurance companies, which do not always cover the full range of medical services offered. In addition, health insurance reimbursement structures for remote workers also have economic limitations (Shan *et al*., 2019). Although outpatient initiatives are rare, it can be seen in the literature that recent changes in reimbursement policies have already brought positive results for the growth of e-health adoption (Rosner *et al*., 2017).

In addition to the influence on reimbursement strategies, the growth of e-health technologies disrupts the traditional healthcare model and leaves hang-ups when it comes to legal regulatory means (S4). In countries like the USA, the requirement of specific medical licensing for each state where the patients reside limits the strategy of expanding remote interventions (George *et al*., 2020; Haulman *et al*., 2020). It is also important to highlight regulatory issues that aim to ensure the integrity, confidentiality and availability of the content generated in digital health networks, especially regarding user privacy issues (Rosner *et al*., 2017). Although it is possible to find a plethora of e-health devices in the market, the regulation and licensing of these devices is not yet satisfactory (Shan *et al*., 2019). The large number of unregulated e-health technologies (especially applications) can contribute to consumer confusion about choosing the right device and reluctance on the part of healthcare professionals. Thus, a clearer alignment is needed between state regulatory means and the needs of patients, professionals and health care providers (Rosner *et al*., 2017). Such alignment contributes to the standardization of the presentation of the technologies developed, which facilitates the interoperability of technological innovations and the needs of the health system and the evolution of e-health systems (Lew *et al*., 2021).

The limitations of scalability due to the cost of adopting e-health systems are also a barrier (S3), especially when the service is aimed at low-income users. However, in the literature, there is some optimism regarding developers' efforts to make e-health devices more accessible to consumers with different medical needs and financial means (e.g., Hixson & Braverman, 2020; Weerdmeester *et al*., 2020).

3.1. 3 Work design subsystem

In this review, the work design subsystem consists of five benefits (Table 6):

Table 6. Benefits of e-health adoption related to the sociotechnical subsystem of influence caused by work design

Work design subsystem elements that influence knowledge transfer		
Code	**Element Detail**	**Number of References**
OB1	Decreased health care burden	44
OB2	Increased comprehensiveness of information for decision making	41
OB3	Standardization for presentation of information	9
OB4	Quality of health care service	22
OB5	Increased information sharing between users and health professionals	70

E-health technologies enable the widest comprehensiveness of information on which to base medical decision-making (OB2). In addition, e-health systems seek standardization in the presentation of information to avoid miscommunication between different medical professionals and specialties (OB3). This need for standardization of the information generated and transmitted within e-health systems is essential for the effectiveness of medical systems, as the healthcare environment becomes more dependent on digital interactions between those involved.

One of the biggest challenges of health care systems worldwide is the fiscal and social burden of managing and preventing disease, especially chronic diseases (Wicks *et al*., 2014). E-health technologies have the potential to improve the efficiency of healthcare while reducing the burden not only on patients, but also on healthcare providers and professionals (OB1). E-health systems reduce the burden and costs of medical care by simplifying complex tasks through machine processing, as well as by avoiding the duplication of unnecessary diagnostic or therapeutic interventions (Wicks *et al*., 2014). In addition, remote medical interventions can be done synchronously and asynchronously, increasing care flexibility (Haulman *et al*., 2020). Thus, e-health systems fill gaps in current health services, enabling more efficient healthcare for the public and consequently reducing waiting lists (OB4). In addition to the benefits, the work design subsystem is also composed of six barriers (Table 7):

Table 7. Barriers to e-health adoption related to the sociotechnical subsystem of influence caused by work design

Work design subsystem elements that influence knowledge transfer		
Code	**Element Detail**	**Number of References**
O1	Availability of the medical institution to offer the devices/services	7
O2	Organizational implementation risks	4
O3	Disqualification of the professional due to dependence on technology	2
O4	Not able to read body/emotional language / lack of face-to-face treatment	6
O5	Acceptability of the system / acceptance of healthcare providers/professionals (results/overload)	25
O6	Corrosion of the doctor-patient relationship	1

Studies have raised concerns about the corrosion of the relationship between doctors and patients caused by the implementation of e-health in healthcare systems (O6). Healthcare providers report that the absence of face-to-face consultations that would enable emotional connection between the parties and the reading of the patient's body language is harmful to treatment (O4). Furthermore, patients report the need to establish a level of trust with healthcare teams for greater security in the use of these technologies (Shegog *et al*., 2020). Other authors also point out that the greater autonomy granted to patients, due to the use of e-health devices, can be a risk as it might motivate patients to self-medicate or self-adjust their treatments (P9). Thus, most of the studies included in this review suggest that e-health technologies are not substitutes, but complementary to face-to-face clinical analysis (Lew *et al*., 2021).

