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Acceptance of digital health in Portugal: an example of digital divide

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Acceptance of digital health in Portugal: an example of digital divide

Aceitação da saúde digital em Portugal: um exemplo de divisão digital

Short Title: Digital health in Portugal

Abstract
Digital health technologies are becoming increasingly important in achieving broader healthcare goals worldwide, with significant investments in infrastructure and legislative frameworks to regulate this growing sector. However, despite substantial structural support, a gap remains between investment and consumer usage, particularly evident in Portugal. This study aims to understand attitudes and behaviors towards digital health among the Portuguese population and identify key variables influencing their adoption. Utilizing the Technology Acceptance Model, socio-demographic and subjective factors were examined in a national online survey, part of the CROss-National Online Survey 2 panel associated with the European Social Survey Round 10. The results indicate a positive perception of digital health technologies, with high scores for perceived ease of use (M = 4.97, SD = 1.18) and for the value attributed to these tools (M = 4.71, SD = 1.14). However, their actual use remains relatively low (M = 1.23, SD = 0.94), with concerns about the quality of care and dependence on technology (M = 4.01, SD = 0.94). Older people perceived less ease of use of digital health tools (r = -.234, p < .01), along with less favorable attitudes (r = -.195, p < .01) and lower intention to use them (r = -.145, p < .01). In contrast, literacy, income and education level were positively associated with the above dimensions, highlighting the digital health divide. While digital health technologies offer promising opportunities, it is essential to address their potential to exacerbate health inequalities. This study underscores the significance of understanding socio-demographic and subjective factors in shaping attitudes and behaviors towards digital health. The implications of the findings for policy and intervention aiming to enhance digital healthcare engagement and accessibility are discussed, including the implementation of targeted national digital health literacy programs and the integration of digital health education into formal education curricula.
Keywords: digital health attitudes and behaviors; social determinants of health; Technology Acceptance Model; Portugal
Resumo
As tecnologias digitais na área da saúde estão a tornar-se cada vez mais importantes para alcançar objetivos em matéria de cuidados de saúde em todo o mundo, com investimentos significativos em infra estruturas e em legislação para regulamentar este setor em crescimento. No entanto, apesar do substancial apoio estrutural neste domínio, continua a existir uma discrepância grande entre o investimento e a utilização pelos consumidores, particularmente evidente em Portugal. Este estudo visa compreender as atitudes e comportamentos em relação à saúde digital entre a população portuguesa e identificar as principais variáveis que influenciam a sua adoção. Utilizando o Modelo de Aceitação da Tecnologia, foram analisados fatores sociodemográficos e subjetivos numa pesquisa nacional online, parte do painel CROss-National Online Survey 2 associado à European Social Survey Round 10. Os resultados indicam uma perceção positiva das tecnologias de saúde digital, com pontuações elevadas na facilidade de utilização percebida (M = 4,97, SD = 1,18) e no valor atribuído a estas ferramentas (M = 4,71, SD = 1,14). No entanto, a sua utilização real continua relativamente baixa (M = 1,23, DP = 0,94), com preocupações quanto à qualidade dos cuidados e à dependência da tecnologia (M = 4,01, DP = 0,94). As pessoas idosas perceberam menor facilidade de utilização das ferramentas digitais de saúde (r = -.234, p < .01), e apresentam também atitudes menos favoráveis (r = -.195, p < .01) e menor intenção de utilizá-las (r = -.145, p < .01). Em contrapartida, a literacia, o rendimento e o nível de escolaridade foram associados positivamente às dimensões acima referidas, destacando a exclusão digital na saúde. Embora as tecnologias digitais de saúde ofereçam oportunidades promissoras, é essencial abordar o seu potencial para aumentar as desigualdades na saúde. Este estudo sublinha a importância de compreender os fatores sociodemográficos e subjetivos na formação de atitudes e comportamentos em relação à saúde digital. São discutidas as implicações dos resultados para políticas e intervenções que visam melhorar o envolvimento e a acessibilidade aos cuidados de saúde

digitais, incluindo a implementação de programas nacionais específicos de literacia digital em saúde e a integração da educação em saúde digital nos currículos do ensino formal.

Palavras-chave: atitudes e comportamentos em relação à saúde digital; determinantes sociais da saúde; Modelo de Aceitação de Tecnologia; Portugal

Introduction

Technology is now widely accepted as a way to achieve broader and improved healthcare goals. For this reason, comprehensive digital strategies and legislative proposals have been developed to regulate this growing sector, both at the European level [1] and globally at the World Health Organization (WHO) [2] and the Organization for Economic Co-operation and Development (OECD) [3]. Digital health is defined as the use of digital technology to deliver healthcare services [4]. This is often propelled by governmental activity, as was the case in Portugal in the last 12 years under the Shared Services of the Ministry of Health (SPMS) action [5], but it is also a growing multi-billion global market, at an annual growth rate of 19% [6]. This substantial market expansion is only feasible with a systematic increase in the number of patients and healthcare professionals utilizing digital health technologies. Indeed, 96% of GPs in Europe used Electronic Health Record in their practice in 2019 [7] and the number of American doctors adopting digital tools has grown significantly between 2016 and 2022, regardless of gender, age, or specialty [8]. Similarly, the use of digital tools by patients has also seen growth in recent years. For instance, the number of health app downloads and users has consistently increased since 2018 [9].

The positive impact of digital transformation in healthcare has been well documented [10]. For example, digital health allows closer relationships between healthcare providers and patients, particularly in chronic care and mental health, and enhances workflow efficiency. However, the effectiveness of technological advancements is not solely determined by the intrinsic value of the technologies involved, as has long been argued in consumer behavior and technology acceptance studies [11, 12]. In this case, there is acknowledged resistance to and concerns about the use of digital technologies in this sector by both healthcare professionals (e.g., frustration, lack of training, excessive workflow) and patients (e.g., privacy concerns) [13, 14].

