

Digital literacy, self-efficacy, and desired support among healthcare professionals, patients, and informal caregivers: A cross-sectional study

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ABSTRACT

Objectives: Digital health technologies have potential to improve (preventive) healthcare, but not everyone benefits equally. Here, digital literacy, self-efficacy, and support appear to be important factors in the healthcare context. To support the digital transition in healthcare optimally, this study aims to identify explanatory factors of digital literacy, self-efficacy, and desired support among healthcare professionals, patients, and their informal caregivers.

Methods: A cross-sectional study was performed among healthcare professionals ($n = 1372$) and patients and their informal caregivers ($n = 539$). The survey assessed enthusiasm for digital developments, digital literacy, self-efficacy, the way people seek support (support patterns), desired support, and demographics. Multiple linear regressions identified explanatory factors for digital literacy and self-efficacy, and binomial logistic regressions examined the factors related to the support needs.

Results: Among both groups, digital literacy was explained by self-efficacy, enthusiasm, the independent support pattern, and age. Among healthcare professionals, additional factors included desired support, gender, type (e.g., nurses and paramedics), and the help-seeking support pattern. Self-efficacy was explained by digital literacy, enthusiasm, and the independent support pattern in both groups, complemented by desired support and age for professionals. Finally, support needs were explained by self-efficacy, age, and type for both groups. Among professionals, digital literacy and support patterns were also found to be explanatory. Participants expressed a preference for support from the hospital with new digital developments (56.3 % of patients/caregivers, 49.0 % of professionals), ideally through digital coaches, videos, and help desks.

Practice implications: Individuals with higher age, lower digital literacy, lower self-efficacy, and those seeking social support to solve technology-related problems may be more likely to experience support needs. To enhance accessibility, it may be especially relevant to consider support strategies for these individuals.

Conclusions: Efforts to provide adequate support could enhance digital literacy and self-efficacy, thereby contributing to self-reliance and reduced support needs.

1. Introduction

1.1. Background

Digital health technologies are transforming healthcare worldwide, bringing with them the potential to enhance patients' self-management and self-reliance [1] and to make healthcare more efficient and accurate [2–4]. These technologies were proven beneficial in various health contexts, including cancer care [5], COPD self-management [6], and palliative care [7]. Moreover, digital health technologies can facilitate

the use of health-related information sources such as Electronic Medical Records (EMRs) and patient portals, enabling both caretakers and care providers to access and share health-related information online. This allows for easier communication, independent scheduling of appointments, and access to informational and educational material and support [1,3,8]. As a result, digital health technologies are deemed to be beneficial in (preventive) healthcare.

However, not everyone is likely to benefit equally from digitalization in healthcare [5]. Vulnerable groups such as the elderly, ethnic minorities, and people with a low socio-economic position are susceptible to

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low digital inclusion [5,9,10] due to their risk of having lower digital literacy and less access to mobile devices or the Internet [10–13]. Here, lower digital literacy refers to a lower “ability to seek, find, understand, and appraise information from electronic sources and apply the knowledge gained to address or solve a problem” [12], which is referred to as digital health literacy within the digital health context. Due to reduced access and digital (health) literacy, vulnerable groups of people are less likely to use digital health technology [1,12,14], by which existing inequities in access to healthcare could be magnified [12,15]. To ensure that digital health technologies enhance access to care and reduce the digital divide, it is essential to understand the factors that influence digital health technology use and the needed support therewith.

1.2. Related work

A literature search was conducted on factors influencing the use of digital health technology in the clinical context. Here, it was found that higher digital (health) literacy increases access to and use of digital health technology [1,5,12,14,15], while higher age and lower education levels are related to lower digital health technology use [15]. Higher age and lower education levels were also found to be associated with lower digital literacy [12,15,16], which, in turn, is linked to a higher desired support [16,17].

This association was also found among clinical patients specifically, as digital literacy and support appeared to be facilitative for digital health technology use [4,18,19], with a higher age indicating a lower digital literacy [19] and a higher support need [4]. On the other hand, it was found that a lack of digital literacy and self-efficacy toward the use of digital health technology were barriers to use among hypertension patients [4], rheumatology patients [19], and Chronic Obstructive Pulmonary Disease (COPD) patients [18].

A lack of digital literacy and self-efficacy was also perceived as a barrier for use among patients' informal caregivers (i.e., friends or family who take care of a relative who is ill, disabled, or aged) [20]. Digital health technology has the potential to make their caregiving more efficient, effective, safe, and less stressful by providing access to tailored information (e.g., information about patient symptoms, medication management, health status, and procedures) and providing increased and efficient communication with healthcare professionals [21,22]. In addition, digital health technologies can offer support in addressing psychological and physical problems that informal caregivers may experience due to their continuous or prolonged caregiving. However, mainly older informal caregivers tend to have insufficient digital literacy and self-efficacy, which impedes digital health technology use and heightens their need for support [20]. Thus, given the above, it is important to facilitate use of digital health technologies among informal caregivers.

