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Article

Promoting Self-Management and Independent Living of Elders with Chronic Diseases through Technology: A Study of Self-Reported Needs, Priorities, and Preferences

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Abstract: *Background and Objectives*: Elders' needs are rarely examined beforehand, and thus, although technology-based tools can enhance self-management, acceptability rates are still low. This study aimed to examine and compare self-reported needs, priorities, and preferences of elders with heart failure (HF), diabetes mellitus (DM), and chronic obstructive pulmonary disease (COPD) toward technology use to enhance self-management. *Materials and Methods*: A convenience sample of 473 participants over 60s (60.5% females), diagnosed with HF (N=156), DM (N=164), or COPD (N=153) was recruited. They were administered a questionnaire about the usefulness of technology in general and in specific areas of disease management. *Results*: Most participants (84.7%) admitted that technology is needed for better disease management. This was equally recognized across the three groups both for the overall and specific areas of disease management (in order of priority: 'Information', 'Communication with Physicians & Caregivers', and 'Quality of Life & Wellbeing'). Sociodemographic differences were found. Cell phones and PCs were the devices of preference. The four common features prioritized by all three groups were related to 'information about disease management' (i.e., monitoring symptoms, reminders for medication intake, management and prevention of complications), whereas the fifth one was related to 'communication with physicians and caregivers (i.e., in case of abnormal or critical signs). The top disease-specific feature was also monitoring systems (of respiratory rate or blood sugar or blood pressure, oxygen), whereas other disease-specific features followed (i.e., maintaining normal weight for HF patients, adjusting insulin dose for DM patients, and training on breathing exercises for COPD patients). *Conclusions*: Elders in these three samples seem receptive to technology in disease management. mHealth tools, incorporating both common and disease-specific features and addressing different chronic patients, and being personalized at the same time, could be cost-saving and useful adjuncts in routine clinical care to improve self-management.

Keywords: chronic non-communicable diseases; disease management; digital health technologies; technology-based applications; mHealth; mobile apps

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1. Introduction

Health prevention and promotion of the elderly are the most important public health challenges that Western societies will have to face in the coming years. Alongside the growing life expectancy, the incidence and prevalence of chronic non-communicable diseases (CNCD; e.g., cardiovascular diseases, chronic respiratory diseases, and diabetes mellitus) are reaching an epidemic level with 71% of deaths each year [1]. The increasing numbers of CNCDs compromise people's productivity and quality of life, result in steadily increasing healthcare utilization and, therefore, excessive national healthcare expenditures [2].

Self-management (e.g., disease monitoring, medication intake, decision-making, lifestyle modifications) [3] enhances patients' autonomy and sense of control over the disease and is considered one of the most important factors in ensuring health prevention and promotion. It is associated with adherence to therapy, reduction in hospitalizations, decreased healthcare costs, improved health outcomes, and quality of life [1, 4]. Yet, actively engaging chronic patients in self-management has been difficult [5]. Digital health technologies (DHT), such as web-based solutions, eHealth, and mHealth (i.e., mobile apps), are promising, patient-centered, and cost-effective tools that offer the possibility of self-management of CNCDs (e.g., improve disease monitoring, increase adherence, promote healthy lifestyles, and improve health-related behaviors) [6]. DHT has been associated with improved quality, accessibility, cost, and efficiency of healthcare, such as reductions in mortality rates, hospitalizations, and readmissions [7], along with substantial improvements in independent living, adherence, and quality of life [8].

In spite of the fact that the unprecedented speed of proliferation and availability of DHT has made them abound nowadays, and relevant studies have suggested DHT be a useful facilitator in the prevention or management of CNCDs, particularly in the elderly [9], acceptance and adoption rates remain relatively low among the elderly [10]. The studies on the effectiveness of DHT in self-management have been limited [11] and, though promising [12] have not yet provided convincing evidence, and results are rather mixed and inconsistent [13-15]. Old age is intertwined with features such as low health literacy, and limited smartphone experience [16-18], and older people typically have low adherence, low eHealth use [13, 19], and low commitment levels. Though reluctantly curious, they have also been shown to be ambivalent towards e-health [20].

