ICD Recipients´ technology readiness level and the relation to self-reported health: An exploratory study

Natasha Rosenmeier, David Busk, Camilla Kofoed Dichman, Kim Mechta Nielsen, Lars Kayser, Mette Kirstine Wagner

Table of Contents

ICD Recipients´ technology readiness level and the relation to self-reported health: An exploratory study

Natasha Rosenmeier[1][*] HS, BSc, MSc; David Busk[1][*] HS, BSc, MSc; Camilla Kofoed Dichman[2] HS, RNC; Kim Mechta Nielsen[2] HS, RNC, MHR; Lars Kayser[1] HS, BSc, Dr med, PhD; Mette Kirstine Wagner[2] HS, RNC, MSc, PhD

[1]Department of Public Health University of Copenhagen Denmark Copenhagen DK
[2]Department of Cardiology Copenhagen University Hospital Rigshospitalet Copenhagen DK
[*]these authors contributed equally

Corresponding Author:
Natasha Rosenmeier HS, BSc, MSc
Department of Public Health
University of Copenhagen
Denmark
Øster Farimagsgade 5
Copenhagen
DK

Abstract

Background: Worldwide, every year approximately 200,000 Implantable Cardioverter Defibrillators (ICDs) are implanted on primary and secondary prophylactic indications. Approximately 20% of ICD recipients experience clinically significant psychological distress. Despite the acknowledged issue, there are currently no national or international ICD guidelines that specifically address the management of mental health issues as an integral component of rehabilitation programs which also ensures adequate psychological well-being and overall quality of life. Current practice is often aimed at enhancing the ICD recipients understanding of the underlying disease, prognosis, and preparing for a life with an ICD. There is a need for incorporating new elements, such as emotional distress, social interactions and prepare for the usage of technologies in the future course such as apps and virtual communication. This necessitates the development of innovative approaches in clinical care and rehabilitation without increasing the demand for additional hours from healthcare professionals.

Objective: We aim to demonstrate how data from the Readiness for Health Technology Index (READHY), combined with socio-demographic characteristics and exploratory interviews, can be utilized to construct profiles of ICD recipients describing their ability to manage their condition, their need for support, and their digital health literacy. This aims to enhance healthcare professionals' understanding of different patient archetypes, serving as guidance in delivering personalized services tailored to the needs, resources, and capabilities of individual ICD recipients.

Methods: Overall, 79 ICD recipients participated in a survey assessing technology readiness using the Readiness for Health Technology Index (READHY). The survey also collected sociodemographic data as age, sex, and educational level. Self-reported health was measured using a Likert scale. Cluster analysis categorized participants into profiles based on their READHY scores. Correlations between READHY scores and self-reported health were examined. Additionally, qualitative interviews with representatives from different readiness profiles provided deeper insights.

Results: Four technology readiness profiles were found: Profile 1 (low digital health literacy insufficient on 5 scales), Profile 2 (sufficient in all dimensions), Profile 3 (consistently sufficient readiness in all dimensions), and Profile 4 (insufficient readiness in 9 dimension). Participants in Profile 4, characterized by the lowest readiness levels, were significantly younger and had lower self-reported health compared to those in Profile 3. A correlation analysis revealed that higher READHY scores were associated with better self-reported health across all dimensions. Qualitative interviews highlighted differences in self-management approaches and the experience of support between profiles, emphasizing the essential role of social support in ICD recipients' rehabilitation journeys. Two personas were created based on the characteristics from the highest and lowest created profile.

Conclusions: Employing the READHY instrument to create profiles of ICD recipients demonstrates how the instrument can be utilized to make health care professionals aware of specific needs within the group of ICD recipients.

Preprint Settings

1) Would you like to publish your submitted manuscript as preprint?

✔ **Please make my preprint PDF available to anyone at any time (recommended).**
   Please make my preprint PDF available only to logged-in users; I understand that my title and abstract will remain visible to all users.
   Only make the preprint title and abstract visible.
   No, I do not wish to publish my submitted manuscript as a preprint.

2) If accepted for publication in a JMIR journal, would you like the PDF to be visible to the public?

✔ **Yes, please make my accepted manuscript PDF available to anyone at any time (Recommended).**
   Yes, but please make my accepted manuscript PDF available only to logged-in users; I understand that the title and abstract will remain v
   Yes, but only make the title and abstract visible (see Important note, above). I understand that if I later pay to participate in <a href="http

Original Manuscript

ICD Recipients´ technology readiness level and the relation to self-reported health: An exploratory study

Rosenmeier Natasha / Busk David[1], Dichman Camilla[2], Nielsen Kim Mechta[2], Kayser Lars[1], Wagner Mette Kirstine[2]

[1] Department of Public Health, University of Copenhagen, Copenhagen, Denmark
[2] Department of Cardiology, Copenhagen University Hospital, Rigshospitalet, Copenhagen Denmark

Original Paper

Corresponding   author
Name: Natasha Rosenmeier
Address: Bjellekjearvej   13
           3700 Velsoe Sjealland
           Denmark
E-mail: natasha.rosenmeier@sund.ku.dk

Abstract

Background: Worldwide, every year approximately 200,000 Implantable Cardioverter Defibrillators (ICDs) are implanted on primary and secondary prophylactic indications. Approximately 20% of ICD recipients experience clinically significant psychological distress. Despite the acknowledged issue, there are currently no national or international ICD guidelines that specifically address the management of mental health issues as an integral component of rehabilitation programs which also ensures adequate psychological well-being and overall quality of life. Current practice is often aimed at enhancing the ICD recipients understanding of the underlying disease, prognosis, and preparing for a life with an ICD. There is a need for incorporating new elements, such as emotional distress, social interactions and prepare for the usage of technologies in the future course such as apps and virtual communication. This necessitates the development of innovative approaches in clinical care and rehabilitation without increasing the demand for additional hours from healthcare professionals

Objective: We aim to demonstrate how data from the Readiness for Health Technology Index (READHY), combined with socio-demographic characteristics and exploratory interviews, can be utilized to construct profiles of ICD recipients describing their ability to manage their condition, their need for support, and their digital health literacy. This aims to enhance healthcare professionals' understanding of different patient archetypes, serving as guidance in delivering personalized services tailored to the needs, resources, and capabilities of individual ICD recipients.

Methods: Overall, 79 ICD recipients participated in a survey assessing technology readiness using the Readiness for Health Technology Index (READHY). The survey also collected sociodemographic data as age, sex, and educational level. Self-reported health was measured using a Likert scale. Cluster analysis categorized participants into profiles based on their READHY scores. Correlations between READHY scores and self-reported health were examined. Additionally, qualitative interviews with representatives from different readiness profiles provided deeper insights.