Finally, among healthcare professionals, while digital literacy appeared to be relatively high, it did vary among professional groups [13]. Van der Vaart et al. [23] found that literacy was lower among less educated and older healthcare professionals, whereas Brørs et al. [13] found that literacy varied by profession; physicians had a higher digital health literacy than other healthcare providers. Nonetheless, sufficient knowledge and skills in digital health technology could be considered a prerequisite among healthcare professionals for the digitalized healthcare system [8], with health workers ideally possessing the capabilities to deploy or use digital health technologies in their work [24], to introduce the technologies to patients [25], and to teach them related concepts and skills accordingly [8].

1.3. Objectives

While digital literacy, self-efficacy, and support appear to be particularly important for the use of digital health technology, little empirical research has investigated the factors that influence these

variables in the healthcare context. The current study aims to fill this knowledge gap by empirically investigating the explanatory factors for digital literacy (SQ1); self-efficacy towards the use of digital devices (SQ2); and support needs (SQ3) of patients and their informal caregivers and of healthcare professionals (RQ) to support the digital transition in healthcare optimally. The theoretical model is shown in Fig. 1.

2. Methods

2.1. Study design and measurements

A cross-sectional survey study (see Appendix A.1 and A.2) was performed at the Zuyderland Medical Center in the Netherlands among two groups: 1) healthcare professionals and 2) patients and informal caregivers. The survey included 25 questions for patients and informal caregivers and 27 for healthcare professionals, assessing demographics, digital technology use, enthusiasm for digital developments, support patterns, support needs, and literacy levels. These variables were deemed explanatory for digital literacy [13,16,19,20,26,27], self-efficacy [16,20,28], and support needs [4,22] based on previous literature.

2.1.1. Demographics

Age was measured using 7 categories (a higher score indicating a higher age) and was treated as a continuous variable in the correlation and regression analyses. Gender was measured as a categorical variable (1 = male; 2 = female; and 3 = other). With only 1 participant in the ‘other’ category, this participant was excluded and gender was included as a binary variable in the regression analyses (1 = male; 2 = female). Finally, the participants' role or profession was assessed with the variable ‘type’. For patients and informal caregivers: 1 = patient; 2 = informal caregiver. For healthcare professionals: 1 = nurses and paramedics; 2 = executives; 3 = medics; 4 = support staff with patient contact; and 5 = support staff without patient contact. This variable was dummy-coded with executives as the reference category.

2.1.2. Use of digital technology

In both groups, the use of smartphones or tablets, computers, and e-mail was measured by the statement ‘I use... [a computer/smartphone and/or tablet/e-mail]’. Among patients and informal caregivers, the use of social media (e.g., Facebook, Instagram, LinkedIn) was measured. All items ($n = 4$) were measured on a 4-point Likert scale ranging from ‘never’ (1) to ‘daily’ (4).

2.1.3. Enthusiasm for digital developments

This variable was assessed by the statement ‘I get excited about new digital developments in the hospital (e.g., patient portal, video calling, and chatting)’ measured on a 4-point Likert scale ranging from ‘totally disagree’ (1) to ‘totally agree’ (4).

2.1.4. Support patterns

According to Van Deursen et al. [16], people can be categorized in three groups according to the way they seek support (i.e., support patterns): social support seekers, formal support seekers, and independents. When having inadequate skills, social support seekers seek support from family and friends, formal help seekers seek support from a help desk, computer experts, or formal courses, and independents do not seek any support. In the current study, the support patterns are assessed by two separate variables. The independent support pattern was assessed by the item ‘I search for solutions myself when an activity fails me on the smartphone/tablet/computer’. The social and formal support patterns were combined into the variable ‘help-seeking support pattern’ and assessed by the item ‘I ask people for help when an activity fails me on the smartphone/tablet/computer’. Both items were measured on a 4-point Likert scale ranging from ‘never’ (1) to ‘always’ (4). The higher the rating, the more likely a person is to employ the respective support

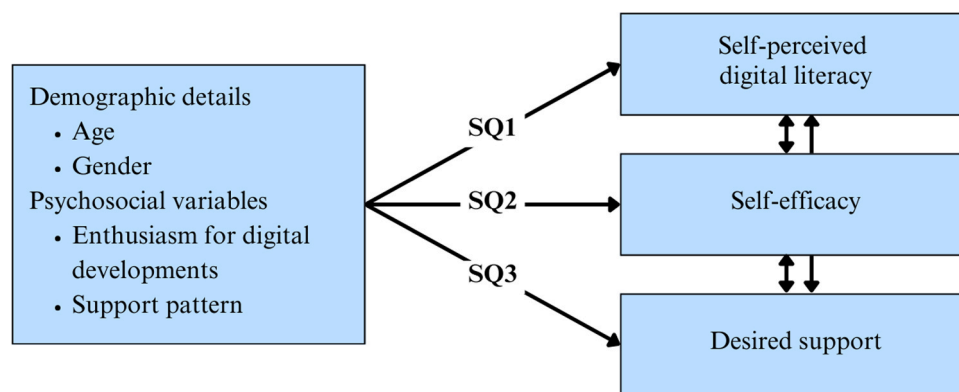


Fig. 1. Theoretical model explaining digital literacy, self-efficacy, and desired support. *Note.* The variables ‘self-perceived digital literacy,’ ‘self-efficacy,’ and ‘desired support’ are also considered independent variables in those analyses where they were not included as dependent variables. In SQ1, self-efficacy and desired support are included; in SQ2, digital literacy and desired support are included; and in SQ3, digital literacy and self-efficacy are included as independent variables.

pattern.

