






Willingness to participate in cardiac telerehabilitation: results from semi-structured interviews

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Aims

Cardiac rehabilitation (CR) is indicated in patients with cardiovascular disease but participation rates remain low. Telerehabilitation (TR) is often proposed as a solution. While many trials have investigated TR, few have studied participation rates in conventional CR non-participants. The aim of this study was to identify the percentage of patients that would be willing to participate in a TR programme to identify the main perceived barriers and facilitators for participating in TR.

Methods and results

Two groups of patients were recruited: CR non-participants and CR participants. Semi-structured interviews were conducted. Thirty non-participants and 30 participants were interviewed. Of CR non-participants, 33% would participate in TR and 10% would participate in a blended CR programme (combination of centre-based CR and TR). Of CR participants, 60% would participate in TR and 70% would be interested in a blended CR programme. Of those that would participate in TR, 44% would prefer centre-based CR, 33% would prefer a blended CR programme, and 11% would prefer a full TR programme. In both groups, the main facilitating aspect about TR was not needing transport and the main barrier was digital literacy.

Conclusion

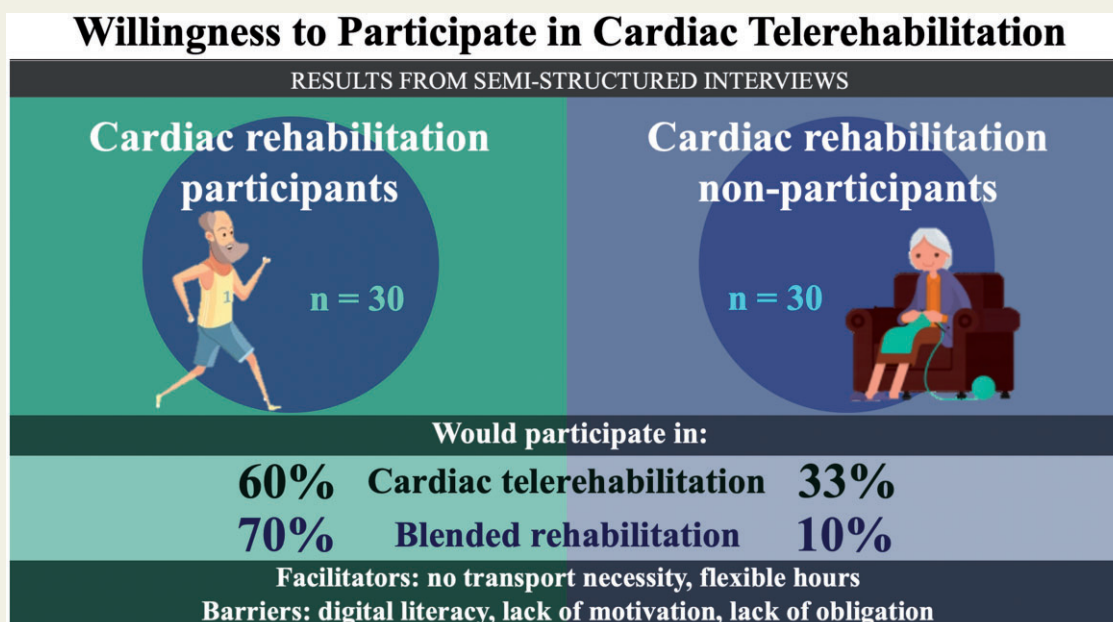
For CR non-participants, TR will only partly solve the problem of low participation rates and blended programmes might not offer a solution. Cardiac rehabilitation participants are more prepared to participate in TR and blended CR. Digital literacy was in both groups mentioned as an important barrier, emphasizing the challenges for health-care and local governments to keep educating all types of patients in digital literacy.

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Graphical Abstract



Keywords

Cardiac rehabilitation • Telerehabilitation • Remote rehabilitation • Participation rates • Digital health • Digital literacy • Willingness to participate • Willingness to pay

Introduction

Cardiac rehabilitation (CR) is indicated in patients with a wide range of cardiovascular diseases. Its benefits are well-studied and participation in CR is thus stated as a Class IA recommendation in the 2021 guidelines on cardiovascular disease prevention published by the European Society of Cardiology.¹ However, in earlier EUROASPIRE studies, and again in the most recent EUROASPIRE V study, it was shown that inclusion rates in CR programmes are disappointingly low.² There are well-known barriers in CR and secondary prevention on the physician side, such as low guideline adherence³ and low patient referral to CR,² and on the patient side, such as difficulties with transport to CR facilities,^{4, 5} older age,⁶ and incorrect beliefs about and poor understanding of their heart disease.⁷ Also, healthcare system barriers and hospital implementation barriers exist such as limited financial incentives, competing workload priorities, and poorly designed preventive programmes.⁸