Results: Four technology readiness profiles were found: Profile 1 (low digital health literacy insufficient on 5 scales), Profile 2 (sufficient in all dimensions), Profile 3 (consistently sufficient readiness in all dimensions), and Profile 4 (insufficient readiness in 9 dimension). Participants in Profile 4, characterized by the lowest readiness levels, were significantly younger and had lower self-reported health compared to those in Profile 3. A correlation analysis revealed that higher READHY scores were associated with better self-reported health across all dimensions. Qualitative interviews highlighted differences in self-management approaches and the experience of support between profiles, emphasizing the essential role of social support in ICD recipients' rehabilitation journeys. Two personas were created based on the characteristics from the highest and lowest created profile.

Conclusion: Employing the READHY instrument to create profiles of ICD recipients demonstrates how the instrument can be utilized to make health care professionals aware of specific needs within the group of ICD recipients.

Background

Worldwide, approximately 200,000 Implantable Cardioverter Defibrillators (ICDs) for primary and secondary prophylactic indications are implanted every year (1). In Denmark, 2000 people were treated with an ICD in 2020 (2). It is evident that implantation of an ICD with a primary prophylactic indication, significantly improves the survival of high-risk cardiac patients with symptomatic heart failure and a left ejection fraction below 35% (3). Despite a significant benefit on reduction in mortality in ICD recipients (4) and the fact that most ICD recipients effectively adapt to life with an ICD (5) a systematic review involving 45 studies and over 5000 recipients found that approximately 20% of ICD recipients experience clinically significant psychological distress (6). Despite the acknowledged issue, there are currently no national or international ICD guidelines that specifically address the management of mental health issues as an integral component of rehabilitation. Previously, it has been proposed that rehabilitation programs should incorporate customized hospital-based services tailored to the unique requirements and preferences of ICD recipients, with the aim of ensuring adequate psychological well-being and overall quality of life (5,7). Currently, the initial rehabilitation program after discharge comprises activities aimed at enhancing understanding of the underlying disease, prognosis, and preparing the ICD recipient for life with an ICD. However, there is a need to incorporate specific elements addressing the individual's unique challenges, such as emotional distress, perceived lack of support, or other person-specific concerns (8). This necessitates the development of innovative approaches in clinical care and rehabilitation without increasing the demand for additional hours from healthcare professionals. A study involving individuals with chronic obstructive pulmonary disease (COPD) (9) recommends incorporating both virtual and in-person components to enhance adherence (10). We propose that a redesign targeted ICD recipient, should include patient-reported outcome (PRO) data and blended virtual and in-person activities tailored to the

individuals' needs.

When proposing the use of digital services and technology, it should be noted that approximately one-third of the older adult population lacks a sufficient level of health literacy or digital health literacy (11). It may be assumed that a significant number of ICD recipients too, are challenged if expected to actively engage with digital health information. This number may even increase if the recipients are expected to participate in web-based activities in relation to a rehabilitation program. However, the challenge may be greater for ICD recipients than for other groups with long-term health conditions, as many ICD recipients are burdened by cognitive impairment as a consequence of a recent cardiac arrest, heart failure, general arteriosclerotic disease, or psychological distress (12,13). We consider it essential, in the design of a new rehabilitation program, to address the individual needs of ICD recipients in relation to the heterogeneity of this group, with respect to their ability to manage their condition, their need for support, and their digital competences. Such a redesign will enhance both the patient experience and assist in a more efficient allocation of healthcare professional's resources. This may involve providing virtual or even generative artificial intelligence-based services to individuals who are digitally literate and allocating in-person hours to those who require more personal contact due to social exclusion. Based on prior research involving patients with inflammatory bowel disease (IBD) (14), type 2 diabetes mellitus (15), and cancer survivors (16), we hypothesize, that by utilizing a patient-reported outcome (PRO) dataset, such as the Readiness and Enablement Index of Health Technology (READHY) (16), alongside supplementary data on socio-demographic characteristics, it is feasible to map individuals' perceived support, self-management capabilities, and digital health literacy. This approach can facilitate the creation of patient profiles, thereby enhancing healthcare professionals' awareness of the diverse needs of their patients.

The purpose of this study is to demonstrate, in the context of ICD recipients, how READHY data, supplemented with socio-demographical characteristics and explorative interviews can be used to

create profiles of ICD recipients describing their needs, resources and capabilities with respect to their technology readiness. First, READHY was utilized to assess ICD recipients in terms of their self-management skills, social support, and digital health literacy. Cluster analysis was then applied to categorize participants into clinically relevant profiles. Subsequently, interviews were conducted with selected participants belonging to a group with either low or high levels of READHY scores, to enrich these profiles with more information about their specific needs and behavior. Based on two enriched profiles we illustrate how personas can be developed to increase the health care professional's awareness of various patient archetypes, which can serve as guidance for healthcare professionals in delivering more personalized services tailored to the needs, resources, and capabilities of the individual ICD recipients.

Methods

Study Design

The study consisted of a mixed-methods cross-sectional design in two parts: part one encompassed quantitative analysis, while part two involved a qualitative inquiry. In the first part, the analysis of READHY data led to the creation of four profiles based on participants' self-management capabilities, perceived support levels and digital health literacy (technology readiness). Subsequently, individuals representing high and low levels of technology readiness were invited for interviews. This approach was employed to provide a voice to these profiles and to illustrate the varying perspectives within the group of ICD recipients.

Setting, recruitment and participants

Participants included in this study was ICD recipients who participated in the voluntary ICD rehabilitation meeting following implantation at Department of Cardiology at University Hospital of Copenhagen, Rigshospitalet. The ICD rehabilitation meeting were conducted on a monthly

basis, and each recipient attended only once after their device implantation. The purpose of the meeting was to address common questions about living with an ICD, provide general information and guidance about the technology behind the ICD, and explore how the treatment affects both the patient and their close relatives, including both physical and mental health issues. The meeting were facilitated by specially trained nurses, physiotherapists, and ICD technicians from the Department of Cardiology. Eligible participants were adults of primary and secondary prophylactic ICD indication. Recipients were approached and invited to attend the ICD meeting, either during an outpatient meeting or at their initial device control at the hospital, typically occurring one to two months after implantation. Participants generally took part in the meeting within six months following their hospital discharge, and all attendees consented to study participation and completed READHY. In total, 82 were included in this study, in which three were excluded due to missing items. The participating recipients had the distribution of 29 primary and 47 secondary prophylactic indication, in three participants the device indication was unknown. The inclusion took place from November 2019 to May 2022. In November 2021, six participants, selected from a pool of 38 individuals, were invited to take part in individual semi-structured interviews. Three recipients were identified from a profile of 26 individuals characterized by high levels of technology readiness, while the other three recipients were identified from a profile of 12 with particularly low levels of technology readiness. The selection and invitation of participants was facilitated by the author, MKW, amongst those still in an active follow-up program at Rigshospitalet.