2.1.5. Desired support

The support need was assessed by the statement ‘I would like to get support from Zuyderland when new digital developments occur (e.g., patient portal, video calling, and chatting)’ measured on a 4-point Likert scale ranging from ‘totally disagree’ (1) to ‘totally agree’ (4). A binary scale was then created with the answer options ‘totally disagree’ and ‘disagree’ coded as 0 = ‘no support needed’ and the answer options ‘agree’ and ‘totally agree’ as 1 = ‘support needed’.

2.1.6. Digital literacy

Digital literacy was measured by one item (“I would rate myself a ... in terms of my proficiency with digital tools, such as computers, smartphones, and tablets.”) with an answer option from 1 to 10. The higher the score, the better the digital literacy.

2.1.7. Self-efficacy

The self-efficacy towards the use of digital technology was assessed by 11 statements measured on a 4-point Likert scale ranging from ‘totally disagree’ (1) to ‘totally agree’ (4). See [Appendix B](#) for the included statements for both groups. Both scales had good reliability (Cronbach $\alpha = .915$ for the patients/caregiver scale; Cronbach $\alpha = .835$ for the professionals’ scale). The higher the self-efficacy score, the higher the belief in one’s digital abilities.

2.2. Required sample size and power

Since the two-tailed multiple linear regression was the primary analysis method for the current study, this statistical method was used for the sample size calculation. Using G*Power [29], the minimum required sample size was 160 respondents, with 8 independent variables, an effect size of 0.15, an error probability of 0.05, and a power of 0.95.

2.3. Data collection and analysis

The current study is based on secondary data. The cross-sectional survey was conducted from March 28th to April 14th of 2023 by staff of the Zuyderland Medical Center. Participants were recruited using convenience sampling. Healthcare staff were approached via email by managers and the hospital’s internal website. Patients and informal caregivers were approached by the staff of the four hospital locations of the medical center (i.e., Sittard-Geleen, Heerlen, Brunssum, and Kerkrade) to fill out the questionnaire on-site either on paper or online. Furthermore, they were invited through social media (i.e., LinkedIn, Facebook, Instagram), the hospital’s website, and the monthly

newsletter to fill in the digital questionnaire (via the Analyzer software). Participants had to be 18 years or over to be included in the study.

After data collection, the dataset was anonymized and imported into SPSS [30]. Descriptive analyses were performed and correlation matrices were derived for both the patient/informal caregiver and for the professional group to gain insight into the univariate correlations between measured concepts. Next, four multiple linear regressions (with pairwise deletion and enter-method) were performed to identify the factors associated with digital literacy (SQ1) and self-efficacy (SQ2) for the healthcare professional and patient/caregiver groups separately. For this purpose, all variables were standardized using z-scores. Missing data were handled through pairwise deletion. The first regression model consisted of 8 independent variables (i.e., gender, age, type, self-efficacy, enthusiasm for digital developments, independent support pattern, help-seeking support pattern, and desired support) with digital literacy as the dependent variable. The second regression model consisted of 8 independent variables (i.e., gender, age, type, digital literacy, enthusiasm for digital developments, independent support pattern, help-seeking support pattern, and desired support) with self-efficacy as the dependent variable. To answer SQ3, two logistic regressions were performed to identify the factors associated with the desired support for the two groups. This regression model consisted of 7 independent variables (i.e., gender, age, type, self-efficacy, digital literacy, independent support pattern, and the help-seeking support pattern) with desired support as the dependent variable. The study was reported in accordance with the CROSS checklist [31].

3. Results

3.1. Sample description

The survey was filled in by 569 patients and informal caregivers and 1381 healthcare professionals. However, 32 surveys were incomplete and 7 participants were under 18 years old. Thus, a total of 1911 respondents were included: 539 patients and informal caregivers (28.2 %) and 1372 healthcare professionals (71.8 %). An overview is given in [Table 1](#).

Of the healthcare professionals, 6.0 % were executives, 30.4 % were nurses and paramedics, 4.7 % were medics, 12.0 % were support staff with patient contact, 21.6 % were support staff without patient contact, and 25.2 % held other functions. Of the patients and informal caregivers, 83.9 % were patients and 16.1 % were caregivers. Most patients and informal caregivers were between 66 and 75 years old, while most healthcare professionals were between 56 and 65. In both groups, there were predominantly female participants. Among the participants, there was relatively high digital literacy and use of digital devices and media; over 92 percent of the patients and informal caregivers and over 98

Table 1

Overview of participants' demographics, use of digital technology, digital proficiency, and support need.