One solution that is often proposed is telerehabilitation (TR).^{9–12} Telerehabilitation is defined as the use of digital innovations such as smartphone applications, smartwatches, and teleconsultations to deliver CR from a distance.¹³ It enables the remote monitoring of patients and the remote provision of comprehensive rehabilitation using all CR modalities. Multiple trials have already established that TR is effective, and a systematic review has recently confirmed the

effectiveness and cost-effectiveness of TR in coronary artery disease and heart failure.¹³ Yet, many trials have studied TR as an intervention in patients that already agreed to participate in a conventional CR programme,^{14–16} thereby precluding the possibility to investigate whether patients who are eligible but choose not to participate in conventional CR would participate in TR. One study specifically addressed elderly CR non-participants for participating in a TR programme and found that of those patients not participating in CR, only 26% was willing to participate in their TR trial.¹⁷ In this study, barriers and facilitators were not specifically investigated.

It is thus not known what the participation rates in TR would be in a population of patients of all ages with cardiovascular disease, including patients not willing to participate in conventional CR. This information is particularly important if CR participation rates are to be increased. Also, while barriers associated with non-participation in conventional CR have been studied,⁴ evidence about barriers and facilitators to participation in TR remains rare. In those studies that do mention barriers, lack of patient confidence, digital literacy, lack of access to technology, and concerns about safety are most often put forward.^{10, 18}

The aim of this study was to identify the percentage of patients that would be willing to participate in a TR programme, in both conventional CR participants and non-participants, and to identify the main perceived barriers and facilitators for participating in TR. This is

deemed crucial information for the future design of TR programmes tailored to the patients' needs and for the roll-out and implementation of these TR programmes.

Methods

Participants and procedure

Routine care

In our centre, routine care consists of patient screening for indications for CR by the hospital physical therapists, and offering and motivating patients for participation in the centre-based CR programme. The CR programme is a reimbursed programme with a minor co-payment cost for the patient. The programme consists of 45 sessions of comprehensive CR, consisting of a combination of physical exercise training, dietary counselling, psychosocial counselling, and health education. Based on patient preferences, sessions are organized twice or three times per week, resulting in a total duration of 3–6 months of CR.

Patient selection

Patients were recruited from the hospital cardiology and cardiac surgery departments, as well as the CR unit. All patients with an indication for CR were eligible. Two groups of patients were included in this study. The first group were patients refusing participation in conventional CR. This group is defined as the rehabilitation 'non-participants'. The second group consists of patients that were already participating in CR. This group is defined as the rehabilitation 'participants'.

Patients were, as part of routine care, screened for an indication for CR by a team of physiotherapists during their hospitalization on the cardiology departments of a general hospital (Jessa hospital, Belgium), on the short stay, long stay, or cardiac intensive care units, as well as on the cardiac surgery department. Patients with an indication for CR are encouraged to participate in the CR programme. If a patient was not willing to participate, he/she was asked to participate in the study as part of the 'non-participants' group.

The participants were screened for eligibility by a team of physiotherapists in the CR facility and were asked to participate in the study during a CR session. All patients currently included in a CR programme with an indication for CR were eligible for the study. Patients could be included at any time during their CR programme.

Procedure

In both groups, after signing an informed consent, a single investigator (M.F.) conducted a semi-structured interview. For the non-participants group, a screening register was kept of all patients that were asked to participate to the study, including the reasons not to participate in the study.

Measures

Sociodemographic and health-related characteristics

Ten questions were asked about general characteristics (length, weight, smoking status, educational level, working status, relational status, smartphone ownership, transport time to the rehabilitation facility, and means of transport).

Baseline characteristics

Baseline characteristics were collected from the hospital electronic health records in all patients that signed an informed consent.

Semi-structured interview

An open-question survey was constructed based on previous literature^{4–6, 19} by a team of CR and TR experts. Open-ended questions were used to allow the patient to come up with barriers and facilitators that were most important to them. The final survey consisted of 13 open-ended questions about conventional CR and TR in the non-participants group, and of the same 13 questions with an additional 3 questions in the participants group.