Organizational risks also represent a barrier to the acceptance of e-health systems among healthcare providers (O1 and O2). Organizational risks are associated with challenges of cost/scalability of technology implementation (Fetterman *et al*., 2017) and structure/available time to support the required workload (Sticherling *et al*., 2009). The dependence on technology for the proper functioning of the digital healthcare system affects not only the structure of medical institutions, but also the healthcare professionals. Besides the work overload that can be placed on health professionals due to their "greater availability" (O5), the dependence on technological resources that facilitate medical care can cause the disqualification of these professionals (O3).

4. Gaps in the e-health literature

Although e-health systems are apparently well accepted by consumers (Yusif, Hafeez-Baig & Soar, 2017), there are a number of technical factors that can influence the perceived value of these technologies by their users, whether they are patients, healthcare professionals, or healthcare providers. First, there was a need to decrease the latency corresponding to the data traffic between client and server. In order to decrease not only latency and technical failures (T3), but also to reduce the problems caused by interference (T2) and data privacy insecurity (T9), future research should explore the use of Fog Computing, Edge Computing, and Dew Computing technologies that would enable computational processing closer to the requesting device.

Also in reference to the technical aspect of e-health technologies, barriers related to insecurity about the privacy of data transmitted over a network were observed (T9)(Hixson & Braverman, 2020). In this context, Blockchain seems to be a promising technology for data standardization, system interoperability, security, privacy, and accessibility of medical records. Blockchain technologies provide a secure, decentralized framework for controlled sharing of patient information (Muiruri *et al.,* 2019). Through Blockchain, the elimination of risks and vulnerabilities can be more effective from solutions present in the cloud, with the combination of personalized passwords and logins, encryption and decryption steps, and structured risk systems (Riaz & Atreja, 2016). While measures such as high-level encryption, authentication, and access control mechanisms can offer protection against many security risks and data breaches, clearer laws are needed to increase user trust in these technologies (George *et al.,* 2020).

The International Human Genome Research Institute defines personalized healthcare as based primarily on the use of the genetic profile of patients for medical decision-making (Li & Meyre, 2014). Making medical decisions that incorporate personalized characteristics according to each patient's biological features has the potential to improve treatment outcomes. Patients and healthcare providers have been generating large amounts of data from diverse sources such as electronic medical records, wearables, and other sensors that allow the collection of genomic data (Cahn *et al.,* 2018). Sharing personalized data can contribute to persuasive health promotion techniques with a focus on prevention (Nittas *et al.,* 2018). Thus, it becomes increasingly imperative that future research consider the alignment between sensor technologies, computational data processing technologies, and human genetics, bridging barriers associated with the need for personalization of services (P9).

Acceptability of e-health systems by healthcare providers and professionals also constitutes one of the main obstacles to spreading this technology (O5). Among healthcare professionals, resistance is found to be a result of several factors, including changes in workflow, reservations about reimbursement structures, and a lack of robust evidence regarding the effectiveness of these technologies (Riaz & Atreja, 2016). Developers and researchers of e-health technologies must be aligned with healthcare organizations, enabling more effective results of the developed devices (Athilingam & Jenkins, 2018). Thus, it becomes imperative that healthcare providers and professionals participate in the process of developing and creating e-health devices (Kelso & Feagins, 2018).However, guidelines developed solely by healthcare professionals differ from those based on consumer preference, which lack guidance on their development (Blackwood *et al*., 2020). There is reasonable evidence to indicate that e-health devices developed with the collaboration of their users are more likely to be used (Lee *et al*., 2019). Thus, several studies in the literature recommend the involvement of consumers in the creation process of e-health systems. Developers should be guided by the perceptions of end users, which enable the identification of barriers and facilitators for a more efficient implementation of e-health systems (Reeder & David, 2016). Therefore, future research should correctly select scientific methods that enable the understanding of consumers' perception of e-health technologies (Zhang *et al*., 2020). In addition, the literature suggests that research explore which features would be most effective for particular groups of consumers (Shan *et al*., 2019).