	Patients and informal caregivers	Healthcare professionals
Age		
18–25 years	7 (1.3 %)	93 (6.8 %)
26–35 years	22 (4.1 %)	210 (15.3 %)
36–45 years	27 (5.0 %)	232 (16.9 %)
46–55 years	63 (11.7 %)	377 (27.5 %)
56–65 years	126 (23.4 %)	451 (32.9 %)
66–75 years	180 (33.5 %)	7 (0.5 %)
76 years and over	113 (21.0 %)	2 (0.2 %)
Gender		
Male	215 (39.9 %)	296 (21.6 %)
Female	323 (59.9 %)	1072 (78.1 %)
Other	1 (0.2 %)	4 (0.3 %)
Use of smartphone and/or tablet		
Never or monthly	42 (7.8 %)	20 (1.5 %)
Weekly or daily	497 (92.2 %)	1352 (98.6 %)
Use of computer		
Never or monthly	122 (22.6 %)	12 (0.8 %)
Weekly or daily	417 (77.4 %)	1360 (99.2 %)
Use of social media		
Never or monthly	158 (30.7 %)	N/A ^a
Weekly or daily	356 (69.3 %)	N/A ¹
Use of e-mail		
Never or monthly	42 (8.0 %)	12 (0.9 %)
Weekly or daily	479 (91.9 %)	1343 (99.1 %)
Digital literacy (1–10 scale)	<i>M</i> 6.94 (<i>SD</i> 1.75)	<i>M</i> 7.51 (<i>SD</i> 1.22)
Self-efficacy (1–4 scale)	<i>M</i> 3.50 (<i>SD</i> .56)	<i>M</i> 3.78 (<i>SD</i> .35)
Desired support (1–4 scale)	<i>M</i> 2.54 (<i>SD</i> .89)	<i>M</i> 2.41 (<i>SD</i> .82)

^a The use of social media was not surveyed among healthcare professionals.

percent of the healthcare professionals regularly use a smartphone and/or tablet. For the use of a computer, this was over 77 and 99 percent respectively.

3.2. Correlations between the independent and dependent variables

Pearson correlations were calculated for the two groups separately (patients/informal caregivers and healthcare professionals) between the independent variables and the dependent variables *digital literacy*, *self-efficacy*, and *desired support*. Table 2 shows all correlations. For the patients and informal caregivers, there was a strong and positive

Table 2

Pearson (R_s) correlations.

Patients and informal caregivers	1	2	3	4	5	6	7	8
1 Self-efficacy patients and informal caregivers								
2 Self-perceived digital literacy	,667**							
3 Desired support	-,277**	-,178**						
4 Enthusiasm for digital developments	,524**	,581**	-,092*					
5 Independent support pattern	,620**	,593**	-,165**	,476**				
6 Help-seeking support pattern	-,085	-,116**	,103*	-,093*	-,096*			
7 Age	-,200**	-,337**	,211**	-,172**	-,239**	,023		
8 Gender	-,037	-,077	-,055	-,106*	-,132**	,067	-,252**	
Healthcare professionals	1	2	3	4	5	6	7	8
1 Self-efficacy healthcare professionals								
2 Self-perceived digital literacy	,549**							
3 Desired support	-,241**	-,258**						
4 Enthusiasm for digital developments	,476**	,495**	-,172**					
5 Independent support pattern	,543**	,571**	-,240**	,447**				
6 Help-seeking support pattern	-,104**	-,129**	,133**	-,031	-,074**			
7 Age	-,301**	-,389**	,173**	-,240**	-,320**	-,034		
8 Gender	-,110**	-,210**	,042	-,123**	,167**	,091**	,031	

** Correlation is significant at the 0.01 level.

* Correlation is significant at the 0.05 level.

significant correlation between the independent variables *enthusiasm for digital developments* and *independent support pattern* with the dependent variables *digital literacy* and *self-efficacy*. For the healthcare professionals, there was a strong and positive significant correlation between the independent variable *independent support pattern* and the dependent variables *digital literacy* and *self-efficacy*.

3.3. Factors explanatory of digital literacy, self-efficacy, and support needs

Two multiple linear regressions were run for the two groups separately, respectively patients and informal caregivers and healthcare professionals, to understand the associations of demographic and psychosocial variables with the digital literacy (overview in Table 3). The regression model significantly explained the digital literacy of patients

Table 3

Results of the multiple linear regression explaining digital literacy.

	<i>B</i>	<i>SE B</i>	β	<i>p</i>	Adjusted R^2
Regression 1: Patients and informal caregivers (<i>n</i> = 416)					51.7 %
Self-efficacy of patients and caregivers	,377	,044	,408	< .001	
Enthusiasm for digital developments	,171	,038	,186	< .001	
Independent support pattern	,165	,041	,183	< .001	
Age	-,085	,025	-,126	< .001	
Regression 2: Healthcare professionals (<i>n</i> = 1322)					49.3 %
Self-efficacy of healthcare professionals	,186	,021	,217	< .001	
Enthusiasm for digital developments	,186	,021	,204	< .001	
Desired support	-,068	,019	-,078	< .001	
Independent support pattern	,249	,025	,252	< .001	
Help-seeking support pattern	-,054	,017	-,061	,002	
Gender ^a	-,220	,042	-,106	< .001	
Age	-,131	,015	-,195	< .001	
Type					
Nurses and paramedics	-,119	,044	-,064	,007	
Medics	-,186	,083	-,047	,026	

Note. Model = 'Enter' method in SPSS Statistics; *B* = unstandardized regression coefficient; *SE B* = standard error of the coefficient; β = standardized coefficient.