Sociodemographic and technology readiness

A survey consisting of READHY, socio-demographic characteristics, and self-reported health, were administered at the meetings. READHY is a validated instrument that has previously been used on individuals with type 2 diabetes, inflammatory bowel disease, and with cancer survivors

(15,17,18). In this study, the instrument consisted of 13 scales with a total of 65 items related to self-management, social support, and digital health literacy. The instrument was compiled from validated instruments, including The Health Education Impact Questionnaire, The Health Literacy Questionnaire, and The eHealth Literacy Questionnaire (19–21). All items had a four-point response scale ranging from 'completely disagree' to 'completely agree.' An average score ranging from 1 to 4 was calculated for each of the scales. Within the dimension of self-management, scale heiQ8 (emotional distress), was reversed so that higher values represents less distress (16).

Self-rated health was assessed using a single item from SF36 (22). The response options ranged from 'very bad' to 'very good,' graded on a scale from 1 to 5, with values of 1 to 3 indicating low self-reported health and values of 4 to 5 indicating high self-reported health. Age was recorded in years, and sex was categorized as male or female. The response options for educational level were reported based on the International Classification of Education (ISCED) (23). The five levels were: "workers education" (e.g., waiter), "skilled in craftsmanship," "short-cycle higher education," "medium-cycle higher education," and "longer education". Low educational level was categorized (scores 1-3) and high educational level (scores 4-5).

Data analysis

Data were presented as mean (SD) for continuous variables and numbers (proportions) for frequencies. Pearson's product-moment correlation r was used to examine the correlation between self-rated health and READHY values. Welch Two Sample t-test was used to compare READHY scores between recipients with primary and secondary prophylactic ICD indication.

Cluster analysis

Individuals were divided into profiles using k-means cluster analysis based on their READHY

scores. The objective of the cluster analysis was to identify a profile characterized by particularly low response values across all READHY dimensions. Given the consistently low response values, this group was considered to be of particular clinical relevance for examination and comparison with profiles displaying higher response values.

Performing a k-means cluster analysis requires a pre-specification of the number of clusters before the analysis can be conducted. K-means cluster analysis with 3, 4, 5 clusters were tested in 10 iterations to determine which number of clusters had the most clinically relevant distribution. The seed value of this distribution was then saved, so that all future calculations were made from the same distribution.

Differences among the identified profiles concerning their sociodemographic characteristics and ICD indication were assessed using Fisher's exact test for categorical variables and one-way ANOVA for continuous variables. The results of the one-way ANOVA are presented with p-values, and effect size is calculated as eta-squared (η^2), and Tukey multiple comparisons of means was used to assess which groups means differed significantly from each other.

Statistical calculations were performed using R (version 1.4.1717; 2021).

Explanatory interviews

This section is reported according to COREQ checklist (24). Individual semi-structured interviews were conducted with six participants recruited as described above. The interviews were led by the first author, NR, Female, who had no prior relationship with the participants. Each interview began with a thorough introduction to the project including the purpose of interviewing, and the professional background of the interviewer. Furthermore, participants were informed that the interview was being recorded for the purpose of transcribing the conversation for further analysis. In this context, the elements of the consent form and information sheet were reviewed with the

participant. Present at the interviews were the participant, and the two first authors, NR, DB. Field

notes were made during the interview by DB. The interviewer, NR, holding a master's degree in

health informatics from the University of Copenhagen, is trained in conducting quantitative analyses.

Additionally, throughout the entire research period, the interviewer received continuous supervision

from experienced researchers within the author group, LK, MKW.

A guide for the semi-structured interviews was developed based on the READHY framework

(Multimedia annex A, p. 37). The intention of the interviews was to explore the participant's

perspectives on becoming an ICD recipient. The interview duration varied from 30 to 60 minutes,

with a mean duration of 44.5 minutes. Interviews were conducted at various locations, including the

hospital (n=2), the patients' homes (n=3), and at the university (n=1), accommodating the preferences

of the individual participants.

Following the conclusion of each interview, a verbatim transcription was meticulously generated

from the digital audio recordings. This transcription process ensured that the data were accurately

and comprehensively captured for subsequent analysis. The analysis of the interview data was

carried out using a content analysis with an abductive approach (19).The software package NVivo12

by Lumivero (Denver, CO/USA) was used. The coding was based on the READHY framework with

the main categories: *self-management* (six notes), *social support* (four notes) and *digital health*

literacy (four notes). Participants has not been presented with the transcribed data nor provided

feedback on the findings.

Ethics

This study adheres to the ethical principles outlined in the Declaration of Helsinki (25). The Danish

Data Protection Agency approved the handling of data under journal number P-2019-78, I-Suite

number 6423. Furthermore, permission to conduct the study was obtained from the heads of the Department of Cardiology at Rigshospitalet. All participants provided individual written informed consent before completing the questionnaire and participating in the interviews.

Results

Sociodemographic characteristics

The mean age of the 79 participants who completed the survey was 60.4 years (SD ± 12.3). The distribution was 73% (56/77) male, and 63% (49/78) had a secondary prophylactic ICD indication. The participants originated from the Capital region of Denmark and region Zealand, Denmark.

Comparison of READHY scores and prophylactic ICD indication

A comparison of READHY scores of those with primary and secondary prophylactic ICD indication is shown in Table 1. Lower READHY scores were observed for all 13 READHY scales for those with primary prophylactic indication compared to those with secondary prophylactic indication. Significant for HQL1 (*P*=.01), HLQ4 (*P*<.001), eHLQ2 (*P*=.03), eHLQ4 (*P*<.001) and eHLQ6 (*P*=.05).

READHY dimensions, mean	*P* value	Primary prophylactic indication	Secondary prophylactic indication
heiQ3: Self monitoring and insight	.46	2.95	3.02
heiQ4: Constructive Attitudes and Approaches	.09	3.01	3.14
heiQ5: Skill and Technique Acquisition	.97	2.85	2.95
heiQ8: Emotional Wellbeing (reversed scale)	.98	2.77	2.95
HLQ1: Feeling understood and supported by healthcare providers	.01	3.03	3.23
HLQ4: Social support for health	<.001	2.89	3.46

eHLQ1: Using technology to process health information	.69	2.81	2.99
eHLQ2: Understanding of health concepts and language	.03	3.01	3.17
eHLQ3: Ability to actively engage with digital services	.22	2.96	3.09
eHLQ4: Feel safe and in control	<.001	3.13	3.31
eHLQ5: Motivated to engage with digital services	.14	2.88	3.1
eHLQ6: Access to digital services that work	.05	2.99	3.16
eHLQ7: Digital services that suit individual needs	.77	2.79	2.98

Table 1. Comparison of READHY scores of recipients with primary and secondary prophylactic indication (n=76)

Correlation between READHY and self-rated health

The correlation between READHY scores and self-rated health is shown in Table 2. All 13 READHY scales were positively associated with self-rated health with heiQ4 ($r(77)=.60$, $P<.001$), heiQ5 ($r(77)=.51$, $P<.001$) and heiQ8 ($r(77)=.59$, $P<.001$) having a Pearsons r above 50. The lowest association was identified for eHLQ4 ($r(77))=0.25$ ($P=.02$) and eHLQ1 ($r(77))=0.28$ ($P=.01$).