Understanding and accounting for older people's needs and preferences in the development of a mHealth tool prior to its design could potentially enhance DHT benefits by increasing acceptance, commitment, and clinical outcomes [21, 22]. However, research on patients' needs has been lacking and it typically focuses either on specific diseases or on other age groups than the elderly [23]. Studies mainly examine features and effectiveness (feasibility and usability, and health outcomes) of mHealth tools [24-26] once they have been designed and used [15] and barriers and facilitators in using apps (intention, acceptance), such as the characteristics of a device (e.g., user-friendly interface, intriguing features) [10, 27], and very few have examined elderly patients' attitudes, beliefs, experiences, and expectations towards e-health services as factors influencing commitment to such tools. [20]. Elders' self-reported needs are rarely addressed or prioritized in the design or implementation phases of DHT and few applications have been evidence-based such as need analysis studies [28].

Therefore, the purpose of this study was to examine self-reported needs, priorities, and preferences of elders suffering from chronic diseases toward technology use to enhance autonomy in disease management, and also explore potential differences between three chronic diseases (i.e., heart failure, diabetes mellitus, and chronic obstructive pulmonary disease).

2. Materials and Methods

This study was conducted within the framework of the project entitled 'Empowered: An Integrated, intelligent assistant to support independent living for the elderly', funded by the action RESEARCH-CREATE-INNOVATE Operational Programme Competitiveness, Entrepreneurship, and Innovation (ESPA 2014-2020) (EPAnEK) (Ref. No 5070922/29-9-2020).

2.1. *Study Design and Participants*

This is a cross-sectional study, conducted from May until July 2022. Eligibility criteria were people (1) primarily diagnosed with at least one of the following diseases: heart failure (HF), diabetes mellitus (DM), or chronic obstructive pulmonary disease (COPD) and (2) aged over 60 years old. A sample of 473 people diagnosed with either heart failure (N=156, 33.0%) diabetes mellitus (N=164, 34.7%), or chronic obstructive pulmonary disease (N=153, 32.3%) participated in the study. They were mostly females (60.5%), 71-80 years old (33.4%), single or divorced (52.9%), unemployed (59.4%), and had elementary education (35.1%). The detailed socio-demographics of the three samples can be found in Table 1.

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Table 1. Sociodemographic characteristics of the three samples.

		Total sample (N=473)		Heart failure (N=156)		Diabetes mellitus (N=164)		Chronic obstructive pulmonary disease (N=153)	
		n	%	n	%	n	%	n	%
Gender	*Male / Female*	187 / 286	39.5 / 60.5	63/93	40.4/59.6	67/97	40.9/59.1	57/96	37.3/62.7
Age (years)	*60-70*	147	31.1	56	35.9	51	31.1	40	26.1
	71-80	158	33.4	50	32.1	57	34.8	51	33.3
	81-90	133	28.1	43	27.5	44	26.8	46	30.1
	>90	35	7.4	7	4.5	12	7.3	16	10.5
Family status	*Married, Cohabited*	223	47.1	83	53.2	74	45.1	66	43.1
	Single, Divorced	250	52.9	73	46.8	90	54.9	87	56.9
Education	*Up to Elementary*	166	35.1	54	34.6	56	34.1	56	36.6
	Junior high school	120	25.4	31	19.9	43	26.2	46	30.1
	High school	83	17.5	31	19.9	31	18.9	21	13.7
	University / College	82	17.3	32	20.5	28	17.1	22	14.4
	Postgraduate studies	22	4.7	8	5.1	6	3.7	8	5.2
Financial situation	*Bad*	40	8.5	9	5.8	18	11.0	13	8.5
	Moderate	224	47.4	74	47.4	68	41.5	82	53.6
	Good/Very Good	209	44.2	73	46.8	78	47.6	58	37.9
Employment (yes)		192	40.6	66	42.3	67	40.9	59	38.6
Disease	*Heart failure*	156	33.0	144	30.4				
	Diabetes mellitus	164	34.7	22	4.7	145	30.7		
	Chronic obstructive pulmonary disease	153	32.3	10	2.1	26	5.5	126	26.6
Perceived self-ability / Self-management	*Not at all*	51	10.8	18	11.6	20	12.2	13	8.5
	Moderately	203	42.9	62	39.7	67	40.8	74	48.4
	Very much	219	46.3	76	48.7	77	47.0	66	43.1
Need for support	*Not at all*	167	35.3	50	32.1	58	35.4	59	38.6
	Moderately	143	30.2	49	31.4	51	31.1	43	28.1
	Very much	163	34.5	57	36.5	55	33.5	51	33.3
Need for technology	*Not at all*	74	15.6	22	14.1	23	14.0	29	19.0
	Moderately	142	30.0	51	32.7	55	33.5	36	23.5
	Very much	257	54.4	83	53.2	86	52.5	88	57.5