^a Binary variable with 1 = male and 2 = female.

and informal caregivers ($F(8, 407) = 56.422, p < .001$) and healthcare professionals ($F(11,1310) = 117.827, p < .001$), accounting for respectively 51.7 % and 49.3 % of the variation (adjusted R^2). Explanatory for the digital literacy of patients and informal caregivers were *self-efficacy* ($B = .377, p < .001$), *enthusiasm for digital developments* ($B = .171, p < .001$), the *independent support pattern* ($B = .165, p < .001$), and *age* ($B = -.085, p < .001$). Likewise, explanatory for the digital literacy of healthcare professionals were *self-efficacy* ($B = .186, p < .001$), *enthusiasm for digital developments* ($B = .186, p < .001$), the *independent support pattern* ($B = .249, p < .001$), and *age* ($B = -.131, p < .001$). Additionally, for the healthcare professionals, *gender* ($B = -.220, p < .001$), *desired support* ($B = -.068, p < .001$), the *help-seeking support pattern* ($B = -.054, p = .002$), and *type* (nurses and paramedics $B = -.119, p = .007$; medics $B = -.186, p = .026$) were found to be explanatory.

Next, two multiple linear regressions were run for the two groups to understand the associations with self-efficacy (overview in Table 4). The regression model significantly explained the self-efficacy of patients and informal caregivers ($F(8, 407) = 64.548, p < .001$) and healthcare professionals ($F(11,1310) = 86.426, p < .001$), accounting for 55.1 % and 41.6 % of the variation (adjusted R^2) in self-efficacy respectively. Explanatory for the self-efficacy of patients and informal caregivers were *digital literacy* ($B = .411, p < .001$), *enthusiasm for digital developments* ($B = 0.182, p < .001$), and the *independent support pattern* ($B = .301, p < .001$). In line with this, explanatory for the self-efficacy of healthcare professionals were *digital literacy* ($B = .293, p < .001$), *enthusiasm for digital developments* ($B = .215, p < .001$), and the *independent support pattern* ($B = .319, p < .001$). Moreover, *age* ($B = -.046, p = .016$) and *desired support* ($B = -.064, p = .006$) were found to be explanatory.

Two binomial logistic regressions were run to ascertain the explanatory value of demographic and psychosocial variables on support needs (overview in Table 5). The final regression models of patients and informal caregivers ($\chi^2(7) = 62.334, p < .001$) and healthcare professionals ($\chi^2(10) = 150.519, p < .001$) were statistically significant, explaining 18.6 % and 14.4 % of the variance (Nagelkerke R^2) in desired support. The final model correctly classified 68.8 % and 63.1 % of cases respectively.

For patients and informal caregivers, *age* ($B = .303, p < .001$), *self-efficacy* ($B = -.671, p = .021$), and *type* ($B = .656, p = .029$) appeared to be a statistically significant explanatory factor. A higher self-efficacy and a lower age resulted in a lower likelihood of having a higher desire for support. Moreover, informal caregivers appeared to be more likely to desire support. For healthcare professionals, all explanatory variables except for *gender* were statistically significant. Medics were more likely to have higher support needs than the executives reference

Table 4
Significant factors in the multiple linear regression explaining the self-efficacy.

	<i>B</i>	<i>SE B</i>	β	<i>p</i>	Adjusted R^2
Regression 1: Patients and informal caregivers (<i>n</i> = 416)					55.1 %
Digital literacy	.411	.048	.379	< .001	
Enthusiasm for digital developments	.182	.039	.183	< .001	
Independent support pattern	.301	.041	.307	< .001	
Regression 2: Healthcare professionals (<i>n</i> = 1322)					41.6 %
Digital literacy	.293	.034	.251	< .001	
Enthusiasm for digital developments	.215	.027	.201	< .001	
Independent support pattern	.319	.031	.276	< .001	
Desired support	-.064	.023	-.063	.006	
Age	-.046	.019	-.058	.016	

Note. Model = 'Enter' method in SPSS Statistics; *B* = unstandardized regression coefficient; *SE B* = standard error of the coefficient; β = standardized coefficient.

Table 5

Significant factors in the binomial logistic regression explaining the desired support.