The acceptance of digital health technologies by the public is also significantly influenced by a complex interplay of ethical considerations. Core concerns such as data privacy, informed consent, and the protection of sensitive health information represent substantial barriers to the adoption of these innovations. Addressing these challenges through transparent governance structures and comprehensive ethical guidelines is essential to building public trust and ensuring equitable implementation across diverse populations. Empirical evidence highlights the importance of robust ethical frameworks. For instance, Rezaei et al. [15] identified six key ethical indicators in digital healthcare—procedural values, responsibility, privacy, autonomy, security, and justice—through the Delphi method and confirmatory factor analysis. Their findings offer a validated structure to guide stakeholders in mitigating ethical risks during digital health implementation [15]. Also, privacy protection remains a particularly pressing issue. The risk of data breaches and misuse of personal information not only threatens individual autonomy but also undermines public confidence. Jokinen et al. [16], in an integrative review of 26 studies, identified four core ethical domains in eHealth: privacy, beneficence and nonmaleficence, justice, and trust. Their analysis underscores the importance of transparent information sharing, data security, and inclusive design in the creation of ethical digital health tools [16]. Further, personalized digital health technologies raise additional ethical concerns, including algorithmic bias, lack of explainability, and unequal access. Maeckelberghe et al. [17] emphasize the need for a people-centered approach, advocating for transparency, accountability, and inclusivity in the design and deployment of personalized digital interventions [17]. Ultimately, these studies converge on a common conclusion: ethical guidance is not merely a regulatory necessity but a critical enabler of public trust and technology acceptance. As digital health continues to evolve, embedding ethical reflection into its core design and deployment strategies is imperative for its long-term success and societal acceptance [18].

The growing use of digital technologies in healthcare can only be understood by considering both societal structural and technological conditions and the subjective factors that act as barriers or facilitators [19,20]. This approach proposes a person-centered perspective to understand the implementation of digital health solutions and contributes to the development of more effective digital interventions. Recent reviews of the factors explaining adherence to digital technologies in healthcare suggest the importance of infrastructural and technical factors (such as existing technologies, technology integration), as well as two other set of factors: digital literacy and technological competences (closely associated with socioeconomic status), and the attitudes and beliefs of both users and healthcare professionals [21, 22, 23, 24, 25].

Socioeconomic status, education level, and geographic location profoundly shape the ability to engage with digital health technologies. Economic disparities limit access to devices, Internet connectivity, and digital literacy, hindering marginalized communities' participation. Consequently, older people, those who are socioeconomically disadvantaged, or those living in rural areas show disproportionately lower rates of use of digital health tools [26] and present lower levels of digital health literacy [27]. For this reason, some authors refer to digital literacy and Internet connectivity as 'super social determinants of health' because they influence all other social determinants of health [28]. More recently, technological factors have been termed 'digital determinants of health' because they impact sociodemographic disparities, health inequities, and challenges with care accessibility, affordability, and quality outcomes [29]. The World Health Organization is aware of this source of inequality in access and acceptance of health technologies and its potential to increase health disparities [30].
[Figure 1]
Besides social determinants, one of the most widely used theoretical models to explain adherence to technologies is the Technology Acceptance Model [31, 32, 33]. This socio-cognitive model identifies four predictors of users' behavioral intention (see Figure 1): *perceived usefulness* (the degree to which users believe the technology will improve outcomes), *perceived ease of use* (the perceived effort required to use the technology), both contributing to a *general attitude* towards technology use, and *external variables* that can influence its adoption (such as demographic characteristics or access to the technology). Later models [34] added *social influence* as a determinant of behavioral intentions, representing the extent to which individuals perceive that others believe they should use the technology. These models have been successfully applied to understand perceived barriers and facilitators of innovative technology use, more recently in the healthcare domain [35]. For example, some authors [13] used it to explore nurses' resistance to adopting digital technologies, while others [36] investigated perceptions of healthcare professionals and administrators regarding digital technologies in palliative care, and others [37] employed the model to understand patients' intention to implement a Personal Health Record system as a means of actively managing their health.

The Portuguese case

Portugal is an interesting case study in the development of e-health, as Portugal has been involved in telemedicine since 1990 and was early in the use of Electronic Health Records in Primary Care (before 2000). From 2012 onward Portugal's eHealth strategy and developments accelerated with a dedicated digital health agency (SPMS) and a set of developments [38]. According to an EU survey [39] the Portuguese eHealth profile was close to the European average, and clearly above on "e-Prescribing" (48% above) and "Broadband > 50Mbps" (30% above). Moreover, one-third of Portuguese hospitals have offered telemedicine services since 2014 [40, 41]. Portugal was one of the first European countries to introduce e-prescriptions (mandatory since 2015) and the first, together with Finland, Estonia, and Croatia, to implement European cross-border e-prescriptions. Since 2016, there has been almost total dematerialization of prescriptions (98.5%) [42], and close to 4 million citizens have used/downloaded the health portal and/or used the SNS24 app, both of which provide access to health data. In the Recovery and Resilience Plan submitted to the EU, a quarter of the planned health investment is designated for digital health [43]. For these reasons, Portugal shows one of the greatest improvements in digital maturity in the digital health sector in the EU, with an excellent connectivity infrastructure and an increase of 40% on the composite eHealth score in 2024 [44]. However, to meet the European target of ensuring that 100% of citizens have access to their electronic health records by 2030, there is still a need to improve the population's basic digital skills and the proportion of ICT specialists in employment.

This highly supportive structural environment does not have a similar adherence by the users. In fact, only 17% of the citizens use a website for scheduling medical appointments [45], an essential support for the integration of care. This seems unrelated to Internet access or use, as 89% of Portuguese households have Internet and/or broadband connection and 86% of the resident population aged 16 to 74 used the Internet in the last 3 months [46], nor with lack of trust in technology, as Portugal is one of the European countries with higher levels of trust in the impact of science on health. Indeed, according to the 2021 Eurobarometer [47], 70% of Portuguese respondents believe that science and technology improve our quality of life (compared to the EU average of 57%), and 70% would grant doctors and healthcare professionals access to their health and wellbeing data (the same proportion found in the EU average).