The survey started with questions about conventional CR. In the non-participants group, the questions addressed the reasons of not participating in conventional CR, while in the participants group, the questions addressed the positive and negative aspects of the patients' current CR trajectory. After the initial questions a structured explanation about TR was provided to the patients in predefined wording, explaining the meaning of a TR programme, the fact that it would make use of digital technology (computer and/or smartphone), the fact that it could be offered largely at home and explaining that it would consist of a comprehensive TR including telemonitoring, exercise guidance, smoking cessation, dietary, and psychosocial follow-up (see [Supplementary material online, Appendix](#)). Then, the question was asked if the patient would participate in such a TR programme. Barriers and facilitators were then assessed, as well as willingness to pay. At the end of the interview, general questions about baseline characteristics were asked.

Qualitative data analyses

Interviews were recorded using an audio recorder. One investigator (M.F.) transcribed all interviews in full length. Responses were independently coded by two investigators (M.F. and M.S.). Both investigators had experience in clinical research as well as clinical patient care. Responses were coded using Microsoft Excel (version 2019). Per question a coding system was constructed in which every reason was coded into a variable to which the outcome could be coded as positive or negative. In this manner, a qualitative data analysis database was constructed. Interobserver comparison was manually performed and areas of disagreement were highlighted. In case of disagreement, this was solved by a third investigator (P.D.) who made a final decision based on the transcriptions.

The investigators assessed the primary reasons indicated by all patients based on the transcriptions. A first analysis was performed using only the direct answers to the semi-structured questions and the primary reasons for not participating, resulting in a first quantitative analysis (i.e. 'How many patients would participate in TR and what is the highest-ranking primary reason to do or not do so?').

Afterwards, an in-depth qualitative analysis was performed in which every reason given by patients in reply to the open-ended questions is further analysed (i.e. 'What other reasons do patients have for participating or not participating in TR?').

Most definitions used are self-explicatory. For digital literacy, there is no universal definition. It is often defined as 'the ability to seek, find, understand and appraise information from electronic sources and apply the knowledge gained to addressing or solving a problem', while digital health literacy applies more specifically to health information.²⁰ In this study, the term digital literacy was applied for all situations in which patients indicated that they did not feel sufficiently confident or experienced using digital tools to apply them in a health-related or TR context.

Statistical analysis

Data analysis was performed using SPSS (version 27). For continuous data, mean and standard deviation were calculated. Data were tested for normality using the Kolmogorov–Smirnov and Shapiro–Wilk tests. Differences between continuous variables were tested by either independent samples *t*-tests or Mann–Whitney *U* tests. The χ^2 test was used

for comparison of categorical variables. Univariate and multivariate logistic regression was performed to identify factors that affect the odds of choosing to participate in TR.

A *P*-value of <0.05 was considered to be statistically significant.

Ethical committee approval and data privacy

The study complied with good clinical practice in accordance with the Declaration of Helsinki and the laws and regulations applicable in our centre. Written approval from the appropriate ethics committee was obtained (study codes 20.84-reva20.06 and 2020/170). All patients provided written informed consent, granting permission for the conduction and recording of the interviews and for access to their patient record for assessment of baseline characteristics. All data remain stored on a secure drive owned by the research centre for a predefined period of time.

Results

Sample characteristics

Sixty interviews, 30 in non-participants and 30 in participants, were conducted between 16 October 2020 and 5 March 2021. Sociodemographic and health-related characteristics for the total sample (*n* = 60), for the non-participants and the participants, and for those willing to and not willing to participate in TR are depicted in [Tables 1](#) and [2](#). Significant differences between groups are highlighted. By means of logistic regression, it is demonstrated that the odds for participating in TR in the study sample were significantly lower when not owning a smartphone and when not having any familial risk factors.

Non-participants

Screening register

Fifty-three CR non-participants were screened. Eleven patients refused to participate in the interview. Eleven patients were interested in participating in the study, but could not be scheduled for the interview before the time of hospital discharge. One patient declared at the beginning of the interview that he was going to participate in CR and was thus excluded from the non-participant group. Thirty patients met the inclusion criteria and were interviewed as part of the non-participants group.

Quantitative analysis

Results for the CR non-participants are depicted in [Table 3](#). For the quantitative analysis, only the primary reasons mentioned by patients are considered. Across all patients (*n* = 30), the primary reasons not to participate in conventional CR were transport issues (14), already being physically active at home (4), lack of motivation or not seeing the utility of following CR (3), lack of time (3), costs of CR (2), comorbidities (2), or bad experiences with CR in the past (2).