	<i>B</i>	<i>SE B</i>	<i>p</i>	Odds ratio	95 % CI for Odds Ratio	
					Lower	Upper
Regression 1: Patients and informal caregivers^a (<i>n</i> = 416)						
Age	.303	.087	< .001	1.354	1.141	1.606
Self-efficacy of patients and caregivers	-.671	.291	.021	.511	.289	.904
Type ^c	.656	.301	.029	1.927	1.069	3.474
Regression 2: Healthcare professionals^b (<i>n</i> = 1322)						
Age	.139	.052	.008	1.149	1.038	1.271
Self-efficacy of healthcare professionals	-.669	.225	.003	.512	.329	.797
Digital literacy	-.185	.066	.005	.831	.729	.946
Independent support pattern	-.254	.089	.004	.775	.652	.922
Help-seeking support pattern	.259	.061	< .001	1.296	1.150	1.460
Type						
Medics	.757	.293	.010	2.131	1.200	3.784

Note. *B* = unstandardized regression coefficient; *SE B* = standard error of the coefficient.

^a Sensitivity was 74.1 %, and specificity was 62.5 %.

^b Sensitivity was 57.6 %, and specificity was 68.4 %.

^c Binary variable with 1 = patient; 2 = informal caregiver.

group ($B = .757, p = .010$). On the other hand, being younger ($B = .139, p = .008$) and higher scores on digital literacy ($B = -.185, p = .005$) and self-efficacy ($B = -.669, p = .003$) resulted in a lower likelihood of having a desire for support. In addition, people looking for solutions themselves are less likely to desire help ($B = -.254, p = .004$), whereas people who ask others for help are more likely to desire help with digital developments ($B = .259, p < .001$).

3.4. Support to facilitate the use of digital health technology

Hospital support for new digital developments was desired by 56.3 % of patients and caregivers and 49.0 % of healthcare professionals. Participants mostly preferred support through a digital coach (19.3 % of patients/ caregivers, 21.0 % of professionals). An educational video was also appreciated by patients and informal caregivers (15.6 %) as well as healthcare professionals (18.7 %). Patients and informal caregivers also prefer support through written information (19.7 %) and a physical help desk (18.6 %). Healthcare professionals, on the other hand, desire online training (20.6 %) and a telephone help desk (20.8 %). For healthcare professionals, the information desk at the hospital was the least preferred option (5.5 %), whereas the least preferred option for patients and caregivers was training - either in a group (4.8 %) or online (6.7 %).

4. Discussion and conclusion

4.1. Discussion

This study provided insight into the demographic and psychosocial factors that influence digital literacy, self-efficacy, and support needs of both caretakers and caregivers with the use of digital health technology.

4.1.1. Demographic variables

Age explained lower digital literacy and self-efficacy and higher support needs, supporting earlier findings [13,19,22,28,29]. Among professionals, gender was also explanatory: male healthcare professionals were more likely to have higher digital literacy than female professionals (in line with previous literature [13]). Further, nurses, paramedics, and medics were more likely to have lower digital literacy

compared to executives. According to Brørs et al. [13], higher digital literacy was associated with higher education level, which might partly explain the difference we have found. Notably, medics were also more likely to have higher support needs relative to executives. Possibly, nurses and (para)medics receive less digital skills training and may have fewer opportunities to develop digital literacy through their focus on patient care [32,33]. Executives and support staff, on the other hand, might be more likely to use technology in strategic or administrative contexts, which may contribute to higher digital literacy. Next, informal caregivers appeared to be more likely to have higher support needs than patients. Zhang and Bennett [34] found that providing informal care is associated with lower psychological well-being due to the responsibilities, which may increase the need for support from the hospital with new digital developments.

4.1.2. Psychosocial variables

In line with the proposed research model, enthusiasm for digital developments was associated with digital literacy and self-efficacy for both groups. Here, a strong positive interrelationship has been revealed between self-efficacy, digital literacy, and enthusiasm for digital developments (see also correlation matrix in Table 2). Such a relationship was also found by Peng et al. [35], with greater enthusiasm for digital advancements and self-efficacy enhancing digital literacy. Additionally, Dallora et al. [28] found a positive association between both digital health literacy and self-efficacy with enthusiasm for technology, with higher digital health literacy and self-efficacy indicating greater enthusiasm toward technologies, confirming the results of the current study. These findings suggest that interventions should not only focus on users' skills, but also on their confidence and motivation. Moreover, support patterns appeared to be an important psychosocial explanatory variable. People who tend to seek solutions themselves (i.e., independent support pattern) had higher digital literacy and self-efficacy, and lower support needs. Professionals with a help-seeking support pattern had lower digital literacy and higher support needs. Herewith, the results of the current study give indications that support is important not only for patients but for caregivers as well, with an important emphasis on providing adequate support for people who cannot solve technology-related problems independently.

4.1.3. Limitations and future research

This study entails three limitations that should be taken into consideration when interpreting and valuing the research findings. They also provide indications for follow-up studies. First, based on previous research [12,29,36], a relationship between education level and digital literacy could be expected. Moreover, based on the extended UTAUT model [37] and previous studies [3,38], there is also expected to be an influence of motivation (to cope and to avoid discomfort) on the chosen support and the use of digital health technologies. However, as the study relied on secondary data, no information was available on educational attainment or motivation. A follow-up study to address the influence of educational attainment and motivation is therefore recommended. Ideally, this might also increase the explanatory power of the final model explaining desired support. Second, questionnaire validity may not have been optimal. The questionnaire was developed by the hospital and to a limited extent based on scientific sources from the health psychology field. As a result, items did not always align optimally with the concepts being measured. For future research, it is recommended to measure the concepts with more items and validated questionnaires to increase their validity. Third, the cross-sectional nature of this study precludes causal relationships, requiring a cautious interpretation of the results. It is recommended to conduct a longitudinal follow-up study to gain insight into the cause-and-effect relationships.