However, the levels of literacy and health literacy of the Portuguese population are quite different from the European one. The first national study on health literacy was published using a representative sample of the

Portuguese population [48]. The authors assessed the General Health Literacy Index in accordance with the HLS-EU methodology, using face-to-face interviews. In this study, Portugal is characterized by the presence of 11% of respondents with an inadequate level of literacy and around 38% with a problematic one. Compared to the European Health Literacy Survey data, Portugal is situated below the average for the countries in the European study. Health literacy scores tended to increase as respondents engaged in more daily practices involving reading and the use of information and communication technologies. This stresses that health literacy levels are low in Portugal, and this cannot be dissociated from general literacy. Other more recent studies report a more positive situation. According to Eurostat [49], the level of digital literacy of the Portuguese population is mild (55%), like the EU average. However, this average mask a very heterogeneous reality. Portugal exhibits large disparity in digital skills between younger and older individuals (64 percentage points), and highly educated individuals and those with no or low formal education (66 percentage points). These findings align with a research study [50], which examined digital health literacy and its correlations with health literacy levels in Portugal, using telephone interviews. Their study found that 43% of the surveyed population revealed adequate levels of digital health literacy, higher than the general health literacy that remained very similar to Espanha and Ávila [48] results (8% of respondents with an inadequate level of literacy and 22% with a problematic one). Digital health literacy was well associated with socio-economic determinants. Notably, the proportion of individuals with a very low level of literacy is much higher in digital health literacy (28%) than in general health literacy (8%). All these results give a very unequal portrait of the Portuguese population in terms of health literacy.

Purpose of the present study

In the present study, our aim is to describe and understand the attitudes and behaviors towards digital health among the Portuguese population. Given the disparity between the substantial structural investment in e-health by the National Health Service and the limited levels of consumer usage, we expect that the analysis of the socio-demographic and subjective factors will shed light on the key variables for understanding adherence to digital health services in Portugal. Our analysis will be informed by the widely used theoretical framework in this field, the Technology Acceptance Model, enabling comparison of our findings with those generated in other contexts. Besides, as the study was conducted among the general population, a wide range of contextual variables will be used to characterize the acceptance of digital health, including both social determinants (education, income, age) and other socio-demographic ones (political orientation, health status, or digital skills).

Method

Procedure

This survey was conducted as part of the CROss-National Online Survey 2 (CRONOS-2) panel, which includes Portugal among the 12 participating countries [51]. At the end of the main European Social Survey Round 10 [52] questionnaire, respondents from each of the 12 European countries were invited to participate in the online panel across six waves. In this longitudinal design, waves 1, 2, 4 and 5 were cross-national, while waves 3 and 6 were specific to each country, as proposed by national teams. The survey on “Digital Health: Attitudes and Determinants” was selected through an open competition in Portugal. Respondents from Round 10 of the ESS (2020/2022) in Portugal who had Internet access were invited to participate in the CRONOS-2 panel. All panelists were offered incentives worth €5 for their participation. Out of the 1830 respondents from Portugal in the ESS R10, 1231 were deemed eligible for CRONOS2 due to their Internet access. Of these, 719 (58.4%) were recruited for the panel, and from this group, 403 (56.1%) participated in Wave 3. Recruitment was impacted by the COVID-19 pandemic. Because of the diversity of governmental public health measures, the collection of country data was grouped into 4 clusters. Portugal belonged to Group 3, with data collected between January 2022 and February 2023. In each wave, a 20-minute main survey was administered using Qualtrics survey software.

Participants

The present study included 403 residents from Portugal, aged 18 to 87 years (*M* = 45.1, *SD* = 15.4). Of these, 216 (53.6%) were female and 187 (46.4%) were male. Concerning educational attainment, 26% of participants had completed primary education, 39% had completed secondary education, and 35% had completed tertiary education. In terms of income level, 28% reported low income, while 42% reported medium income, and 30% reported high income. Most participants were actively employed (63%), and a large proportion used the Internet daily (87%). This study utilized a national sample, and the data analysis procedure used a weighting factor as recommended by ESS to ensure that the resulting sample is representative of the broader population of adults with Internet access.

Instruments

The survey utilized 30 items based on the Digital Health Scale (DHS) [53], comprising 20 items related to attitudes and 10 items related to behaviors. The survey started with the following definition of digital health: 'Digital technologies can be used to obtain health information or to receive care (for example, SNS24, video conference consultations). Messages, Internet services, and apps are methods used to monitor health conditions, make an appointment with the doctor, send a picture to a health professional, receive prescriptions on our mobile phones or by email, or receive reminders of a scheduled consultation. We would like to know your opinion about these new methods for receiving health and caregiving information. The survey operationalized several concepts from the Technology Acceptance Model, and respondents rated their degree of agreement with each item on a Likert-type scale [54] ranging from 1 (*Fully disagree*) to 7 (*Fully agree*).

Perceived ease of use of digital health. It was assessed with 4 items ("I can use the Internet to resolve problems related to my health and my family's health"; "I think I can use the Internet well"; "I know how to use digital technologies in health"; "Digital health technologies are easy to use"). The alpha coefficient is .87. An index was computed by averaging these items, with higher values indicating greater levels of perceived ease of digital health.

Perceived usefulness of digital health. It was measured with 5 items ("Digital technology improved healthcare"; "Digital technologies reduce human error in health"; "I am excited to use new digital methods in health"; "Digital health technologies are good for everyone"; "I would like to see more digital technologies in health care") that have a good level of internal consistency (a = .82). An index was computed averaging these items, with higher values meaning greater levels of perceived usefulness of digital health.

Attitudes towards digital health. It was assessed with 8 items, that were mainly framed in a negative way, including mistrust and concern ("The idea of booking an appointment or a medical examination online makes me anxious"; "I'm not particularly eager to use digital technologies in health"; "It is challenging to find information online regarding healthy behaviors, like exercising, eating healthy and nutrition"; "Health professionals and health institutions trust too much digital technologies"; "I am worried that digital technology can put at risk of disclosure my private health data"; "Health technologies can fail and put my healthcare at risk"; "Digital technologies won't be able to replace meeting in person health professionals"; "Video and telephone appointments with your doctor are as good as meeting your doctor in person" - reverse scored). The internal validity value was acceptable for this set of variables (a = .67). The items were averaged, and an attitude index was constructed reversing the sense of the scale, so that high values indicate positive attitudes towards digital health.