READHY dimensioner		r	95% CI	*P* value
Self-management				
	heiQ3: Self monitoring and insight	0.33	0.12-0.52	.003
	heiQ4: Constructive Attitudes and Approaches	0.60	0.44-0.73	<.001
	heiQ5: Skill and Technique Acquisition	0.51	0.33-0.66	<.001
	heiQ8: Emotional Wellbeing (reversed scale)	0.59	0.43-0.72	<.001
Support				
	HLQ1: Feeling understood and supported by healthcare providers	0.39	0.19-0.56	<.001

	HLQ4: Social support for health	**0.44**	**0.25-0.61**	**<.001**
eHealth literacy				
	eHLQ1: Using technology to process health information	**0.28**	**0.06-0.47**	**.012**
	eHLQ2: Understanding of health concepts and language	**0.41**	**0.21-0.58**	**<.001**
	eHLQ3: Ability to actively engage with digital services	**0.33**	**0.12-0.51**	**.003**
	eHLQ4: Feel safe and in control	**0.25**	**0.04-0.45**	**.023**
	eHLQ5: Motivated to engage with digital services	**0.37**	**0.16-0.55**	**<.001**
	eHLQ6: Access to digital services that work	**0.40**	**0.20-0.57**	**<.001**
	eHLQ7: Digital services that suit individual needs	**0.38**	**0.17-0.55**	**<.001**

Table 2. Correlation between READHY scores and self-rated health (n=79)

Readiness for Health Technology index

Table 3 displays four health technology readiness profiles, organized in ascending order based on their average READHY scores. Profile 3 consistently exhibited sufficiency across all scales, while profile 2 was lower than profile 3 mostly in eHealth dimensions, but also showed a sufficient level across all scales. Profile 1 showed a sufficient level on scales related to self-management and support, but insufficient levels on 5 eHealth Literacy scales except on eHLQ4 and eHLQ2. Profile 4 showed a generally insufficient level across the scales, except on HLQ1, eHLQ2, eHLQ4 and eHLQ5.

Parameters		Profiles			
		4 (n=12)	1 (n=9)	2 (n=32)	3 (n=26)
READHY dimensions, mean					
Self-management					
	heiQ3 (Self-monitoring and insight)	2.69	3.04	2.87	3.26
	heiQ4 (Constructive Attitudes and Approaches)	2.35	3.16	2.93	3.65
	heiQ5 (Skill and Technique Acquisition)	2.21	2.97	2.81	3.36
	heiQ8 (Emotional Wellbeing; reversed)	1.80	3.56	2.80	3.35
Support					
	HLQ1 (Feeling understood and supported by healthcare providers)	2.77	3.17	2.97	3.55

	HLQ4 (Social support for health)	2.58	3.13	3.19	3.68
eHealth literacy					
	eHLQ1 (Using technology to process health information)	2.67	2.31	2.76	3.51
	eHLQ2 (Understanding of health concepts and language)	2.82	2.84	2.93	3.58
	eHLQ3 (Ability to actively engage with digital services)	2.60	2.35	2.93	3.67
	eHLQ4 (Feel safe and in control)	3.08	2.87	3.06	3.73

Table 3. Four health technology readiness profiles on the READHY scale ranging from 1 (Strongly disagree) to 4 (Strongly agree). Within each dimension, the average READHY scores are color coded relative to the other profiles from red (lowest score) to green (highest score).

Characteristics of profiles

Differences in sociodemographic characteristics between profiles are presented in Table 4. A difference in age df(3,70) F=3.1 , *P*=.03, η²=0.12 was observed. The biggest difference in age was observed between profile 4 and profile 3 (P=0.06) and between profile 4 and profile 1 (P=0.07). A difference in self-rated health df(3,75) F=6.4, *P*=.001, η²=0.20 was observed between the four profiles. The biggest difference in self-rated health was observed between profile 4 and profile 3 (P<.001) and profile 3 and profile 2 (P=.01). No difference in sex and educational level were found. When examining for differences between the profiles with respect to ICD indication no significant differences were found (P= 0.62). Though, the percentage receiving the ICD on primary prophylactic indication in the 'low-level group' was 50% compared to the 'high-level group' with only 23%.

Characteristics	All (N=79)	Profile 1 (n=9, 11.4%)	Profile 2 (n=32, 40.5%)	Profile 3 (n=26, 32.9%)	Profile 4 (n=12, 15.2%)	*P* value
Sex n (%)						.45
Women	21 (26.6)	1 (11.1)	8 (25)	9 (34.6)	3 (25)	
Men	56 (70.9)	8 (88.9)	24 (75)	15 (57.7)	9 (75)	
Unknown sex	2 (2.5)	0 (0.0)	0 (0.0)	2 (7.7)	0 (0.0)	
Age, mean (SD)	60.38	66 (10.0)	63 (12.7)	58 (12.8)	53 (7.8)	.03

	(12.3)				
Highest attained level of education, n (%)					**.27**
Long education	29 (36.7)	4 (44.4)	10 (31.2)	12 (46.2)	3 (25.0)
Short education	40 (50.6)	4 (44.4)	20 (62.5)	11 (42.3)	5 (41.7)
Unknown education	10 (12.7)	1 (11.1)	2 (6.3)	3 (11.5)	4 (33.3)
Self-rated health, n (%)					**.001**
High self-rated health	43 (54.4)	6 (66.7)	15 (46.9)	20 (76.9)	2 (16.7)
Low self-rated health	36 (45.6)	3 (33.3)	17 (53.1)	6 (23.1)	10 (83.3)
Prophylactic indication, n (%)					**.62**
Primary	29 (36.7)	4 (44.4)	13 (40.6)	6 (23.1)	6 (50.0)
Secondary	47 (59.5)	5 (55.6)	18 (56.3)	18 (69.2)	6 (50.0)
Unknown prophylactic indication	3 (3.8)	0 (0.0)	1 (3.1)	2 (7.7)	0 (0.0)

Table 4. Sociodemographic characteristics of participants (N=79) across profiles. Data are presented as mean (SD) for continuous variables and numbers (proportions) for frequencies.

Interview findings

To explore how differences in READHY scores related to the participants experiences of becoming ICD recipients we conducted interviews with representatives from profile 3 and profile 4. Profile 4, characterized by the lowest scores in 12 out of 13 READHY scales and lowest self-rated health, was contrasted with profile 3, which demonstrated the highest scores in all 13 scales as well as self-rated health. For the interviews, we recruited three participants from profile 3 (the 'high-level group') and three participants from profile 4 (the 'low-level group'). These interviews revealed significant differences in how individuals from these groups were able to manage their condition, perceived the support they received, and approached digital proficiency.