4.2. Conclusion

Both demographic and psychosocial factors were found to be

associated with digital proficiency and support needs in clinical context. Enthusiasm for digital developments and support patterns were strongly linked to digital literacy and self-efficacy for both groups. Moreover, people who tend to seek solutions themselves were found to have higher digital literacy, self-efficacy, and lower support needs. In making digital health technology more accessible, attention should be paid to people with a higher age, lower digital literacy, and lower self-efficacy, with an important emphasis on providing adequate support for people who cannot solve technology-related problems independently. Interventions such as a digital coach, educational videos, and a help desk (phone for professionals, physical for patients and informal caregivers) could increase digital skills and self-efficacy, thereby increasing self-reliance and decreasing support needs.

4.3. Practice implications

The study suggests that several groups may be more likely to experience support needs, including individuals with a higher age, those with lower digital literacy and self-efficacy, medics, and those with a help-seeking support pattern. These groups may be more vulnerable in the context of the adoption and use of digital health technology. To enhance accessibility, it may be especially relevant to consider support strategies for these individuals. As recommended by Pourrazavi et al. [39], this could include training, the use of videos and images, social support, and motivation of older adults, which may, in turn, induce self-efficacy and digital health literacy. Based on our findings, a combination of a digital coach, educational videos, and help desks (phone for professionals, physical for patients/caregivers) would be appropriate for both patients and informal caregivers and the healthcare professional group. Over time, this could increase digital skills and self-efficacy, thereby contributing to self-reliance and reduced support needs. Nevertheless, the organizational readiness to implement support infrastructure, time and resource constraints among healthcare professionals, and the diversity of user preferences and help-seeking behavior should also be considered. Future research is recommended to explore these practical and systemic conditions to inform sustainable implementation.

CRedit authorship contribution statement

T.M. Hengst: Writing – original draft, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **C. Boumans:** Writing – review & editing, Resources. **L. Lechner:** Writing – review & editing, Supervision, Methodology, Conceptualization. **C.A.W. Bolman:** Writing – review & editing, Validation, Supervision, Methodology, Conceptualization.

Ethics statement

This study was registered in OSF (<https://doi.org/10.17605/OSF.IO/94FVR>). The study was conducted according to the Ethical Principles of Psychologists and Code of Conduct [40].

Conflicts of interest

TMH, LL, CB, and CAWB declare that there is no conflict of interest with respect to the research, authorship, and/or publication of this article.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A.1. Survey for patients and informal caregivers

1. Gender (male/female/other)
2. Age (0–18; 18–25; 26–35; 36–45; 46–55; 56–65; 66–75; 76–85; 86–96; 96 and over)
3. I visit the hospital as (patient, informal caregiver, visitor)
4. I would rate myself ... when it comes to using digital tools (e.g. computer, smartphone, tablet) (1–10)
5. I use a computer (never/monthly/weekly/daily)
6. I use a smartphone and/or tablet (never/monthly/weekly/daily)
7. I manage to download and use an app on my smartphone and/or tablet (never/sometimes/often/always)
8. I manage to use a touchscreen (never/sometimes/often/always)
9. I can open the Zuyderland website (never/sometimes/often/always)
10. I manage to fill in a digital form/questionnaire (never/sometimes/often/always)
11. I can make a video call (e.g. Facetime, Whatsapp video, Zoom, Skype) (never/sometimes/often/always)
12. I am able to chat (e.g. WhatsApp, service desk on a website) (never/sometimes/often/always)
13. I use email (never/monthly/weekly/daily)
14. I manage to open a link from an email (never/sometimes/often/always)
15. I manage to log in to the patient portal 'Mijn Zuyderland' with my DigiD (or in the portal of my health insurer or tax authority) (never/sometimes/often/always)
16. I manage to look up the information I need in the patient portal (or in the portal of my health insurer or tax authority) (never/sometimes/often/always)
17. I manage to open a link from a text message (phone) (never/sometimes/often/always)
18. I use social media (e.g., Facebook, Instagram, LinkedIn) (never/monthly/weekly/daily)
19. I am able to scan a QR code (never/sometimes/often/always)
20. I look for solutions myself if an activity fails me on the smartphone/tablet/computer (never/sometimes/often/always)
21. I ask people for help if an activity fails me on the smartphone/tablet/computer (never/sometimes/often/always)
22. I get enthusiastic with new digital developments in the hospital (e.g., patient portal, video calls, and chat) (completely disagree/disagree/agree/completely agree)
23. I would like to receive support from Zuyderland with new digital developments (e.g., patient portal, video calls, and chat) (completely disagree/disagree/agree/completely agree)
24. I would like to receive support by... (information meetings/physical help desk at Zuyderland/telephone helpdesk/chat/educational video/information via social media/written information/digital coach/training with a group/online training/other, namely)
25. Do you have another tip or comment?