2.2. Instrument

A questionnaire was developed by the researchers, which included two sections that were common among the three groups of patients: 10 socio-demographic questions and 21 questions, allocated in three subgroups, about patients' views on the extent that the use of technology could be useful in various aspects of disease management: *quality of life/well-being* (8 questions, such as dealing with stress and depression, reminders for health-enhancing behaviors, such as exercise, diet, medical appointments, positive reinforcement for achieving disease improvement goals); *information & disease management* (7 questions, such as monitoring of current health status, reminders to take medication, prevention, and management of disease-related complications); *communication with physicians and caregivers* (6 questions, such as warning and caregiver notification when necessary or immediate medical attention is required). Additionally, a third section was selectively administered to the patients, depending on their disease, to record their views on whether technology use can help various aspects of the disease-specific management: heart failure patients (4 questions; e.g., maintain a normal weight, monitor respiratory rate), diabetes mellitus patients (7 questions; e.g., monitoring of vision, blood sugar, blood pressure, cholesterol levels, adjustment of insulin dose), and chronic obstructive pulmonary disease patients (10 questions; e.g., increase fluid intake, coping with shortness of breath, use of monitoring devices for blood pressure, oxygen, etc). A five-point Likert-type scale, ranging from 'not at all' to 'very much', was used to rate responses.

2.3. Procedure

A convenience sampling method was used for data collection since researchers had access to potential participants. The questionnaire was administered through interviews or individually using a paper-and-pencil form of the questionnaire. The mean time to complete the questionnaires was approximately 15 min. There was no compensation

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for participating in the study. Ethics and confidentiality were assured throughout the study process. The study was conducted in accordance with the Declaration of Helsinki and approved by the Hellenic Mediterranean University Ref. No. of approval 74/θ.21/18.11/2020).

2.4. Statistical Analysis

Statistical analysis was conducted using IBM SPSS Statistics for Windows, v.26.0, Armonk, NY: IBM Corp.). Self-management of the disease was assessed with three questions: the perceived ability of self-management, the need for support on disease management, and the need for technology to better disease management. The usefulness of technology was assessed in three areas of disease management: Quality of Life/Well-being (8 items), Information & Disease Management (78 items), and Communication with Physicians and Caregivers (6 items). For the comparison of frequency distributions, the 95% confidence intervals (95% CI) were calculated respectively, while the differences in response distributions in the aspects of disease management (i.e., Quality of Life & Well-Being, Information & Management of the Disease, and Communication with Physicians and Caregivers) were estimated through the method Friedman. Their validity and reliability were determined through independent cross-questioning. The shape of the distributions of the scores of the three aspects of disease management was checked through the Blom method (QQ plot) and due to slight asymmetry, their univariate correlation followed with the Pearson parametric method both among themselves and with the characteristics of the participants. This was followed by an analysis of variance test between the three aspects of disease management and Student t regarding the categories of the characteristics. An acceptable level of significance was set at 0.05.

3. Results

3.1. Self- or supported management of disease.

In Table 1 can be seen that, although the vast majority of the participants (nearly 90%) reported that they moderately (42.9%) or very much (46.3%) could manage their disease satisfactorily, the majority (nearly 65%) also reported that they need moderately (30.2%) or very much (34.5%) support to this. Nearly 85% believed that the use of technology (e.g., a smartphone application) can better help disease management, either moderately (30.2%) or very much (54.5%).

3.1.1. Usefulness of technology in disease management.

The participants reported a significantly higher need for technology use in the area of Information & Disease Management (M=3.57) and Communication with Physicians and Caregivers (M=3.51) compared to Quality of Life & Wellbeing (M=3.38) ($p<.001$). The detailed responses, hierarchically, in each of the three areas of disease management can be found in Table 2.

Table 2. Hierarchical distribution of responses to the usefulness of technology in the three areas of self-management (i.e., quality of life/well-being, information & disease management, and communication with physicians and caregivers).

	M	SD
Quality of Life/Well-being	**3.38**	**0.46**
1. Reminders for health-enhancing behaviors (e.g., exercise, diet, medical appointments, etc.)	3.54	1.02
2. Quality of life improvement	3.53	0.95
3. Positive reinforcement for achieving disease improvement goals	3.53	1.04
4. Record of current health status	3.49	0.94
5. Maintaining optimism and hope	3.42	1.03
6. Quality of sleep improvement	3.30	0.92
7. Dealing with stress	3.05	1.15
8. Dealing with depression	2.99	1.08
Information & Disease Management	**3.57**	**0.50**
9. Use of monitoring devices/equipment (e.g., blood pressure, oxygen, glucose, etc.)	3.74	1.00
10. Reminder on medication intake according to medical instructions	3.66	0.94
11. Management of disease-related complications (e.g., diabetic foot care, infections for COPD, etc.)	3.66	1.09