The behavioral part of the survey includes 10 items. Six statements are adapted from The Digital Health Scale [53], while 4 questions are adapted from Special Eurobarometer 460 [55]. The three behavioral indicators were constructed from a principal component factor analysis on the 10 items.

Behavioral intention to engage in digital health interactions, 4 items ("When I want to make a doctor's appointment, I prefer to speak to a real person instead of searching the Internet"; "I rarely use digital technologies in health"; "When I want to make an appointment with a health professional, I prefer to speak to a person rather than use the Internet"; "If it were possible, I would prefer to receive my blood test results on my cell phone"; a = .76. High scores on this index correspond to preference for digital health interactions. The answer was given in a 7-point scale ranging from 1 (*Fully disagree*) to 7 (*Fully agree*). Higher values on this variable indicate more frequent use of digital strategies in case of illness.

Use of digital health tools, 4 items ("In the last 12 months, how often did you use or do any of the possibilities or actions referred to on the following questions: Make an appointment with a health professional through your computer or use an app on your phone?"; "Receive a prescription by SMS or by email?"; "Had a consultation with a health professional by video or by phone on your computer?" ; "Used the General Directorate for Health website or searched on the Internet to obtain information on health care?";α = .65), 0 *Never*, 1 *Once*; 2 *Twice*, 3 *Three times,* 4 *Four times;* 5 *Five or more times.* Higher values on this variable indicate more frequent use of digital tools.

Use of digital health tools in sickness. 2 items ("When I am sick, I prefer to go to the doctor instead of searching for medical information online" (reversed); "When I'm ill, I search for medical information online") were averaged to construct an index of digital behavior in illness (α = .57). The answer was given in a 7-point scale ranging from 1 (*Fully disagree*) to 7 (*Fully agree*). Higher values on this variable indicate more frequent use of digital strategies in case of illness.

The survey also included contextualization questions, namely all the questions in the ESS R10, both the socio-demographic ones and the ones corresponding to the fixed and rotating modules. The following were selected to obtain a more general picture of the attitudes towards:

Subjective general health. It was measured through a single item by asking participants to rate their overall health. Responses ranged from 1 (*Very good*) to 5 (*Very bad*). Scores were recoded, with higher scores indicating a more positive perception of health.

Health literacy. The Single-Item Health Literacy Screener ("How often do you need help understanding instructions, pamphlets, or other informational material given by your doctor or pharmacy?" *Never* (1) to *Always* (7), [56] was included in the national rotating module.

Digital skills. Three items were used, adapted from Hargittai & Hsieh [57] proposal to assess web-use skills: "How familiar are you with each of the following computer and Internet-related items: Preference settings? Advanced search? PDF?" Answers were given in a 5-point Likert scale, where 1 stands for *Not at all familiar* and 5 for *Completely familiar*. As the three items were very correlated (α = .96), the three were averaged in a composite index, where higher values stand for higher levels of digital skills.

Political orientation was measured using the following item: "In politics people sometimes talk of "left" and "right". Using this card, where would you place yourself on this scale, where 0 means the left and 10 means the right?".

Religiosity was measured with the following item: "Regardless of whether you belong to a particular religion, how religious would you say you are?". Answers ranged from 1 (*Not at all religious*) to 10 (*Very religious*).

Data analysis

Data were analysed with IBM SPSS Statistics (version 29.0.2). No case elimination was performed because the percentage of missing values was less than 5% for all variables included. For example, the variable perceived ease of use had 2% missing values and the variable use of digital health tools had 2.2% missing values. Since the proportion was low and randomly distributed, it was decided to retain the cases with available data for each analysis. Several descriptive, correlational and path analyses among others were performed among the main variables under study.

[Table 1]

Results

Descriptive

Descriptive statistics and correlations of the main variables are presented in Table 1. The findings reveal a generally positive view of digital health, with perceived ease of use (*M* = 4.97, *SD* = 1.18) and perceived value of digital health tools (*M* = 4.71, *SD* = 1.14) scoring above 4.5 for more than 60% of the respondents. However, attitudes towards digital health are somewhat less positive, with the average score aligning closely with the midpoint of the scale (4). Analysis of individual index items indicates mixed sentiments: while some items reflect positive attitudes towards digital health (e.g., clear disagreement with statements such as "I'm not particularly eager to use digital technologies in health", *M* = 2.87, *SD* = 1.75; "It is challenging to find information online regarding healthy behaviors, like exercising, eating healthy and nutrition", *M* = 2.96, *SD* = 1.88; or "The idea of booking an appointment or a medical examination online makes me anxious", *M* = 2.99, *SD* = 1.90), congruent with high ease-of-use ratings, others express concerns about the quality of healthcare with digital support ("Digital technologies won't be able to replace meeting in person health professionals", *M* = 5.27, *SD* = 1.69; "Video and telephone appointments with your doctor are not as good as meeting your doctor in person", *M* = 5.02, *SD* = 1.62; "Health technologies can fail and put my healthcare at risk", *M* = 4.48, *SD* = 1.52).

The behavioral intention measure shows a slight preference for digital health solutions in healthcare (with 40% scoring 5 or above), what is congruent with the overall positive attitude described above. However, when facing illness, the digital is not an option for most of the respondents, as 60% score below 4, the middle of the response scale). The use of digital health services in the last three months was also low, with 43% of the sample reporting not have used them once in the last 3 months (value below 1). *Never* answers were more common for a digital consultation with a health professional (76%) or a digital appointment with a health professional (50%) and less common for a digital prescription (21.5%) or online search to obtain information on health (35%). Table 1 also shows the inter-correlation matrix. All the attitudinal variables are well correlated, and the behavioral items show lower level of association with the other variables.

[Table 2]

To understand the social determinants of these variables, the associations with the main socio-demographic indicators were explored (Table 2). Men perceive more value in the digital health solutions (M = 5.03, SD = 1.13) than women (M = 4.42, SD = 1.09), $t(393) = 5.43$, $p < .001$, and they also show higher intention to use digital options in health (M = 4.66, SD = 1.35) than women (M = 4.23, SD = 1.45), $t(393) = 3.03$, $p = .003$. These differences are consistent with gender role beliefs, according to which men are expected to be more interested and capable of using technologies [58].