However, guidelines developed solely by healthcare professionals differ from those based on consumer preference, which lack guidance on their development (Blackwood *et al*., 2020). There is reasonable evidence to indicate that e-health devices developed with the collaboration of their users are more likely to be used (Lee *et al*., 2019). Thus, several studies in the literature recommend the involvement of consumers in the creation process of e-health systems. Developers should be guided by the perceptions of end users, which enable the identification of barriers and facilitators for a more efficient implementation of e-health systems (Reeder & David, 2016). Therefore, future research should correctly select scientific methods that enable the understanding of consumers' perception of e-health technologies (Zhang *et al*., 2020). In addition, the literature suggests that research explore which features would be most effective for particular groups of consumers (Shan *et al*., 2019).

Brazil has developed health information and communication technologies, but the systems are fragmented and the actions to integrate them are still lacking (T8) (Fornazin & Joia, 2016). Lack of evidence on the specific factors affecting e-health utilization rates in Brazil (Alkmim *et al.,* 2015), as well as other digital technologies (Fettermann *et al.,* 2021; Nascimento et al., 2022) is an opportunity for future research. Besides, although there are several studies that address the use of e-health in Latin America (e.g., Díaz & Koch, 2016; Vaiaz Ruiz & Sanchez, 2019) and Brazil (e.g., Dantas *et al.,* 2021; Guimarães *et al*., 2021), there is a lack of relevant studies that analyze the acceptance of these technologies by the Latin American population, and that can also be explored in the future.

5. Conclusion

This research aimed to identify the barriers and benefits of adopting e-health technologies. A systematic review of the literature was conducted, obtaining 130 records considered in this research. As a contribution, this study promoted the gathering of information that makes the adoption of e-health systems possible, and that is scattered in different fields of study. In addition, it also contributes by indicating the main difficulties for developers, organizations, and healthcare systems in adopting these technologies, as well as identifying opportunities for future research on the topic. For practice, as a contribution, this review presents considerations on the implementation and adoption of e-health technologies, which can serve as a support for the future development of digital health technologies.

According to the findings, there are several possibilities for future research which can explore the following topics: the incorporation of Dew and Edge Computing technologies for the improvement of computational processing latency; the exploration of blockchain technologies to ensure the privacy and security of users' data; the alignment between digital health technologies and genetic knowledge for the increase of personalization of medical care; the acceptability of e-health technologies considering the perceived value of different users, whether they are healthcare providers, healthcare professionals or patients; and the identification of the technological resources that would be indispensable to compose the e-health product/system/device, vis-à-vis consumers' perception. The barriers and benefits found in this review can serve as a basis and guide for the development of such future research opportunities.

As for user acceptability, the development of new e-health devices has added efforts to develop digital health technologies in an ethical way, but there is a lack of relevant evidence to ensure the potential benefits for the users' health. Furthermore, the literature indicates, in several studies, the need to involve consumers in the research and creation process of e-health technologies. From the consumers' perceived value, it is possible to quickly identify barriers to be avoided and benefits that can guide the development of the technology (Reeder & David, 2016; Echeveste et al., 2017; Calegari *et al*., 2018). The literature further suggests that analyses of consumer perception of e-health technologies should consider socioeconomic factors of the study population, such as literacy, culture, socioeconomic status, diseases, and treatment plan (Shan et al., 2019). In addition to this, guidelines from Food and Drugs Administration (FDA) indicate the importance of patient involvement in directing the development of medical devices, starting with the identification of the features most needed according to users' perception (Shuren, Patel, & Gottlieb, 2018). Although there are already studies aimed at understanding consumer acceptance of e-health technologies (e.g., Ismail *et al.,* 2012; Kohnke *et al.*, 2014), direct engagement between patients and healthcare system stakeholders aims at alignment between research and development funding and the needs of medical decision makers.

Finally, it is noticeable that there is still isolation among e-health developers, which prevents the sharing of information and reduces compatibility between health systems and the various devices already available on the market. Thus, greater collaboration among developers is needed, as that would allow the development of new devices/systems to occur in a cohesive, orderly, and standardized manner to facilitate interoperability between health systems and e-health technologies.

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