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12. Prevention of disease-related complications (e.g., foot control, infections for COPD, etc.)	3.64	1.02
13. Increasing knowledge about disease	3.57	1.08
14. Education - Adoption of proper nutrition	3.51	1.07
15. Stop smoking	3.02	1.33
Communication with Physicians and Caregivers	**3.51**	**0.54**
16. Notifying the caregiver (family or doctor) when there are abnormal or critical signs	3.60	1.01
17. Warning when immediate medical assistance is required	3.51	1.04
18. Direct contact with the health care system when required	3.50	1.07
19. Increase in perceived support (e.g., an app helps you manage your illness)	3.49	0.99
20. Improving communication with health professionals	3.48	1.01
21. Scheduling visits to the doctor	3.46	1.01

3.1.2. Usefulness of technology and sociodemographic characteristics.

Those with higher (i.e., postgraduate) education (3.90±0.49), those employed (3.57±0.51), and those with a very good financial situation (3.42±0.45) reported significantly higher scores in the usefulness of technology in Information & Disease Management, Communication with Physicians and Caregivers, and Quality of Life & Well-being respectively, compared to those with lower education (Elementary, 3.47±0.53; $p<0.05$), not being employed (3.46±0.54; $p<0.05$), and with a bad financial situation (3.25±0.50; $p<0.05$) (results not shown in table/figure).

3.2. Usefulness of Technology in Disease Management across the three groups of patients.

High mean scores on the usefulness of Technology in disease management (overall and its three aspects) were found for the three groups of patients (scores ranging from 3.4 to 3.6). However, no significant differences were found between the three groups of patients neither in the overall disease management score nor in its three aspects (results not shown in table/figure).

3.2.1. Device Preference for disease management

The rates of patients reporting the device of their preference for helping them in disease management can be seen in Table 3. Cell phones and PCs outweighed the rest of the devices. DM and COPD patients prioritized the cell phone over the rest of the devices and secondly, the PC, whereas the rates for HF patients are vice versa.

Table 3. Device preference for disease self-management.

	HF (N=156)	DM (N=164)	COPD (N=153)
Cell phone	26.3	27.4	28.8
PC	27.6	23.2	20.9
Tablet	23.1	22.0	17.6
Smartwatch	12.8	13.4	17.6
Other	10.3	14.0	15.0

Note. Numbers are percentages. HF=Heart failure patients; DM=Diabetes mellitus patients; COPD= Chronic obstructive pulmonary disease patients.

3.2.2. Preference of disease-specific features for disease management

In Table 4 can be seen that the HF patients reported the highest mean score on 'Record/monitor of respiratory rate and single-lead electrocardiogram' (3.60±1.09) and the lowest on 'Appropriate exercise program' (3.46±0.87) ($p>0.05$). The DM patients reported the highest mean scores on 'Measuring/monitoring blood sugar' (3.84±1.00) and the lowest on 'Monitoring/control of weight' (3.46±1.13) ($p=0.004$). The COPD patients reported the highest mean scores on 'Use of monitoring devices/equipment' (3.73±0.97) and the lowest on 'Increased fluid intake' (3.39±1.01) ($p>0.05$).

Table 4. Hierarchical distribution of responses (means and standard deviations) for the preference of disease-specific features for disease management.

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	M (SD)
Heart failure patients (HF)	**3.53 (0.60)**
1. Record/monitor respiratory rate and single-lead electrocardiogram	3.60 (1.09)
2. Maintaining a normal weight	3.54 (1.03)
3. Appropriate exercise program	3.46 (0.87)
Diabetes mellitus patients (DM)	**3.60 (0.54)**
1. Measuring/monitoring blood sugar	3.84 (1.00)
2. Adjusting insulin dose according to glucose levels	3.73 (1.02)
3. Measuring/monitoring cholesterol	3.59 (1.06)
4. Eye check	3.54 (1.08)
5. monitoring blood pressure	3.46 (1.13)
6. Monitoring/control of weight	3.46 (0.85)
Chronic obstructive pulmonary disease patients (COPD)	**3.53 (0.45)**
1. Use of monitoring devices/equipment (eg for blood pressure, oxygen, glucose, etc.)	3.73 (0.97)
2. Training on breathing exercises	3.63 (1.03)
3. Knowledge of the use of an oxygen supply device	3.60 (1.03)
4. Appropriate exercise program	3.56 (0.94)
5. Treating shortness of breath	3.50 (1.06)
6. Weight maintenance	3.50 (1.03)
7. Maintaining optimism and hope	3.44 (1.03)
8. Dealing with the fear of possible shortness of breath	3.42 (1.24)
9. Increased fluid intake	3.39 (1.01)

4. Discussion

This study aimed at exploring the needs, priorities, and preferences of three groups of elders suffering from chronic diseases regarding the usefulness of technology in enhancing disease management in three areas (quality of life/well-being, information, and communication with physicians and caregivers).