Participants aged 60 years or older showed lower perceived ease with digital health (F (4, 394) = 8.64, $p < .001$), a less positive attitude towards digital health (F (4, 394) = 4.84, $p < .001$), lower intention of using digital formats in healthcare (F (4, 394) = 3.32, $p = .01$), and less use of digital options when ill (F (4, 394) = 4.65, $p < .001$), than the group of younger participants. Income was also a particularly important differentiator of our sample's opinions. Those who reported having a high level of income, as compared with participants with lower income, perceive as more easy the use of digital health (F (2, 300) = 6.15, $p = .002$), attributed more value to the digital solutions in health (F (2, 300) = 4.88, $p = .008$) and preferred digital health tools (F (2, 300) = 6.47, $p = .002$). The level of education was another important determinant of our results. Participants with higher levels of education, as compared to the ones with less than secondary education, perceived digital health technologies as easier to use (F (5, 394) = 8.20, $p < .001$), had a more positive attitude towards them (F (5, 394) = 10.09, $p < .001$), had more intentions to use digital solutions (F (5, 394) = 9.42, $p < .001$), and used more often digital health (F (5, 394) = 3.22, $p = .007$) also in illness (F (5, 394) = 4.88, $p < .001$). The correlation between the main variable and the socio-demographic indicators is presented in Table 3. It should be noted that health literacy is positively associated with perceived ease of use, attitude towards digital health and intention to use it (but not with perceived value or actual use of digital health tools). Internet use is, as could be expected, positively associated with ease of use of digital health tools.

[Table 3]

As shown in Table 4, the variables associated with digital health were correlated with other general variables, controlling for the main socio-demographic determinants. Political orientation and religiosity were not significantly related to any of the digital health indicators, either before and after controlling for age, gender, and years of schooling. Perceived health status was positively associated with ease of use ($r = .19$, $p < .010$), attitude towards digital health ($r = .19$, $p < .010$), and intentions to use it ($r = .22$, $p < .010$), but these associations disappeared when sociodemographic variables were controlled for. Finally, digital skills were positively associated with ease of use before ($r = .37$, $p < .010$) and after controlling for socio- demographic variables ($r = .28$, $p < .010$). The same happened for usefulness *(*$r = .12$, $p < .050$; after: $r = .15$, $p < .050$) and intention *(*$r = .33$, $p < .01$; after: $r = .18$, $p < .010$). Digital skills showed the stronger effects, probably because it is semantically closer to digital health. In this context, the other variables can be conceived as background unrelated factors.

[Table 4]

Test of the Technology Acceptance Model

We conducted *path analysis* using SPSS Amos to explore the direct and indirect pathways from perceived ease of use and perceived usefulness to attitudes towards using digital health, behavioral intention to use, and the actual use of digital health. The analysis involved 5.000 bootstrap samples, and direct and indirect effects were assessed using percentile-based bootstrapped confidence intervals. The sequence of variables followed the Technology Acceptance Model. Gender, age, and years of schooling were included as covariates in the path analysis model. Figure 2 reports the results from the path analysis. Goodness-of-fit statistics show a good fit of the data to the model ($C^2 = 13.07$, $df = 4$, $p = .01$; GFI = .99; TLI = .92; CFI = .97; RMSEA = .07).

[Figure 2]

All direct effects between the variables of interest in the path analysis were significant (see Figure 2). Perceived ease of use showed a direct relationship with perceived usefulness ($\beta = .49$, SE = .04, $p < .001$) and with positive attitudes towards digital health ($\beta = .36$, SE = .04, $p < .001$). Perceived usefulness was positively associated with positive attitudes towards digital health ($\beta = .15$, SE = .04, $p = .003$) and the behavioral intention to use digital health ($\beta = .15$, SE = .06, $p = .003$). Moreover, positive attitudes were linked to behavioral intention ($\beta = .24$, SE = .07, $p < .001$), and behavioral intention was positively associated with the actual use of digital health ($\beta = .21$, SE = .03, $p < .001$).

All indirect effects in the model were significant. Specifically, there was a significant indirect effect of perceived ease of use to behavioral intention, (β = .18, 95% CI [.11,.26]), and of perceived usefulness to behavioral intention, (β = .04, 95% CI [.01,.08]). This shows that positive attitudes towards digital health significantly mediated the relationship between perceived ease of use and perceived usefulness and behavioral intention to use digital health.

Discussion

The aim of this study was to understand the acceptance of digital health technologies by the general population in Portugal, where strong investment in digital health infra-structures has been made. Our results show, in general, a positive view of digital technologies in healthcare but low levels of use of digital health tools. In fact, the subjective variables considered (*perceived ease of use of digital health*, *perceived value*, and *attitudes towards digital health*) were mainly positive. In general, participants considered this type of technology useful and easy to use, although we should note that this was an online study and that our sample regularly used the Internet. Attitudes towards digital health were less positive and referred to concerns about the quality of healthcare if video or telephone appointments replace in person contacts with health professionals, or if health professionals depend on digital technologies. The participants showed a slight intention to prefer digital health solutions in healthcare, but not in situations of illness when such options are not available for the vast majority of the respondents. The actual use of digital health services in the last three months was low. Digital prescription was the most widely used digital health facility, followed by online search to obtain information on health. Digital consultation or a digital appointment with a health professional were still rarely used in our sample. So, although we received an overall positive view of digital health, concerns and resistance were also noted, and a gap was found between positive attitudes and actual behavior. This has been noted in other national studies, namely in the UK [59, 60].