Ten (33%) patients indicated that they would be interested in participating in a cardiac TR programme; 20 (67%) patients indicated that they would not be interested in a cardiac TR programme. Of those patients willing to participate in TR (*n* = 10), the primary reasons were that transport was not necessary (8) and the flexible hours (1). One patient mentioned no particular reason but would participate nonetheless. Six patients would be willing to pay for participating in a TR programme.

Of those patients not willing to participate in TR (*n* = 20), the primary reasons were a lack of digital skills and digital literacy (15), a lack of motivation or not seeing the utility of rehabilitation (4), and a lack of time (1).

Of all CR non-participants, the majority (25, 83%) would not be interested in participating in a blended rehabilitation programme, defined as a partially centre-based CR and a partially remote TR programme.

No significant correlation was found between the primary reason not to participate in CR and the participation or non-participation in TR (*P* = 0.074). The results demonstrate that 4 out of 14 of those who mention transport as a primary reason and 3 out of 4 of those who mention they are physically active at home would participate in TR, while those who mention a lack of motivation, a lack of time or a concern about costs would all not participate in TR.

Qualitative analysis

For the qualitative analysis, all reasons and arguments mentioned by patients are discussed in detail.

Would participate in telerehabilitation

Ten patients indicated that they would like to participate in a cardiac TR programme. Eight patients said that not needing transport was a reason for them to participate. Three patients said that being able to do the rehabilitation sessions on flexible hours was important to them. Three patients indicated that they understood the importance and the value of a rehabilitation programme, and while they were unable to follow the conventional CR programme, they would be willing to follow TR. Other reasons that were mentioned were high patient autonomy and thus not having to depend on family members (1), no risk of contracting COVID-19 (1), good experiences with CR in the past (1), and being able to keep in touch with the CR team from a distance (1).

No interest in telerehabilitation

Twenty patients indicated that they would not participate in a cardiac TR programme. Seventeen patients mentioned that they could not work with or were not fluent with either a computer (1) or both with computer and smartphone (16). Fourteen patients indicated that they also did not have the required technology available, either by not owning a smartphone (2) or owning neither a computer nor a smartphone (12). Other reasons that were mentioned were motivation (7), not seeing the utility of following a TR programme (5), not having the time to follow TR (3), being sufficiently active at home (3), feeling too old to follow TR (3), not being able to follow TR on fixed hours (2), working obligations (1), being illiterate (1), possible costs of TR (1), and comorbidities hampering participation (1).

Participants

Number of sessions

All 30 patients were at the time of the interview already participating in the CR programme.

The mean (\pm standard deviation) number of sessions that had been followed at the time of the interview was 24 (\pm 24) rehabilitation sessions over all 30 patients.

Table 1 Baseline characteristics for all patients, cardiac rehabilitation non-participants, and cardiac rehabilitation participants

	All patients (n = 60)	Non-participants (n = 30)	Participants (n = 30)	P-value
General				
Age (years)	67.9 ± 9.8	71.8 ± 9.8	63.9 ± 8.2	0.002
Gender (male)	50 (83%)	24 (80%)	26 (87%)	0.488
BMI (kg/m ²)	27.4 ± 4.5	25.9 ± 4.0	28.9 ± 4.5	0.02
Cardiac and comorbidities				
Cardiac risk factors				
Smoking status (current smokers)	6 (10%)	4 (13%)	2 (7%)	0.389
Hypertension	42 (70%)	19 (63%)	23 (77%)	0.260
Diabetes mellitus	14 (23%)	6 (20%)	8 (27%)	0.542
Hypercholesterolaemia	48 (80%)	21 (70%)	27 (90%)	0.053
Familial history	21 (35%)	9 (30%)	12 (40%)	0.417
LVEF (%)	50 ± 14	47 ± 15	54 ± 11	0.142
Length of initial hospital stay (days)	3.6 ± 4	4.8 ± 4.6	2.4 ± 3	0.006
Indication for cardiac rehabilitation				
PCI	24 (40%)	5 (17%)	19 (63%)	
CABG	9 (15%)	7 (23%)	2 (7%)	
Ablation	10 (17%)	6 (20%)	4 (13%)	
Device implantation	6 (10%)	3 (10%)	3 (10%)	
Heart failure	7 (12%)	6 (20%)	1 (3%)	
Valvular procedure	4 (7%)	3 (10%)	1 (3%)	
Index event				
Elective revascularization	8 (13%)	3 (10%)	5 (17%)	0.331
Acute coronary syndrome	24 (40%)	9 (30%)	15 (50%)	
Arrhythmia	15 (25%)	9 (30%)	6 (20%)	
Heart failure	9 (15%)	6 (20%)	3 (10%)	
Other	4 (7%)	3 (10%)	1 (3%)	
Comorbidities				
Neurological (stroke, Parkinson, dementia)	9 (15%)	5 (17%)	4 (13%)	0.718
CKD (eGFR <60 mL/min/1.73 m ²)	21 (35%)	13 (43%)	8 (27%)	0.176
Vascular disease	53 (88%)	26 (87%)	27 (90%)	0.688
Survey data				
Smartphone (owning a smartphone)	36 (60%)	11 (37%)	25 (83%)	<0.001
Transport time to nearest rehabilitation facility (min)	24 ± 18.4	29.2 ± 23.0	19.0 ± 10.3	0.04
Transport independence (independent for transport, not dependent on others)	47 (78%)	20 (67%)	27 (90%)	0.028
Diploma (higher education)	15 (25%)	6 (20%)	9 (30%)	0.371
Employment (currently working)	11 (18%)	3 (10%)	8 (27%)	0.095
Incapacity of work or disabled	4 (7%)	2 (7%)	2 (7%)	
Unemployed	1 (2%)	0 (0%)	1 (3%)	
Retired	44 (73%)	25 (83%)	19 (63%)	
Relationship status (partner or married)	40 (67%)	18 (60%)	22 (73%)	0.273