Self-management

All participants engaged in self-management practices addressing their physical and mental wellbeing. However, there was a distinction in how self-management was interpreted within the 'high-level group' compared to the 'low-level group'. Participants belonging to the 'high-level group' described their pre-ICD implantation lifestyle as characterized by daily physical exertion, which they expressed a strong desire to sustain. For instance, P3 stated;

"*I used to bike to work throughout the year, covering approximately 10 kilometers each way. I engaged in workouts at least twice a week and participated in a weekly spinning class. Exercise, to me, equates to an enhanced quality of life, both presently and prior to my illness. At present, I attend*

one or two spinning classes weekly, which I prefer not to disclose to my doctors, as they disapprove."

In contrast no one in the 'low-level group' used physical activity as a means to preserve their health.

Participants belonging to the 'low-level group' approached self-management in a distinct manner, which primarily involved adhering to medical advice regarding medication adherence and healthcare appointments, particularly evident when asked about their self-care practices. For example, P2 and P5 articulated:

" *After doctors' appointments I am more sensitive and attentive to my body. Naturally, the plan is to initiate lifestyle changes, which I have gradually commenced.*" And "*It seems like that's all I'm engaged in - devoting my time to managing my health. I visit the hospital constantly, and I mean incessantly. Furthermore, I was enrolled in a heart rehabilitation program last year.*"

For individuals within the 'low-level group', a recurring subject was found wherein the participants lived with a constant awareness and apprehension regarding their condition. For instance, when asked *"During your daily routine, when do you find yourself contemplating your ICD?"* P1 articulated:

"Constantly!   It   occupies   my   thoughts   incessantly."   P2   concurred,   stated:

" *I think about it every time I shower, change my clothing, and when I retire for the night; those are the moments when it preoccupies my mind the most. Additionally, I grapple with mental concerns such as whether it would effectively function in the event of an unforeseen circumstance.*"

Similarly, P5 shared, "*All the time! I am in a constant state of unease.*"

When the same question was asked to participants belonging to the 'high-level group', the responses conveyed a sense of calm and trusting emotional state. As exemplified by P4 and P6:

" *My perspective has been somewhat matter of fact; I needed to have this device implanted, and that is simply the way it is. Beyond that, I have not dwelled on it extensively.*" And *"After a full day at*

work, I may experience some soreness, but it reminds me of how reassuring it is to have it watching over me."

Support

Social support

In the management of their ICD, participants who felt a lack of social support from family and friends during the rehabilitation process, have heightened emotional distress, necessitating additional support from healthcare professionals. Without substantial social support from family and friends, the perception of support from healthcare professionals during their hospitalization and rehabilitation process became crucial. A lack of social support affected the participant's ability to place trust in the ICD technology and their capacity to adapt calmly to life with an ICD.

The significance of having access to supportive relatives or spouses was emphasized by the contrast in how the two groups utilized and derived comfort from sharing their concerns with close family members. The 'high-level group' experienced tremendous comfort in doing so, whereas the 'low-level group' tended to conceal their feelings and kept their worries to themselves. For instance, P4 remarked:

 "*Discussing things with my family and my wife, who was present at the time of my cardiac arrest, and having those conversations with people who asked about my experiences, has actually proven more beneficial than speaking with the psychologist.*"

This contrasted to the experiences of recipients in the 'low-level group', who perceived their condition as more burdensome for their families than as a source of support. P2 explained:

"*You may want to confide in your family, but not be completely honest about how frightened you have been and still are about the future. It's a delicate topic. My family was deeply shaken, and they may not wish to revisit it.*"

Similar sentiments were expressed by P5:

"*My children are 22 and 23 years old, but they have been extremely anxious. Being a single mom and trying to stay strong for them is challenging. Yet, they want me to share my feelings. It's just very tough at times.*"

Professional support

Participants who lived alone exhibited a greater demand for support and information from healthcare professionals when compared to participants living with a spouse. Those living alone consistently expressed dissatisfaction with the support provided by healthcare professionals, and commonly expressed high levels of emotional distress, as well as a lack of information, support, and therapeutic options. P1 felt that his needs were overlooked and emphasized the need for more information about his condition, stated:

"*When you get admitted here, you receive absolutely no information. None. That is a flaw. I was operated on at 2 a.m., and by 9 a.m., I was approached by a professor and a nurse who wanted to recruit me for a study. That was bewildering. After surgery, your mind is in turmoil, and here they are asking me to participate in a study.*"

Additionally, another participant who was living alone, P5, expressed dissatisfaction with the lack of fulfillment and comprehension of her needs during her hospitalization, particularly concerning the therapy options offered post-surgery. She stated:

"*During my hospitalization, I attended a few sessions with their psychologist, but it didn't resonate with me at the time. They advised me to go for forest walks and visit the library to socialize. That wasn't what I needed.*"

Contrasting, all participants living with a partner consistently reported the support provided by healthcare professionals as highly satisfactory. P4 stated:

"*I felt safe from the moment I woke up in the hospital and throughout my entire stay. I have been extremely pleased with the care and treatment I received here.*"

P6 similarly expressed positive impressions, saying, "*I wish I could write an article about it; it felt like a five-star hotel. They treated me like royalty, providing me with detailed information, time, and*

care. We were deeply impressed by the dedication and attention they gave us."

Digital health literacy

Both groups of participants expressed a consistent readiness and ability to engage with digital healthcare services and utilize various technological tools as part of their recovery process. They shared a common inclination for monitoring their health data, seeking health information online, and accessing personal health records through digital platforms. There was no noticeable difference in motivation for digital rehabilitation between the two groups, potentially due to their recruitment from a rehabilitation program rather than during hospitalization. Moreover, both groups displayed similar engagement with other health-related technologies, such as smartwatches and pulse oximeters, indicating their willingness to embrace technology for a digitalized rehabilitation experience tailored to their needs.

A participant belonging to the 'low-level group', P5, detailed her utilization of various technologies for managing her condition:

 "*I have been using my Apple Watch since I received my first pacemaker. Sometimes, I would feel unwell and worry about my pulse being too low. Tracking it on my watch gives me peace of mind. Additionally, I regularly log in to my online electronic health record to stay informed about any updates. The more information I acquire, the more at ease I feel.*"

Similarly, P4 belonging to the 'high-level group' expressed: "*I purchased an actual pulse oximeter when my condition first arose. I told my wife that I needed one. I have an imperative need to comprehend what is transpiring*".

Living with an ICD

One distinguishing characteristic of recipients within the 'low-level group' was their lack of trust in the ICD technology and the high levels of emotional distress they experienced living with an ICD. It is noteworthy that the three recipients belonging to the 'low-level group' had previously been diagnosed with heart-related conditions before receiving the ICD, which contrasts with the

participants belonging to the 'high-level group' who had no such prior diagnoses. This study underscores the fact that ICD recipients with primary prophylactic indication or other heart-related comorbidities have distinct support and rehabilitation needs compared to those admitted on secondary prophylactic indication. When receiving the same treatment, the primary ICD implantation group lacks support, information, and therapy options.