Our results also show the strong associations of socio-economic variables with attitudes, values, and intentions towards digital health. Positive views of digital health and more frequent use of digital health tools are much more common among those more educated, richer, younger and with higher levels of health literacy. These results are systematically found in the literature on digital health and extend the *Social Determinants of Health* perspective to this form of healthcare. In fact, it has been long recognized that the conditions in which people are born, grow, work, live, and age have a strong influence on their health [61, 62, 63]. The literature on digital health in the last years has identified the same inequalities of access to digital healthcare and health technologies [64, 65, 66] and to digital health literacy [27]. Those who are more economically and culturally deprived have lower levels of information, knowledge, and skills about digital technologies in health, but they also have more difficult access to the Internet and to afford digital equipment with the quality that could allow them to fully engage in digital health interactions. For this reason, the World Health Organization [2], following the Lancet and Financial Times Commission report [4] proposed the term “digital determinants of health”, defined as:

“The technological factors that are incorporated to provide affordable, accessible, and quality care to consumers enhancing their healthcare engagement and experience. Digital determinants refer to factors intrinsic to the technology in question that impact sociodemographic disparities, health inequities, and challenges with care accessibility, affordability, and quality outcomes. These include aspects such as ease of use, usefulness, interactivity, digital literacy, digital accessibility, digital availability, digital affordability, algorithmic basis, technology personalization, and data poverty and information asymmetry” [29].

Our data provides evidence for this type of inequality in the Portuguese context, even with a sample that is not digitally excluded, as the data collection was conducted online.

But even in this context, all the variables associated with digital literacy (digital skills, Internet use) presented significant associations with the perceptions and use of digital health. Those who use the more frequently and hold better digital skills showed more favorable views and more frequent use of digital health, what suggests that digital training and education and digital experience have a key role in the appropriation of this type of abilities. Indeed, digital literacy competences enable the use of digital technologies to be a positive and beneficial experience. By recognizing the value of this experience, a person tends to expand the use of digital technologies to different domains, seeking to guide this use towards specific objectives and, later, make it more generalised, proactive and transformative [67, 68].

Interestingly, the general social attitudes (such as political orientation or religiosity) showed no relation with the attitudes or behaviors towards digital health. To our knowledge, this is the first time these associations have been explored. Our results suggest that, due to the rapid growth of mobile health tools and telehealth systems in

healthcare delivery, digital health has not yet been framed as a social issue. The fact that technological development is consensually seen as an inevitable and positive future for health can have contributed to this. The benefits of this digital transition have hidden its implications to increase and reinforce health inequalities [69]. For example, in a rare study on the social representations of digital health technology using focus groups [70], there were concerns about privacy, the price of digital technologies, and the difficulties for older users, but social inequalities were not mentioned, and digital technologies are viewed as a neutral social object. Self-reported health status was also not associated with any of the digital health variables, after controlling for socio-demographic variables. Given the important developments in digital services for various health-related purposes, it would make sense that persons with more health problems would use more frequently digital health tools than healthy persons. These associations with broader context variables should be explored in future research.

Finally, in line with prior research, the Technology Acceptance Model (TAM) appears to be an appropriate framework for examining the adoption of innovation in healthcare settings. Variables reflecting participants' perceptions were significantly associated with behavioral variables, and both attitudes toward digital health and intentions to use digital health tools were found to mediate the relationship between perceptions and actual usage behavior. Based on the strength of associations observed in the analysis, perceived ease of use, more so than perceived usefulness, emerged as a key construct. Specifically, ease of use demonstrated stronger correlations with attitudes and showed significant associations with several external variables, including age, education, income, health literacy, digital skills, and Internet use.

The relevance of perceived ease of use is further supported by its inclusion in various extended models of TAM that integrate constructs such as self-efficacy, training, and prior experience, all aimed at improving the model's explanatory power regarding digital health acceptance [35]. In conjunction with the notable influence of social determinants, perceived ease of use may play a critical role in addressing digital health exclusion. This holds particular importance in Portugal, where educational attainment and digital literacy levels align with the EU average among younger populations but fall considerably below for individuals aged 45 and above.

According to official statistics, in 2021, the proportion of the Portuguese population with basic or higher digital skills exceeded the EU-27 average only among those under the age of 45 [46]. Among citizens aged 55 and older—and especially those over 65—this gap widens significantly: only 17% of Portuguese adults in this group possess basic digital skills, compared to 27% across the EU. This disparity is particularly consequential given that individuals over 65 represent a substantial segment of the population; Portugal's old-age dependency ratio is 12, the second highest in Europe [49].

This demographic context highlights the specific relevance of perceived ease of use in the Portuguese setting. The findings suggest that efforts to promote accessible and person-centered digital healthcare services should prioritize initiatives that enhance digital skills and foster user confidence. Such initiatives may include tailored training (e.g., instructional patient videos), personalized support (e.g., digital navigation assistance from volunteers), or community-based resources (e.g., digital inclusion projects co-developed with patient associations), particularly designed for older adults and individuals with lower levels of formal education.

Considering these results, it is crucial to further adopt structured training and digital inclusion measures, in the context of existing policy frameworks and measures, such as the Action Plan for the Digital Transition, approved in 2020, and the ongoing National Digital Competence Initiative – INCoDe.2030. A concrete proposal would be the implementation of national digital health literacy programs in informal education contexts, including, among others, health centers, pharmacies, and community centers. These programs should especially target vulnerable populations (such as older adults, people with low levels of education, and immigrants), ensuring that no one is left behind. These programs should combine in-person sessions, hands-on demonstrations, and interactive digital modules, with, for example, the support of digital and cultural mediators and healthcare professionals (e.g., Eu Sou Digital)

Another effective measure could be the integration of digital health education into formal education curricula and in the ongoing (non-formal) training of health and social care professionals [71,72]. This approach would include basic (technical and operational) and advanced (critical analysis and evaluation of information and responsible communication, interaction and expression) digital competences that allow the use of health platforms, navigation of portals such as SNS 24, and understanding clinical data. Such an education would enable health and social care professionals to gain competence in using digital health technologies in ways that meet the needs of diverse populations in different contexts and that value these populations' concerns (e.g., about data privacy or security) and preferences (e.g., regarding the format of consultation). This, in turn, could contribute to greater

recognition of the benefits associated with the use of digital technologies for health-related purposes and, consequently, their adoption on a wider scale. Digital health literacy could also be boosted by making accessible mobile applications available (with universal and multilingual design) that comply with the Web Content Accessibility Guidelines (WCAG) [73] — an area in which Portugal still needs to improve.