Significant P-values are in bold.

BMI, body mass index; CABG, coronary artery bypass graft; CKD, chronic kidney disease; CR, cardiac rehabilitation; LVEF, left ventricular ejection fraction; PCI, percutaneous coronary intervention.

Quantitative analysis

Questionnaire results for the CR participants are depicted in [Table 4](#). For the quantitative analysis, only the primary reasons mentioned by patients are considered.

Eighteen (60%) patients indicated that they would be interested in participating in a cardiac TR programme. Of these patients, the

primary reasons were not needing transport (6) and the flexibility of training hours (2). Four patients indicated that multiple reasons were important to them and six patients mentioned other reasons as their primary reason, as discussed in the qualitative analysis below. In the same group, possible negative aspects of TR that were mentioned were the lack of a feeling of obligation when doing TR at home (6),

Table 2 Baseline characteristics for telerehabilitation non-participants vs. telerehabilitation participants

	No TR (n = 32)	TR (n = 28)	P-value
General			
Age (years)	70.9 ± 9.0	64.4 ± 9.7	0.012
Gender (male)	26 (81%)	24 (86%)	0.643
BMI (kg/m ²)	26.8 ± 4.5	28.0 ± 4.4	0.411
Cardiac and comorbidities			
Cardiac risk factors			
Smoking status (current smokers)	4 (13%)	2 (7%)	0.490
Hypertension	22 (69%)	20 (71%)	0.821
Diabetes mellitus	8 (25%)	6 (21%)	0.744
Hypercholesterolaemia	26 (81%)	22 (79%)	0.796
Familial history	6 (19%)	15 (54%)	0.005
LVEF (%)	48 ± 15	53 ± 12	0.395
Length of initial hospital stay (days)	3.9 ± 4.3	3.3 ± 3.7	0.522
Indication for cardiac rehabilitation			0.305
PCI	9 (28%)	15 (54%)	
CABG	5 (16%)	4 (14%)	
Ablation	6 (19%)	4 (14%)	
Device implantation	4 (13%)	2 (7%)	
Heart failure	6 (19%)	1 (4%)	
Valvular procedure	2 (6%)	2 (7%)	
Index event			0.274
Elective revascularization	5 (16%)	3 (11%)	
Acute coronary syndrome	9 (28%)	15 (54%)	
Arrhythmia	9 (28%)	6 (21%)	
Heart failure	7 (22%)	2 (7%)	
Other	2 (6%)	2 (7%)	
Comorbidities			
Neurological (stroke, Parkinson, dementia)	6 (19%)	3 (11%)	0.756
CKD (eGFR <60 mL/min/1.73 m ²)	15 (47%)	6 (21%)	0.039
Vascular disease	4 (13%)	3 (11%)	0.830
Survey data			
Smartphone (owning a smartphone)	12 (38%)	24 (86%)	<0.001
Transport time to nearest rehabilitation facility (min)	23.3 ± 14.3	25.1 ± 22.4	0.776
Transport independence (independent for transport = not dependent on others)	24 (75%)	23 (82%)	0.503
Diploma (higher education)	5 (16%)	10 (36%)	0.073
Employment (currently working)	2 (6%)	9 (32%)	0.010
Incapacity of work or disabled	2 (6%)	2 (7%)	
Unemployed	0 (0%)	1 (4%)	
Retired	28 (88%)	16 (57%)	
Relationship status (partner or married)	21 (66%)	19 (68%)	0.855
Likelihood of participating in TR			
	OR (95% CI) for participation in TR		P-value
Participation in CR (no participation)	1.133 (0.258–4.975)		0.869
Age	0.976 (0.903–1.055)		0.546
Familial cardiovascular risk (no familial risk)	0.158 (0.034–0.736)		0.019
CKD (no CKD)	1.453 (0.327–6.452)		0.623
Smartphone (not owning a smartphone)	0.115 (0.021–0.625)		0.012
Employment (not employed)	0.284 (0.036–2.269)		0.235