Appendix A.2. For healthcare professionals

1. Gender (male/female/other)
2. Age (0–18; 18–25; 26–35; 36–45; 46–55; 56–65; 66–75; 76 and over)
3. Department¹ (list of 102 departments, e.g., board affairs/oncology/cardiology/finance/intensive care)
4. Function² (list of 13 functions, e.g., manager/nurse/medical specialist/faculty assistant/intern/other, namely)
5. I would rate myself ... when it comes to using digital tools (e.g. computer, smartphone, tablet) (1–10)
6. I use a computer (never/monthly/weekly/daily)
7. I use a smartphone and/or tablet (never/monthly/weekly/daily)
8. I manage to download and use an app on my smartphone and/or tablet (never/sometimes/often/always)
9. I manage to use a touchscreen (never/sometimes/often/always)
10. I manage to open a link from a text message (phone) (never/sometimes/often/always)
11. I can make a video call (e.g. FaceTime, WhatsApp video, MS Teams, Skype) (never/sometimes/often/always)
12. I am able to scan a QR code (never/sometimes/often/always)
13. I can open a website on the Internet (never/sometimes/often/always)
14. I manage to fill in a digital form/questionnaire (never/sometimes/often/always)
15. I manage to access my pay slip (never/sometimes/often/always)
16. I manage to claim any expenses (never/sometimes/often/always)
17. I manage to look up the information I need in my work, such as:
 - a. Phone number of colleagues, (never/sometimes/often/always)
 - b. Protocols and procedures, (never/sometimes/often/always/N/A)
 - c. Information about my patient (EPD) (never/sometimes/often/always/N/A)
18. I use email (never/monthly/weekly/daily)
19. I manage to add an attachment to an email (never/sometimes/often/always)

¹ To ensure the anonymity of the data, data from question 3 was completely omitted from the shared dataset.

² To ensure the anonymity of the data, data from question 4 was categorized into the following functions: nurses and paramedics; executives; medics; support staff with patient contact; and support staff without patient contact.

20. I look for solutions myself if an activity fails me on the smartphone/tablet/computer (never/sometimes/often/always)
21. I ask colleagues for help if an activity fails me on the smartphone/tablet/computer (never/sometimes/often/always)
22. I avoid digital activities that I find difficult and/or do not master (never/sometimes/often/always)
23. I get enthusiastic with new digital developments in the hospital (e.g., patient portal, video calls, and chat) (completely disagree/disagree/agree/completely agree)
24. Digital developments make my work easier, faster and delivers better patient care (completely disagree/disagree/agree/completely agree)
25. I would like to receive support from Zuyderland with new digital developments (e.g., patient portal, video calls, and chat) (completely disagree/disagree/agree/completely agree)
26. I would like to receive support by... (information meetings/physical help desk at Zuyderland/telephone helpdesk/chat/educational video/information via social media/written information/digital coach/training with a group/online training/other, namely)
27. Do you have another tip or comment?

Appendix B. Operationalization of the dependent variables

Variable	Items	Scale
Digital literacy	I would rate myself a ... in terms of my proficiency with digital tools, such as computers, smartphones, and tablets.	Rating from 1 to 10
Self-efficacy of patients and caregivers (α .915)	I am able to download and use an app on my smartphone and/or tablet I am able to use a touchscreen I can open the Zuyderland website I can fill in a digital form/questionnaire I am able to video call (for example: Facetime, WhatsApp video, Zoom, Skype) I am able to chat (for example: WhatsApp, customer service on a website) I am able to open a link from an email I am able to log in to the patient portal 'My Zuyderland' with my DigiD (or to the portal of my health insurer or Dutch tax authority) I am able to search for the information I need in the patient portal (or in the portal of my health insurer or Dutch tax authority) I am able to open a link from an SMS (on phone) I am able to scan a QR code	4-point Likert scale ranging from 'totally disagree' (1) to 'totally agree' (4)
Self-efficacy of healthcare professionals (α .835)	I am able to download and use an app on my smartphone and/or tablet I am able to use a touchscreen I am able to open a link from an SMS (on phone) I am able to video call (for example: Facetime, WhatsApp video, MS Teams, Skype) I am able to scan a QR code I am able to open an Internet page I can fill in a digital form/questionnaire I am able to search for the information I need in my job such as colleagues' phone numbers I am able to search for the information I need in my job such as protocols and procedures I am able to search for the information I need in my job such as information about my patient (EPR) I am able to add an attachment to an email	4-point Likert scale ranging from 'totally disagree' (1) to 'totally agree' (4)
Desired support	I would like to get support from Zuyderland [hospital] if new digital developments occur (e.g., patient portal, video calling, and chatting)	4-point Likert scale ranging from 'totally disagree' (1) to 'totally agree' (4)

Data availability

Data was collected by the Zuyderland Medical Center. The data that support the findings of this study are therefore available from the Zuyderland Medical Center. Restrictions apply to the availability of these data, which were used under license for this study.

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