Although the vast majority of the participants reported that they could manage their disease satisfactorily in general, the majority also reported that they need support for this. Consistent with others [29], these findings show that patients have unmet needs in several domains of disease management. These unmet needs could comprise the targets of relevant interventions and application development. Pertinent to this, is the equally reported belief in the usefulness of technology (e.g., a smartphone application) in better disease management by the three sampling groups. Taking into consideration that the use of technology-based applications among users of any age in healthcare is very low [30], and old people have even lower rates [9], this is a noteworthy and also reassuring finding which suggests that old people in these three samples are receptive to the use of technology in the management of their disease.

The examination of demographics showed that those well-educated prioritized the need for technology use in the area of information, those employed prioritized the need for technology use in the area of communication with physicians and caregivers, and those with very good financial situations, in the area of quality of life & well-being. The findings were in line with others that have shown that occupational status, high income, and education are associated with high eHealth use [13, 19]. Well-educated people seem to value knowledge and information to facilitate disease management. People with high income seem to have the resources that allow them to ensure information and access to healthcare thus well-being is a priority. Reasons for preference of the area of communication with physicians and caregivers by those employed are less clear; however, it could be due to time constraints.

Common and Specific features

Respondents in all three groups of patients equally identified that technology could be useful in overall disease management and in its three aspects. Rather quite plausibly, Quality of Life & well-being followed the other two first-choice areas of disease management. Participants prioritized technology use in providing Information and secondly communication with physicians and caregivers.

The areas of disease management that participants identified as struggling most and needing help from technology were both a group of common and a group of disease-specific features. As far as the common features are concerned, it is noteworthy that four features related to information for disease management received the highest scores and

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outweighed the others. such as the use of monitoring devices/equipment (e.g., blood pressure, oxygen, glucose, etc.), reminders for medication intake, management of disease-related complications (e.g., diabetic foot care, infections for COPD, etc.), and prevention of disease-related complications (e.g., foot control, infections for COPD, etc.). Not surprisingly, the need for technology-based options for the three CNCDs prioritized monitoring systems [14, 31-32]. Prevention and management of complications through mHealth, such as diabetic foot, have received a lot of attention [33], and medication adherence is one of the top priorities in health apps [10, 34, 35]). The fifth feature came from the communication with physicians and caregivers' area (i.e., notifying the caregiver when there are abnormal or critical signs). To the authors' knowledge, the involvement of the caregiver has been predominately examined in educational interventions of increasing their familiarity with technology [35], whereas Slevin found that COPD patients believed that data derived from DHT could potentially facilitate their interaction with physicians [5]. Fears and insecurity about an unexpected health problem or complication could also explain this finding.

The device of preference is cell phones for DM and COPD patients, and PC for HF patients. We cannot know why this difference was found.

In terms of the disease-specific features, the findings were as anticipated [14, 31-32, 35]: Specific monitoring systems were the first choice by all three groups of patients (recording/monitoring respiratory rate and single-lead electrocardiogram for HF patients [31, 35], measuring/monitoring blood sugar for DM [32], and monitoring devices/equipment for blood pressure, oxygen, glucose, etc. for COPD patients [14]), whereas other disease-specific features followed: maintaining normal weight for HF patients, adjusting insulin dose according to glucose levels for DM patients, and training on breathing exercises for COPD patients. It can be assumed that elders have limited access to healthcare resources and thus, their need for remote monitoring is increased. For this, a vast number of monitoring devices have been developed for these diseases [14, 22, 28, 36].

Limitations

This study has a number of limitations. We don't know whether and to what extent participants had access to healthcare, help from informal caregivers, prior experience and skills of technology use, what were their perceptions and attitudes towards health apps or technology in general, all of which may have impacted participants' attitudes about the importance and usefulness of technology in disease management.