Significant P-values are in bold.

BMI, body mass index; CABG, coronary artery bypass graft; CKD, chronic kidney disease; CR, cardiac rehabilitation; LVEF, left ventricular ejection fraction; OR, odds ratio; PCI, percutaneous coronary intervention; TR, telerehabilitation.

Table 3 Cardiac rehabilitation non-participants

Primary reason not to participate in conventional cardiac rehabilitation			
Transport		14 (47%)	
Already physically active at home		4 (13%)	
Lack of motivation/does not see utility		3 (10%)	
Lack of time		3 (10%)	
Costs are too high		2 (7%)	
Comorbidities		2 (7%)	
Bad experience with rehabilitation in the past		2 (7%)	
Would you participate in cardiac telerehabilitation?			
Yes		10 (33%)	
Primary reason to participate in cardiac TR			
No transport necessary		8 (80%)	
Flexible hours		1 (10%)	
No particular reason		1 (10%)	
Would you be willing to pay for a TR programme?			
Yes		6 (60%)	
No		4 (40%)	
No		20 (67%)	
Primary reason not to participate in cardiac TR			
Lack of digital literacy		15 (75%)	
Lack of motivation/does not see utility		4 (20%)	
Lack of time		1 (5%)	
Primary reason not to participate in CR vs. participation in TR			
	No TR (n = 20)	TR (n = 10)	P = 0.074
Transport	10	4	
Already physically active at home	1	3	
Lack of motivation/does not see utility	3	0	
Lack of time	3	0	
Costs are too high	2	0	
Comorbidities	0	2	
Bad experience with rehabilitation in the past	1	1	
Would you participate in a blended cardiac centre-based rehabilitation and telerehabilitation programme?			
Yes		3 (10%)	
No		25 (83%)	
Inconclusive		2 (7%)	

CR, cardiac rehabilitation; TR, telerehabilitation.

the lack of specialized exercise equipment at home (6), the lack of physical contact with peers or with the rehabilitation team (3), and a lack of digital literacy (1). Two patients could not think of any negative aspects about a TR programme.

All 18 patients would be willing to pay for participation in a TR programme.

Of those patients not willing to participate in a TR programme ($n = 12$), the primary reasons not to participate were a lack of digital literacy (6), the lack of a feeling of obligation to train (4), the lack of equipment at home (1), and safety concerns when training at home (1). In this group, possible positive aspects of TR that were mentioned were not needing transport (1), the obligation to keep training at home (1), and an interest in digital technology in general (1).

Of all patients, the majority (21, 70%) would be interested in participating in a blended rehabilitation programme. When free to

choose, 44% of patients would still prefer the centre-based CR, while an equal proportion (44%) would prefer either TR (11%) or a blended CR programme (33%). Eleven percent of patients did not have a clear preference for either centre-based CR vs. TR.

Qualitative analysis

For the qualitative analysis, all reasons and arguments that were mentioned by patients are discussed in detail.