On an ethical and legal level, the development of digital health literacy must strictly comply with the protection of personal data, in line with the General Data Protection Regulation (GDPR) [74]. It must also make citizens aware of their rights in the European Health Data Space [75], clearly informing them about the benefits of the primary and secondary use of their health data. Citizens' trust is essential for the success of these programs. It is necessary to ensure that access to health data is secure, based on robust authentication systems (such as eIDAS – Electronic Identification, Authentication and Trust Services) [76] and with full transparency about who accesses what data and for what purpose. Citizens must also be able to authorize or revoke third-party access to their data, maintaining autonomy over their clinical information.

Portugal has the potential to stand out in the digital transition of health, but this requires inclusive, ethical, and citizen-centered policies. Investing in digital health literacy is not only a matter of technology, but of equity, citizenship, and quality in access to care.

This was the first study to use a national sample to describe the perceptions and use of digital health by the Portuguese population. It was performed using the European Social Survey structure, and for that reason it could link the specific answers to these questions with broader social attitudes and context variables. However, the methodology adopted by CRONOS-2 is online, and that imposed limits to the data collection. Participants invited to participate had to have Internet access, and that limited the sample to those who have basic digital skills, leaving out the more vulnerable and excluded population. Generalization of our results should take into consideration this limitation.

Conclusion

This study reinforces the view that digital skills and education are fundamental to understanding both the attitudes of the Portuguese population towards digital health and the disparity between structural investments in e-health and the limited levels of consumer usage. In this national online survey, we found a generally positive view of digital health, but the responses were strongly modulated by social variables such as income, education, or age. There is clear evidence of a digital health divide, and our findings support the view of digital determinants of health.

While digital health technologies hold great promise for improving care efficiency and health outcomes, it is critical to recognize their potential to worsen health inequalities. As we embrace these advances, it is essential to be mindful of their unintended effects, particularly in amplifying disparities in healthcare access and outcomes, and to propose concrete, needs-based measures, to mitigate their impact. These measures should take into account the promotion of both digital literacy and digital health literacy. Currently, there are several empowerment, reskilling and upskilling initiatives being implemented for different target groups (e.g., initiatives promoted by INCoDe.2030). However, these initiatives do not reach all those who need them, widening the gap between the digitally literate and the digitally illiterate. Furthermore, as far as it is known, these initiatives do not focus on digital health literacy, which significantly limits citizens' understanding of the benefits of using digital technology in health and social care.

Our research indicates that promoting digital inclusion in healthcare systems requires tailored efforts, such as initiatives to increase digital competencies among patients and health and social care professionals of all skill levels. This includes the implementation of targeted training programs to empower both newcomers to technology and those with limited access to devices and/or with limited digital literacy.

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Statement of Ethics

As part of the European Social Survey procedures, this research was approved by the ESS ERIC Research Ethics Board.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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Author Contributions
Author 1: conceptualization, study design, data analysis, and interpretation, writing and approval of the final version; Author 2: conceptualization, study design, analysis, writing, and approval of the final version; Author 3: study design, writing – reviewing and editing and approval of the final version; Author 4: writing – reviewing and editing and approval of the final version; Author 5: writing – reviewing and editing and approval of the final version; Author 6: conceptualization, writing, and approval of the final version; and Author 7: data analysis, writing -reviewing and editing and approval of the final version and approval of the final version.

Data Availability Statement
As part of the open access policy of the European Social Survey – ERIC project, materials and data collected in CROss-National Online Survey 2 (CRONOS-2) panel are publicly available via the ESS Data Portal (https://ess-search.nsd.no).

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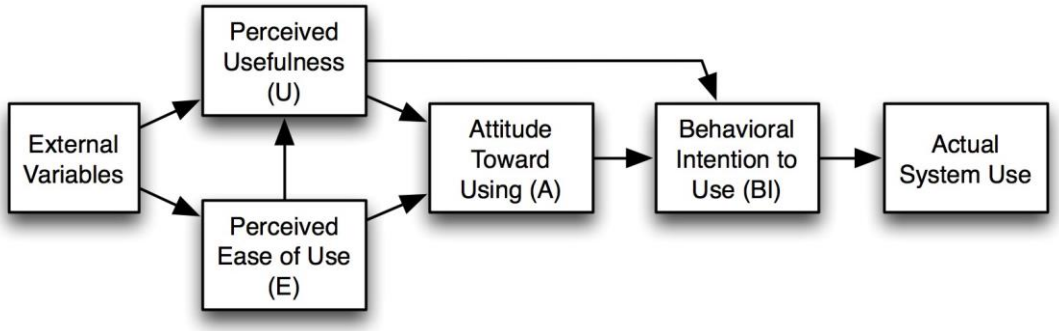
Figure Legends

Fig. 1. Technology Acceptance Model

Fig. 2. The Path Analysis Model of the Direct Effects for the Relationships Between Study Measures

Figure 1.

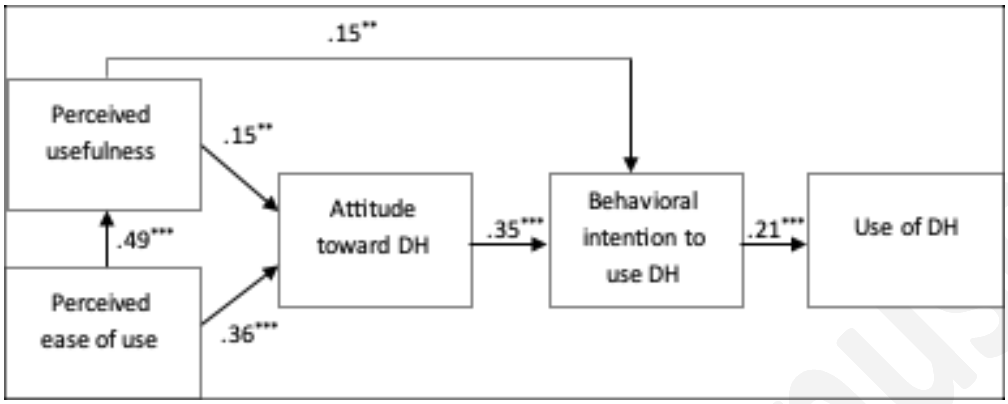
Technology Acceptance Model



Source: Davis FD, Bagozzi RP, Warshaw PR. User acceptance of computer technology: a comparison of two theoretical models. Manag Sci. 1989;35(8): p. 985. doi:10.1287/mnsc.35.8.982.privacy. [32]

Figure 2.