Despite the limitations, one strong point of this study was that it explored patients' needs before developing any mHealth tool, which could guide individualized and tailored solutions. A second one is that the study examined multiple chronic diseases, rather than one, which adds to the understanding of the patients' common and unique needs [25]. Given the satisfactory number of participants in each group of patients, comparisons between the groups were also allowed. The findings of this study may inform the design of apps to simultaneously address multiple chronic patients and be individualized according to their needs and preferences [37].

5. Conclusions

The findings of this study showed that technology-based tools, such as mobile apps, are needed by elders with CNCDs to enhance self-management, improve their independence, and help them achieve optimal health outcomes. Findings also suggest that both common and disease-specific features could be incorporated into mobile apps to improve self-reported management deficits. Mobile apps can be an easy and accessible way to track symptoms and medication adherence and also connect with healthcare providers and caregivers when needed.

Technology and mHealth interventions in general can serve as effective alternatives that increase self-management, and as long as they are accepted by the users, may be useful adjuncts in routine clinical care. They could be incorporated into an integrated management plan by physicians, nurses, and allied health practitioners to increase self-management and enrich care both within and outside the clinical setting. Technologically based self-management solutions can be cost-effective and alleviate significant burdens on professionals, caregivers, and healthcare services in the long run. However, in order to be effective, apps should be evidence-based [10] and align with patients' personalized self-management goals and plans. These features may increase patients' engagement in self-management [21, 22].

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

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References

1. World Health Organization. Noncommunicable Diseases (NCDs) and Mental Health Challenges and Solutions. 2018. Available online: https://www.who.int/beat-ncds/en/ (accessed on 5 December 2018).
2. Centers for Disease Control and Prevention. About chronic diseases, https://www.cdc.gov/chronicdisease/ about/index.htm (2018, accessed 12 October 2018).
3. Van de Velde, D., De Zutter, F., Satink, T., Costa, U., Janquart, S., Senn, D., & De Vriendt, P. (2019). Delineating the concept of self-management in chronic conditions: a concept analysis. *BMJ open, 9(7)*, e027775. https://doi.org/10.1136/bmjopen-2018-027775
4. Talboom-Kamp, E.P.W.A.; Verdijk, N.A.; Kasteleyn, M.J.; Numans, M.E.; Chavannes, N.H. From chronic disease management to person-centered eHealth; A review on the necessity for blended care. Clin. eHealth 2018, 1, 3–7
5. Slevin, P., Kessie, T., Cullen, J., Butler, M. W., Donnelly, S. C., & Caulfield, B. (2019). Exploring the potential benefits of digital health technology for the management of COPD: a qualitative study of patient perceptions. *ERJ open research*, *5*(2), 00239-2018. https://doi.org/10.1183/23120541.00239-2018
6. Executive Board, 142. (2017). mHealth: use of appropriate digital technologies for public health: report by the Director-General. World Health Organization. https://apps.who.int/iris/handle/10665/274134
7. McBain, H., Shipley, M., & Newman, S. (2015). The impact of self-monitoring in chronic illness on healthcare utilisation: a systematic review of reviews. *BMC health services research, 15, 565. https://doi.org/10.1186/s12913-015-1221-5*
8. Debon, R., Coleone, J. D., Bellei, E. A., & De Marchi, A. C. B. (2019). Mobile health applications for chronic diseases: A systematic review of features for lifestyle improvement. *Diabetes & metabolic syndrome*, *13*(4), 2507–2512. https://doi.org/10.1016/j.dsx.2019.07.016
9. Kampmeijer, R., Pavlova, M., Tambor, M., Golinowska, S., & Groot, W. (2016). The use of e-health and m-health tools in health promotion and primary prevention among older adults: a systematic literature review. *BMC health services research, 16 Suppl 5*(Suppl 5), 290. https://doi.org/10.1186/s12913-016-1522-3
10. Xie, Z., & Kalun Or, C. (2020). Acceptance of mHealth by Elderly Adults: A Path Analysis. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, *64*(1), 755–759. https://doi.org/10.1177/1071181320641174
11. Anderson, K., & Emmerton, L. M. (2016). Contribution of mobile health applications to self-management by consumers: review of published evidence. *Australian health review: a publication of the Australian Hospital Association, 40(5),* 591–597. https://doi.org/10.1071/AH15162
12. Aminuddin, H. B., Jiao, N., Jiang, Y., Hong, J., & Wang, W. (2021). Effectiveness of smartphone-based self-management interventions on self-efficacy, self-care activities, health-related quality of life and clinical outcomes in patients with type 2 diabetes: A systematic review and meta-analysis. *International journal of nursing studies, 116,* 103286. https://doi.org/10.1016/j.ijnurstu.2019.02.003
13. Mahmood, A., Kedia, S., Wyant, D. K., Ahn, S., & Bhuyan, S. S. (2019). Use of mobile health applications for health-promoting behavior among individuals with chronic medical conditions. *Digital health, 5,* 2055207619882181. https://doi.org/10.1177/2055207619882181
14. Shaw, G., Whelan, M. E., Armitage, L. C., Roberts, N., & Farmer, A. J. (2020). Are COPD self-management mobile applications effective? A systematic review and meta-analysis. *NPJ primary care respiratory medicine, 30(1),* 11. https://doi.org/10.1038/s41533-020-0167-1
15. Triantafyllidis, A., Kondylakis, H., Votis, K., Tzovaras, D., Maglaveras, N., & Rahimi, K. (2019). Features, outcomes, and challenges in mobile health interventions for patients living with chronic diseases: A review of systematic reviews. *International journal of medical informatics*, *132*, 103984. https://doi.org/10.1016/j.ijmedinf.2019.103984
16. Efthymiou, A., Rovithis, M., & Kalaitzaki, A. (2022). The perspectives on barriers and facilitators in communication by the healthcare professionals and older healthcare users: The role of health literacy. *Journal of Psychology and Psychotherapy Research, 9*, 1-11. https://doi.org/10.12974/2313-1047.2022.09.1
17. Efthymiou, A., Kalaitzaki, A., Kondyilis, B., & Rovithis, M. (2022). Health literacy continuing education courses and tools for healthcare professionals: a scoping review. *Gerontology and Geriatric Education*. https://doi.org/10.1080/02701960.2022.2156865