The ICD recipients with primary prophylactic indication consistently exhibit notably low READHY scores, especially in the domain of social support, when compared to recipients with secondary prophylactic indication. This finding is in line with the interview results (refer to Table 1). All recipients rated their health on a scale ranging from 1 to 5. These analyses highlight a clear correlation between self-rated health and READHY scores. This relationship is further reinforced by the interviews, which revealed that recipients with low self-rated health (rated 1-3) who struggled to cope with and manage their condition, all belonged to the 'low-level group'. Conversely, recipients with a positive outlook on their condition and high self-rated health scores, belonged to the 'high-level group'. We find that the overall health status of the recipient, prior to ICD placement, is an essential determinant influencing the patient's ability to manage the condition. Importantly, the interviewer had no prior knowledge of which group the interviewed participants belonged to.

Based on the above data we have created two personas which are presented below. These demonstrate how the text vignettes can make the profiles more vivid for health care professionals.

Lower group persona

Male, aged 53, with low physical activity levels and low self-rated health. Diagnosed with other comorbidities prior to ICD implantation. The patient is unmarried, lives alone, has a limited social network, and experiences significant emotional distress due to his condition on a daily basis. He

utilizes health technologies and actively seeks information about his condition online. The lower

group patient requires a high level of support from healthcare professionals.

High group persona

A male aged 58, with a high level of physical activity and high self-rated health. He maintains good

health and has no comorbidities prior to his ICD implantation. The patient cohabits with a partner

and has an extensive social network. He maintains a positive attitude toward his condition and

incorporates health technologies into his daily routine.

Discussion

Principal findings

The purpose of this study was to demonstrate how profiles and personas can be developed using the

READHY instrument to make healthcare professionals aware of differences in their patient's needs,

resources, and capabilities in relation to their health technology readiness including their emotional

state. In general the ICD recipients had a sufficient level of health technology readiness in all 13

READHY scales. Using cluster analysis, four clinically relevant profiles were developed. The most

distinct profiles we found were profile 3, characterized by highly sufficient READHY scores across

all dimensions, and profile 4, characterized by nine insufficient READHY scores (below 2.7),

displaying only slight sufficiency within digital literacy. Sociodemographic characteristics, age and

self-reported health differed among the profiles, with the youngest patients having the lowest

READHY scores. No significant differences were found in sex, level of education, or the ICD

indication. This underpins the need of other than these classical characteristics to inform the health

care professionals to understand their patients. The interviews provided valuable insights into the

perspectives of the profiles, emphasizing the crucial role of social support, particularly for those

living alone, who required more professional support. These insights were particularly relevant with

regard to emotional distress and perceived support levels from family and healthcare professionals.

Individuals with no or a short history of poor health conditions tended to adapt more positively to life post ICD implantation, compared to those with a longer history of poor health conditions,   this suggests that it may be significant to take the patients prior and current status of health into consideration in the treatment of them. Interestingly, the interviewed belonging to both the low and high-level groups, embraced technology to a high extent, signifying that in ICD recipients, a low level of health literacy is not related with usage of technology.

Level of health technology readiness in ICD recipients

Regarding the differences in prophylactic indication, it is important to acknowledge that the current treatment pathways vary based on the indication. Patients undergoing secondary ICD placement, often due to acute conditions like cardiac arrest, experience a more prolonged hospital stay compared to those undergoing planned elective primary ICD placement. Conducting a study that combines both primary and secondary indication for ICD placement involves a group of patients who have not undergone the exact same treatment process. Despite this, our qualitative analysis remained impartial, as all interviewed participants underwent secondary ICD placement, ensuring a one-to-one basis for comparison.

Recipients with primary ICD indications had lower, but sufficient levels of all 13 READHY scales compared to those with secondary indications. This was significant in relation to support from both professionals (HLQ1) and relatives/peers (HLQ4), it was also significant in relation to the three digital health scales concerning the experience of data available for those who need them (eHLQ6), trusting how their data is handled (eHLQ4) and understanding the health language (eHLQ2). The higher READHY scores from recipients with secondary indication for ICD placement, could be due to their prolonged hospitalization, which gave them more extensive interaction with healthcare professionals at the department. Another explanation could be that this group has not experienced a

prolonged history of poor health, resulting in fewer interactions with the healthcare sector and potentially fostering a more optimistic outlook.

The finding that self-rated health is positively associated with all 13 READHY scales, demonstrates that perceived health condition may influence the health technology readiness. However it could also be interpreted as a low health technology readiness may influence the perception of your health condition. It was no possible from the interview data to interpret this relation between perceived health condition and responses their scales. An association between self-rated health and READHY has not been reported before, whereas a relation between wellbeing and belonging to a distinct profile has been reported (15). Studies using the HLQ and eHLQ which is part of the READHy instrument, has found a weak positive correlation between self-rated health and some of eHLQ scales in an out-patient clinic, where an association was found between eHLQ 1, 3, 5 and 6 (26). In graduate nursing students there was an association between HLQ 4 and eHLQ 1, 3, 4, 5 and 6 (27).

Profile characteristics

Age and self-rated health

We found significant difference in age and self-reported health among the ICD recipients in different profiles. But no significant difference in sex, educational level or ICD indication. Profile 4, which represents individuals with the lowest READHY scores, is comprised of individuals who are, on average, 13 years younger than those in the oldest profile. This contrasts with previous research, where the older adults tended to have a poorer health outcomes (15). The youngest patients had the lowest scores in self-rated health, indicating that age alone may not be a strong predictor of ICD-related health outcomes. This suggests the importance of considering other factors such as other long-term health conditions and self-rated health status, when assessing patient needs, resources and capabilities, rather than age.

Digital health literacy

The ICD recipients had a relatively high levels of digital health literacy scores in both the 'low-level', and 'high-level' group compared to IBD patients (14). The sufficiency of digital literacy was further confirmed during interviews, where all participants reported regular use of digital health tools in their daily lives. This contrast to prior research, which suggest limited technology engagement among individuals with chronic illnesses (14). In our study, ICD recipients from various profiles actively embraced technology for health monitoring, sought health-related information online, and utilized devices such as smartwatches, fitness trackers, and advanced pulse oximeters, regardless of their profile. This collective engagement suggests an opportunity among ICD recipients to adopt new digital services and technology.

Our interviews involved individuals from profiles 4 and 3. Profile 4 and 3 were selected do to having the overall highest and lowest levels respectively, but it should be noticed that the lowest levels of digital health literacy, was found in profile 1.