Would participate in telerehabilitation

Eighteen patients indicated that they would like to participate in a cardiac TR programme. Nine patients considered that not needing transport was an important advantage. Three patients indicated that they understood the value of following a CR programme for their health and that to them it would not matter if this was centre-based

Table 4 Cardiac rehabilitation participants

Conventional cardiac rehabilitation	
Primary positive aspect about current rehabilitation	
Progressively gaining better fitness	15 (50%)
The obligation of having to train	6 (20%)
Exercise supervision by physiotherapist experts	5 (17%)
Safety of supervised training	3 (10%)
Equipment	1 (3%)
Primary negative aspect about current rehabilitation	
No negative aspects	18 (60%)
Transport to CR facility	8 (27%)
Hard to combine with work	2 (7%)
Combination with taking care for dependent family member	1 (3%)
Hard to come on fixed moments	1 (3%)
Would you participate in cardiac telerehabilitation?	
Yes	18 (60%)
Primary reason to participate in TR	
No transport necessary	6 (33%)
Multiple reasons are important to me	4 (22%)
Flexibility of training hours	2 (11%)
Other	6 (33%)
Possible negative aspects of TR	
Less feeling of obligation if it is only TR	6 (33%)
No equipment at home	6 (33%)
Likes to be among people, train in group and interact with personnel	3 (17%)
No negative aspects	2 (11%)
Lack of digital literacy	1 (6%)
Would you prefer centre-based CR or TR?	
Centre-based CR	8 (44%)
TR	2 (11%)
Combination of centre-based CR and TR (blended)	6 (33%)
No preference for either	2 (11%)
Would you be willing to pay for a TR programme?	
Yes	18 (100%)
No	0 (0%)
No	12 (40%)
Primary reason not to participate in TR	
Lack of digital literacy	6 (50%)
Less feeling of obligation if it is only TR	4 (33%)
No equipment at home	1 (8%)
Safety concerns when training at home	1 (8%)
Possible positive aspects of TR	
No transport necessary	1 (8%)
Obligation to keep training at home	1 (8%)
Interest in digital technology	1 (8%)
Would you participate in a blended cardiac centre-based rehabilitation and telerehabilitation programme?	
Yes	21 (70%)
No	8 (27%)
Inconclusive	1 (3%)

CR, cardiac rehabilitation; TR, telerehabilitation.

CR or TR. Three patients were very interested in digital technology in general, and one patient was already familiar and had positive experiences with an atrial fibrillation telemonitoring programme. Three patients would be interested in TR but would be especially interested in a blended programme that consisted of partially TR and partially CR. Two patients indicated that being able to train at flexible hours is an advantage.

In the group that would participate in TR, the following reasons were nevertheless identified as possible disadvantages of TR. Eleven patients were worried about the lack of sports equipment at their homes. Six patients were worried that they would feel less obligated to do the exercises at home compared to coming to the CR facility. Four patients would miss the physical contact with peers and personnel and liked to train in group. Two patients were worried that their own digital skills and digital literacy might be insufficient to participate.

No interest in telerehabilitation

Twelve patients indicated that they would not participate in a TR programme. Six patients were worried that they would feel less obligated when doing the training at home and that their adherence would thus be lower. Six patients indicated that they were insufficiently fluent with working with either a computer or a smartphone. Four patients indicated that they did not have a computer or a smartphone. Two patients also indicated that they were not interested in digital technology. Four patients indicated that they preferred to train in group and that they like to get to know other people. Four patients indicated that they were concerned about safety when performing exercise at home without supervision, especially in case of a cardiac event. Other reasons were lack of equipment (2), possible costs of TR (1), and feeling too old for TR (1).

Discussion

To our knowledge, this is the first study that directly assessed the willingness to participate in cardiac TR in a broad patient population including conventional CR participants and non-participants.

Our study shows that a minority (33%) of CR non-participants would be prepared to participate in TR, and an even smaller proportion (10%) would be prepared to participate in a blended CR programme. This is in contrast to CR participants in which a majority (60%) would participate in TR with an even larger proportion (70%) being interested in a blended CR programme. An equal proportion of these patients would prefer centre-based CR (44%) vs. either TR or blended CR/TR (44%), with in the latter group most (33%) preferring a blended programme over a full TR programme (11%).

These results correspond to an earlier study in which a similar proportion of elderly CR non-participants participated to a TR trial.¹⁷ Our findings illustrate that, even with new technological solutions, those not participating in CR remain a difficult group to deliver optimal guideline-based therapy to. Blended CR programmes do not offer a solution for this group. Those convinced by a full TR programme constitute a minority. Nevertheless, if one-third of these patients could indeed be convinced to participate in TR programmes, there is a large health benefit to be gained by implementing this technology.

In contrast, those already enrolled in CR are clearly more prepared to try out new ways of CR. Both a full TR and a blended CR programme seem appealing for this patient group, with many patients even preferring to try TR or blended CR over conventional CR. This finding demonstrates that implementation of long-term blended CR programmes could be a future opportunity.