18. Efthymiou, A., Kalaitzaki, A., Rovithis, M. (2023). Cultural adaptation of a Health Literacy toolkit for healthcare professionals working in the primary care setting with older adults. *Healthcare* (Special Issue "Health and Social Care Policy"), *11*(5), 776; https://doi.org/10.3390/healthcare11050776

19. Reiners, F., Sturm, J., Bouw, L. J. W., & Wouters, E. J. M. (2019). Sociodemographic Factors Influencing the Use of eHealth in People with Chronic Diseases. *International Journal of Environmental Research and Public Health, 16(4), 645. https://doi.org/10.3390/ijerph16040645*

20. Nymberg, V. M., Bolmsjö, B. B., Wolff, M., Calling, S., Gerward, S., & Sandberg, M. (2019). 'Having to learn this so late in our lives…' Swedish elderly patients' beliefs, experiences, attitudes and expectations of e-health in primary health care. *Scandinavian Journal of Primary Health Care*, *37*(1), 41-52. https://doi.org/10.1080/02813432.2019.1570612

21. Clemensen, J., Rothmann, M. J., Smith, A. C., Caffery, L. J., & Danbjorg, D. B. (2017). Participatory design methods in telemedicine research. *Journal of telemedicine and telecare*, *23*(9), 780–785. https://doi.org/10.1177/1357633X16686747

22. Desveaux, L., Shaw, J., Saragosa, M., Soobiah, C., Marani, H., Hensel, J., Agarwal, P., Onabajo, N., Bhatia, R. S., & Jeffs, L. (2018). A Mobile App to Improve Self-Management of Individuals With Type 2 Diabetes: Qualitative Realist Evaluation. *Journal of medical Internet research*, *20*(3), e81. https://doi.org/10.2196/jmir.8712

23. Sigurgeirsdottir, J., Halldorsdottir, S., Arnardottir, R. H., Gudmundsson, G., & Bjornsson, E. H. (2019). COPD patients' experiences, self-reported needs, and needs-driven strategies to cope with self-management. *International journal of chronic obstructive pulmonary disease*, *14*, 1033–1043. https://doi.org/10.2147/COPD.S201068

24. Fakih El Khoury, C., Karavetian, M., Halfens, R. J. G., Crutzen, R., Khoja, L., & Schols, J. M. G. A. (2019). The Effects of Dietary Mobile Apps on Nutritional Outcomes in Adults with Chronic Diseases: A Systematic Review and Meta-Analysis. *Journal of the Academy of Nutrition and Dietetics*, *119*(4), 626–651. https://doi.org/10.1016/j.jand.2018.11.010

25. Wildenbos, G. A., Jaspers, M. W. M., Schijven, M. P., & Dusseljee-Peute, L. W. (2019). Mobile health for older adult patients: Using an aging barriers framework to classify usability problems. *International journal of medical informatics, 124, 68–77. https://doi.org/10.1016/j.ijmedinf.2019.01.006*