The characteristics of participants belonging to profile 1 and 2 should also be considered when planning rehabilitation. Identifying individuals within these intermediate profiles is essential, as they may also exhibit low values in specific dimensions. Profile 1 had a sufficient level within the areas of self-management and social support, but was found with lower levels in digital health literacy compared to the other profiles. The introduction of digital technologies may pose a barrier for this group, as they do not possess the same high levels of digital literacy as the other groups. In essence, while they excel in traditional health-related knowledge, they may struggle when it comes to using digital health tools and resources. This group should be approached recognizing their non-digital competence and with a careful introduction of digital solutions.

Profile 2 was the largest group, characterized by having sufficient levels on all scales. Despite having lower levels than those in profile 3, they are considered capable of actively participating in their rehabilitation including complementary digital services and technologies. The key here is to recognize individuals who are less capable as those in Profile 4, but still require increased assistance and rehabilitation services, especially within the self-management area.

Due to the fact that ICD recipients can be clustered into diverse patient profiles where some have low digital literacy, we advocate retaining the in-person ICD rehabilitation meeting as an available option, particularly for individuals belonging to profiles 1 and 4. This group may benefit from additional support, counseling, and information throughout their recovery process, ensuring a more comprehensive and personalized approach to their care. The interviews indicated that all individuals, regardless of which of the two profiles they belonged to, regularly utilized digital services and found them to be comfortable and reassuring. This suggests that most ICD recipients, including those with lower levels of digital health literacy, can benefit from the enhanced integration of technology into the ICD rehabilitation program. Utilizing the READHY instrument to identify profiles and their associated individuals, will serve as a valuable tool in tailoring future ICD treatments to meet individual needs.

Support

In alignment with previous findings (15) our interview data show that emotional and social support from a partner or spouse plays a role in addressing emotional concerns after ICD placement. The participants living with a spouse reported an exceptionally high level of received care from healthcare professionals and had little need to seek additional support. Conversely, participants living alone expressed feelings of abandonment, lack of information, and insufficient care from healthcare professionals.

The impact of social support on mental wellbeing is further evident in the difference in emotional concerns between the 'high-level' and 'low-level group'. The 'high-level group' expressed trust in their ICD and had fewer daily worries about their condition, whereas all participants in the 'low-level group' reported doubts about their ICD's effectiveness and ongoing concerns about their future health. Therefore, the presence or absence of social support in form of a spouse or near family, is a crucial factor to consider when identifying patients who may require additional support and tailored rehabilitation services.

Personas

A way to make the profiles more present and recognizable by healthcare professionals, is to create vignettes which describes a particular average persona belonging to a specific profile.

The personas offer insights into the unique needs, challenges, and behaviors of individuals within the 'low-level' and 'high-level' groups of this study. By delving into the details of these personas, we aim to provide a deeper understanding of how various factors, including health status, social support, and lifestyle, influence the experiences of ICD recipients. The personas serve as representative examples with the purpose of assisting healthcare professionals in identifying patient characteristics, ultimately enabling the delivery of more tailored support and care to the population of ICD recipients. It remains to be tested in a clinical setting, to what extend the personas can help the healthcare professionals in their everyday work.

Strengths and limitations

A strength of the study lies in its foundation on an established model previously used in patients with other chronic conditions. The data help to translate the understanding of health technology readiness into a new clinical area and opens for a new way for healthcare professionals in cardiology to be aware of how to meet their patients' needs and take their resources and capabilities in a digital

context, into consideration including mental and social aspects. A limitation of this study is the absence of interviews with individuals from profile 1, which is characterized by the lowest level of digital health literacy, in particular in scales (eHLQ1, eHLQ3, eHLQ5, eHLQ7). Including interviews with individuals from profile 1, could have yielded valuable insights into the factors contributing to their low digital competence. This would have enriched the depth and comprehensiveness of the data obtained.

Another potential limitation is the relatively low number of participants, which may introduce a Type 2 error, potentially overlooking differences between profiles in sociodemographic characteristics and self-reported health. The survey sampling occurred over a four-year period, and it was not possible to include a larger number of participants within this timeframe. Conducting a multicenter study would have been necessary to achieve a larger sample size. However, despite this limitation, our data still contributes to a better understanding of ICD recipients and the dynamics of their competencies.

A limitation in interpreting the differences between primary and secondary indications for ICD placement was that a subset of individuals within this group may have had pre-existing heart conditions, making them more uniform to patients within the primary group. This factor was not accounted for in the study design. In the data analysis we were not permitted to acquire this information as the involved healthcare professionals no longer had responsibility for the patients. Future studies should place more emphasis on assessing pre-existing heart conditions and the need for cardiac resynchronization therapy (CRT). While the study did reveal differences in READHY scales and self-rated health between the groups, indicating that this may have been a minor issue, it was nonetheless identified as a limitation.

Conclusion

Most ICD recipients are eligible to engage with, and participate in, more digitalized treatment

options, further enhancing the potential of their rehabilitation. In ICD-patients receiving rehabilitation, it is possible to develop four profiles that hold significance in clinical practice and can provide valuable insights for healthcare professionals. The profiles can be used to create personas as concise text vignettes aimed at helping healthcare professionals to be aware of specific needs, particularly concerning self-management and social support. Profile 3, was characterized by high readiness scores across all dimensions, and Profile 4, was marked by low scores in multiple areas, representing two ends of the spectrum, with significant implications for their ability to manage their condition and engage in a rehabilitation process. It is also essential to recognize intermediate profiles (1 and2), as they exhibit unique needs that require tailored approaches to rehabilitation, particularly in the context of digital health literacy. By recognizing the diversity within this population and understanding the impact of sociodemographic factors, health status, and social support, healthcare professionals can provide more personalized care. The personas developed in this study may serve as a practical tool to translate the data into a more comprehendible format and identifying individuals who require additional support and those who may benefit from more virtual contact.

Bibliography

1. Nisam S, Reddy S. The story of … a lead. Eur Eur Pacing Arrhythm Card Electrophysiol J Work Groups Card Pacing Arrhythm Card Cell Electrophysiol Eur Soc Cardiol. 2015 May;17(5):677–88.

2. Dansk Cardiologisk Selskab [Internet]. [cited 2023 Nov 2]. Implanterbar cardioverter defibrillator (ICD). Available from: https://nbv.cardio.dk/icd

3. Al-Khatib SM, Stevenson WG, Ackerman MJ, Bryant WJ, Callans DJ, Curtis AB, et al. 2017 AHA/ACC/HRS Guideline for Management of Patients With Ventricular Arrhythmias and the Prevention of Sudden Cardiac Death: Executive Summary: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines and the Heart Rhythm Society. J Am Coll Cardiol. 2018 Oct 2;72(14):1677–749.

4. Chan PS, Hayward RA. Mortality reduction by implantable cardioverter-defibrillators in high-risk patients with heart failure, ischemic heart disease, and new-onset ventricular arrhythmia: an effectiveness study. J Am Coll Cardiol. 2005 May 3;45(9):1474–81.