The Path Analysis Model of the Direct Effects for the Relationships Between Study Measures



Source: Adapted from Davis FD. Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Q. 1989;13(3):319-340. doi:10.2307/249008 [31]

Table 1

Means, Standard Deviations and Correlations for the main variables

	Descriptive		Correlations				
	M	*SD*	*1*	*2*	*3*	*4*	*5*
1. Ease of use (1-7)	4.97	1.18					
2. Value (1-7)	4.71	1.14	.528**				
3. Attitude (1-7)	4.01	0.94	.450**	.332**			
4. Intention (1-7)	4.43	1.20	.602**	.444**	.585**		
5. Use of digital tools (0-4)	1.23	0.94	.184**	.126*	.091	.159**	
6. Digital in sickness (1-7)	3.18	1.42	.287**	.228**	.287**	.340**	.208**

Note. **Correlation is significant for p < .01.; **Correlation is significant for p < .05.

2

Means and standard deviations of the main variables by levels of the socio-demographic indicators

			Ease of use	Value	Attitude	Intention	Use of digital tools	Digital in sickness
Gender	Male	*M*	5.14	5.03[a]	4.07	4.66 [a]	1.27	3.22
		(SD)	(1.31)	(1.13)	(0.96)	(1.35)	(0.95)	(1.38)
	Female	*M*	4.97	4.42 [b]	3.95	4.23 [b]	1.18	3.15
		(SD)	(1.38)	(1.18)	(0.81)	(1.44)	(0.90)	(1.40)
Age	18-29	*M*	5.59[a]	4.81	4.20[a]	4.93 [a]	1.16	3.60[a]
		(SD)	(1.01)	(1.06)	(0.82)	(1.09)	(0.97)	(1.33)
	30-39	*M*	5.07[a]	4.47	4.20[a]	4.42 [ab]	1.18	3.30[ab]
		(SD)	(1.38)	(1.18)	(0.82)	(1.45)	(0.91)	(1.40)
	40-49	*M*	5.24[a]	4.72	4.11[ab]	4.42 [ab]	1.22	3.33[ab]
		(SD)	(1.12)	(0.99)	(0.83)	(1.36)	(0.91)	(1.40)
	50-59	*M*	5.02 [a]	4.89	3.88 [ab]	4.36 [ab]	1.35	3.06[ab]
		(SD)	(1.30)	(1.21)	(0.98)	(1.47)	(1.11)	(1.41)
	60+	*M*	4.33[b]	4.68	3.66 [b]	4.07[b]	1.18	2.64[b]
		(SD)	(1.68)	(1.25)	(1.18)	(1.60)	(0.78)	(1.45)
Income	Low	*M*	4.78[a]	4.46[a]	3.88[a]	4.37[ab]	1.28	3.32
		(SD)	(1.44)	(1.17)	(0.94)	(1.37)	(0.96)	(1.49)
	Medium	*M*	4.87[a]	4.58[ab]	4.02[ab]	4.12[a]	1.12	3.09
		(SD)	(1.39)	(1.09)	(0.88)	(1.43)	(0.83)	(1.45)
	High	*M*	5.44[b]	4.98[b]	4.21[b]	4.81[b]	1.25	3.23
		(SD)	(1.38)	(1.17)	(0.92)	(1.42)	(0.95)	(1.43)
Education	<lower secondary	*M*	4.42[a]	4.42	3.65[a]	3.64 [a]	1.20	2.56[a]
		(SD)	(1.72)	(1.40)	(1.06)	(1.59)	(0.76)	(1.16)
	lower secondary	*M*	4.75 [ab]	4.69	3.6 [a]	4.19 [ab]	1.03	2.98[ab]
		(SD)	(1.55)	(1.28)	(0.83)	(1.50)	(0.94)	(1.44)
	upper secondary	*M*	5.09 [ab]	4.63	4.06[ab]	4.38 [abc]	1.13	3.34[ab]
		(SD)	(1.14)	(1.00)	(0.86)	(1.26)	(0.89)	(1.39)
	adv vocat. Sub-degr	*M*	4.76 [abc]	4.46	4.04[ab]	4.41 [abc]	1.24	3.05[ab]
		(SD)	(1.35)	(0.93)	(1.01)	(1.34)	(0.79)	(1.70)
	BA level	*M*	5.70[bc]	5.08	4.48[b]	5.13[c]	1.58	3.26[ab]
		(SD)	(1.03)	(1.01)	(0.87)	(1.12)	(1.02)	(1.36)
	>= MA level	*M*	5.61[c]	4.98	4.44[b]	5.08 [bc]	1.47	3.73[ab]
		(SD)	(0.93)	(1.05)	(0.89)	(1.24)	(1.10)	(1.39)

Note: For the same demographic variable, mean values with different letters in the same collum correspond to significant differences (Sheffee test for $p<.05$)

Table 3

Correlations for the main variables with socio-demographic indicators

	Correlations				
	Age	*Income*	*Education*	*Health Literacy*	*Internet use*
Ease of use	-.234**	.180**	.289**	.249**	.135**
Value	.051	.168**	.138**	.116	.007
Attitude	-.195**	.132***	.329**	.366**	.027
Intention	-.145**	.121*	.312**	.415**	.091
Use of digital tools	.034	.068	.158**	-.044	.039
Digital in sickness	-.192**	.012	.218**	.072	.103*

Note. **Correlation is significant for $p < .01$.; *Correlation is significant for $p < .05$

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Partial correlations for the main variables with general variables. after controlling for age. gender and years of schooling

	Correlations			
	Political orientation	*Religiosity*	*Digital skills*	*Perceived Health*
Ease of use	-.026	-.025	.280**	.080
Value	.041	-.060	.151*	.094
Attitude	.001	-.040	.094	.075
Intention	-.047	-.089	.181**	.088
Use of digital tools	-.040	.084	.076	-.067
Digital in sickness	.057	-.018	.066	-.059

Note. **Correlation is significant for $p < .01$.; *Correlation is significant for $p < .05$