In the CR non-participants, not surprisingly, and corresponding to earlier results about non-participation in conventional CR,⁴ the fact that transport is not needed is for this group of patients the most important positive factor about TR. In contrast, a lack of digital literacy is in this group by far the most important reason (75%) not to participate in TR. The latter emphasizes the challenge for healthcare and local governments to, while developing new digital technology, also investigate means to educate all types of patients in digital literacy and basic digital skills and to provide widespread access to digital technology.²¹ As shown in our results, this could directly increase uptake of TR. Another patient group, those with low motivation towards rehabilitation in general (20%), will perhaps remain the most challenging to convince. Possibly, through persuasive design of very low-threshold and user-friendly technology, and by use of gamification in educational tools, also this patient group could be convinced step by step into a higher health literacy, a higher adherence to therapy and possibly a higher participation rate in CR and/or TR.

In the CR participants, the main motivation to participate in TR is more heterogeneous, but no transport necessity still ranks first. In those not willing to participate in TR, digital literacy again appears to be the most important reason. In both those willing to participate as well as those not willing to participate in TR, the lack of specialized equipment at home is mentioned as a possible disadvantage. This barrier could be easily addressed by patient education on how to perform highly efficient exercises without the need for equipment at home. Also, the fact that less obligation might be felt at a distance is often mentioned. Future trials will have to point out if adherence rates are indeed lower in TR compared to centre-based CR programmes, and if so, how to address this patient concern.

A significant difference was seen in smartphone ownership between CR participants and non-participants, which was not shown in earlier studies. This could possibly be fully explained by the older age of the non-participants, although it could also be hypothesized that not owning a smartphone could be correlated with a lower self-efficacy, which is known to be correlated with lower CR participation rates,⁴ and/or with a lower willingness to engage with new experiences (new technology as well as change to new behaviour, such as in CR).

When comparing those who would participate in TR and those who would not, it is seen that those who would participate own a smartphone more often, which can be explained by the fact that some level of technological equipment and skills would be required to participate in a TR programme.

Limitations

The study has certain limitations. The study was conducted between 16 October 2020 and 5 March 2021 with the COVID-19 pandemic still surging worldwide and with continuously evolving government measures such as lockdowns. While fear of or logistical measures due to COVID-19 were only rarely mentioned by patients as an important reason for willingness or non-willingness to participate in TR,

the ever-changing circumstances might have influenced the answers of the patients and thus the results of the study. However, as the pandemic is still ongoing, it is now becoming increasingly clear that some aspects of society have permanently changed, and many facets of healthcare and patients' personal lives are now part of a new reality. The results of this study might therefore be all the more relevant.

A second limitation is that in the structured part of the interview, a TR model comprising of comprehensive, asynchronous rehabilitation with digital support by either computer or smartphone was put forward. Other forms of TR were not systematically discussed with patients, and thus results may not be applicable to other forms of TR.

A third limitation is that, while TR was explained to constitute of telemonitoring, exercise guidance, smoking cessation, dietary and psychosocial follow-up, patients often focused on the physical activity part as this constitutes the majority of CR sessions. However, several patients did indicate that especially for the dietary and psychosocial counselling, remote counselling would be an ideal alternative.

Another limitation is that, due to the nature of the study, only willingness to participate in a TR programme is assessed. Consequent studies that offer participation in an actual TR programme should confirm if participation rates in TR are comparable to these results.

Future studies could focus further on survey-based analysis in larger study populations. Furthermore, studies focusing on development and implementation of TR programmes should incorporate qualitative assessment of those not willing to participate and the main barriers and facilitators that play a role.

Conclusion

A minority (33%) of CR non-participants would be prepared to participate in TR, and an even smaller proportion (10%) would be prepared to participate in a blended CR programme, while a majority (60%) of CR participants would participate in TR with an even larger proportion (70%) interested in a blended CR programme. This illustrates that for CR non-participants, blended programmes might not offer a good solution, and TR will only partly solve the problem of low participation rates. This is in contrast to CR participants that are clearly more prepared to try out TR and blended CR.

In both groups, the main facilitating aspect about TR was not needing transport, and the main barrier was digital literacy and digital skills emphasizing the challenges for healthcare and local governments to keep educating all types of patients in digital literacy and basic digital skills. These results are important for the future roll-out and implementation of TR programmes.

Supplementary material

Supplementary material is available at *European Heart Journal – Digital Health* online.

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Data availability

Data available on request.

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