5. Dunbar SB, Dougherty CM, Sears SF, Carroll DL, Goldstein NE, Mark DB, et al. Educational and psychological interventions to improve outcomes for recipients of implantable cardioverter defibrillators and their families: a scientific statement from the American Heart Association. Circulation. 2012 Oct 23;126(17):2146–72.

6. Magyar-Russell G, Thombs BD, Cai JX, Baveja T, Kuhl EA, Singh PP, et al. The prevalence of anxiety and depression in adults with implantable cardioverter defibrillators: a systematic review. J Psychosom Res. 2011 Oct;71(4):223–31.

7. Berg SK, Pedersen PU, Zwisler AD, Winkel P, Gluud C, Pedersen BD, et al. Comprehensive cardiac rehabilitation improves outcome for patients with implantable cardioverter defibrillator. Findings from the COPE-ICD randomised clinical trial. Eur J Cardiovasc Nurs. 2015 Feb 1;14(1):34–44.

8. Risom SS. National Klinisk Retningslinje for rehabilitering til patienter med atrieflimren, atrieflagren, patienter med endokarditis og patienter behandlet med en Implanterbar Cardioverter Defibrillator (ICD).

9. Palshof MK, Jeppesen FKH, Thuesen AD, Holm CS, Brøndum E, Kayser L. Comparison of the level of eHealth literacy between patients with COPD and registered nurses with interest in pulmonary diseases. Comput Methods Programs Biomed Update. 2023 Jan 1;4:100121.

10. Krag T, Jørgensen EH, Phanareth K, Kayser L. Experiences With In-Person and Virtual Health Care Services for People With Chronic Obstructive Pulmonary Disease: Qualitative Study. JMIR Rehabil Assist Technol. 2023 Aug 14;10:e43237.

11. Poulsen HS, Eiriksson SD, Christiansen ASJ, Wingstrand A. Sundhedsprofil 2021 for Region Sjælland og kommuner "Hvordan har du det?" Region Sjælland, Data og udviklingsstøtte; 2022.

12. Hallas CN, Burke JL, White DG, Connelly DT. A prospective 1-year study of changes in neuropsychological functioning after implantable cardioverter-defibrillator surgery. Circ Arrhythm Electrophysiol. 2010 Apr;3(2):170–7.

13. Kramer DB, Habtemariam D, Adjei-Poku Y, Samuel M, Engorn D, Reynolds MR, et al. The Decisions, Interventions, and Goals in ImplaNtable Cardioverter-DefIbrillator TherapY

(DIGNITY) Pilot Study. J Am Heart Assoc. 2017 Sep 22;6(9):e006881.

14. Nielsen AS, Hanna L, Larsen BF, Appel CW, Osborne RH, Kayser L. Readiness, acceptance and use of digital patient reported outcome in an outpatient clinic. Health Informatics J. 2022 Apr 1;28(2):14604582221106000.

15. Thorsen IK, Rossen S, Glümer C, Midtgaard J, Ried-Larsen M, Kayser L. Health Technology Readiness Profiles Among Danish Individuals With Type 2 Diabetes: Cross-Sectional Study. J Med Internet Res. 2020 Sep 15;22(9):e21195.

16. Kayser L, Rossen S, Karnoe A, Elsworth G, Vibe-Petersen J, Christensen JF, et al. Development of the Multidimensional Readiness and Enablement Index for Health Technology (READHY) Tool to Measure Individuals' Health Technology Readiness: Initial Testing in a Cancer Rehabilitation Setting. J Med Internet Res. 2019 Feb 12;21(2):e10377.

17. Rossen S, Kayser L, Vibe-Petersen J, Christensen JF, Ried-Larsen M. Cancer Survivors' Receptiveness to Digital Technology-Supported Physical Rehabilitation and the Implications for Design: Qualitative Study. J Med Internet Res. 2020 Aug 5;22(8):e15335.

18. Nielsen AS, Appel CW, Larsen BF, Kayser L, Hanna L. Patient perspectives on digital patient reported outcomes in routine care of inflammatory bowel disease. J Patient-Rep Outcomes. 2021 Sep 17;5(1):92.

19. Osborne RH, Elsworth GR, Whitfield K. The Health Education Impact Questionnaire (heiQ): An outcomes and evaluation measure for patient education and self-management interventions for people with chronic conditions. Patient Educ Couns. 2007 May 1;66(2):192–201.

20. Osborne RH, Batterham RW, Elsworth GR, Hawkins M, Buchbinder R. The grounded psychometric development and initial validation of the Health Literacy Questionnaire (HLQ). BMC Public Health. 2013 Jul 16;13:658.

21. Kayser L, Karnoe A, Furstrand D, Batterham R, Christensen KB, Elsworth G, et al. A Multidimensional Tool Based on the eHealth Literacy Framework: Development and Initial Validity Testing of the eHealth Literacy Questionnaire (eHLQ). J Med Internet Res. 2018 Feb 12;20(2):e36.

22. Ware JE, Sherbourne CD. The MOS 36-item short-form health survey (SF-36). I. Conceptual framework and item selection. Med Care. 1992 Jun;30(6):473–83.

23. International Standard Classification of Education (ISCED) [Internet]. 2017 [cited 2023 Nov 1]. Available from: https://uis.unesco.org/en/topic/international-standard-classification-education-isced

24. Booth A, Hannes K, Harden A, Noyes J, Harris J, Tong A. COREQ (Consolidated Criteria for Reporting Qualitative Studies). In: Guidelines for Reporting Health Research: A User's Manual [Internet]. John Wiley & Sons, Ltd; 2014 [cited 2023 Nov 24]. p. 214–26. Available from: https://onlinelibrary.wiley.com/doi/abs/10.1002/9781118715598.ch21

25. WMA - The World Medical Association-WMA Declaration of Helsinki – Ethical Principles for Medical Research Involving Human Subjects [Internet]. [cited 2023 Nov 1]. Available from: https://www.wma.net/policies-post/wma-declaration-of-helsinki-ethical-principles-for-medical-research-involving-human-subjects/

26. Holt KA, Karnoe A, Overgaard D, Nielsen SE, Kayser L, Røder ME, et al. Differences in the Level of Electronic Health Literacy Between Users and Nonusers of Digital Health Services: An

Exploratory Survey of a Group of Medical Outpatients. Interact J Med Res. 2019 Apr 5;8(2):e8423.

27. Holt KA, Overgaard D, Engel LV, Kayser L. Health literacy, digital literacy and eHealth literacy in Danish nursing students at entry and graduate level: a cross sectional study. BMC Nurs. 2020 Dec;19(1):22.

Supplementary Files

Multimedia Appendixes

Untitled.
URL: http://asset.jmir.pub/assets/809092a0e097fd7754114acdc0609673.docx