26. Wang, X., Shu, W., Du, J., Du, M., Wang, P., Xue, M., Zheng, H., Jiang, Y., Yin, S., Liang, D., Wang, R., & Hou, L. (2019). Mobile health in the management of type 1 diabetes: a systematic review and meta-analysis. *BMC endocrine disorders, 19(1),* 21. https://doi.org/10.1186/s12902-019-0347-6

27. Quaosar, G. M. A. A., Hoque, M. R., & Bao, Y. (2018). Investigating Factors Affecting Elderly's Intention to Use m-Health Services: An Empirical Study. *Telemedicine Journal and e-health : the official journal of the American Telemedicine Association*, *24*(4), 309–314. https://doi.org/10.1089/tmj.2017.0111

28. Chantler, T., Paton, C., Velardo, C., Triantafyllidis, A., Shah, S. A., Stoppani, E., Conrad, N., Fitzpatrick, R., Tarassenko, L., & Rahimi, K. (2016). Creating connections - the development of a mobile-health monitoring system for heart failure: Qualitative findings from a usability cohort study. *Digital health, 2, 2055207616671461.* https://doi.org/10.1177/2055207616671461

29. Clari, M., Ivziku, D., Casciaro, R., & Matarese, M. (2018). The Unmet Needs of People with Chronic Obstructive Pulmonary Disease: A Systematic Review of Qualitative Findings. *COPD, 15(1),* 79–88. *https://doi.org/10.1080/15412555.2017.1417373*

30. Al-Rawashdeh, M., Keikhosrokiani, P., Belaton, B., Alawida, M., & Zwiri, A. (2022). IoT Adoption and Application for Smart Healthcare: A Systematic Review. *Sensors (Basel, Switzerland)*, *22*(14), 5377. https://doi.org/10.3390/s22145377

31. Greenhalgh, T., A'Court, C., & Shaw, S. (2017). Understanding heart failure; explaining telehealth - a hermeneutic systematic review. *BMC cardiovascular disorders, 17(1), 156.* https://doi.org/10.1186/s12872-017-0594-2

32. Fleming, G. A., Petrie, J. R., Bergenstal, R. M., Holl, R. W., Peters, A. L., & Heinemann, L. (2020). Diabetes digital app technology: benefits, challenges, and recommendations. A consensus report by the European Association for the Study of Diabetes (EASD) and the American Diabetes Association (ADA) Diabetes Technology Working Group. *Diabetologia, 63(2), 229–241. https://doi.org/10.1007/s00125-019-05034-1*

33. Ploderer, B., Brown, R., Seng, L. S. D., Lazzarini, P. A., & van Netten, J. J. (2018). Promoting Self-Care of Diabetic Foot Ulcers Through a Mobile Phone App: User-Centered Design and Evaluation. *JMIR diabetes, 3(4), e10105. https://doi.org/10.2196/10105*

34. Heiney, S. P., Donevant, S. B., Arp Adams, S., Parker, P. D., Chen, H., & Levkoff, S. (2020). A Smartphone App for Self-Management of Heart Failure in Older African Americans: Feasibility and Usability Study. *JMIR Aging, 3(1), e17142. https://doi.org/10.2196/17142*

35. Jiang, Y., Shorey, S., Nguyen, H. D., Wu, V. X., Lee, C. Y., Yang, L. F., Koh, K. W. L., & Wang, W. (2020). The development and pilot study of a nurse-led HOMe-based HEart failure Self-Management Programme (the HOM-HEMP) for patients with chronic heart failure, following Medical Research Council guidelines. *European Journal of Cardiovascular Nursing*, 19(3), 212–222. https://doi.org/10.1177/1474515119872853

36. Bekfani, T., Fudim, M., Cleland, J. G. F., Jorbenadze, A., von Haehling, S., Lorber, A., Rothman, A. M. K., Stein, K., Abraham, W. T., Sievert, H., & Anker, S. D. (2021). A current and future outlook on upcoming technologies in remote monitoring of patients with heart failure. *European Journal of heart failure*, *23*(1), 175–185. https://doi.org/10.1002/ejhf.2033

37. Morton, K., Dennison, L., May, C., Murray, E., Little, P., McManus, R. J., & Yardley, L. (2017). Using digital interventions for self-management of chronic physical health conditions: A meta-ethnography review of published studies. *Patient education and counseling*, *100*(4), 616–635. https://doi.org/10.1016/j.pec.2016.10.019