Patient interest in mHealth as part of cardiac rehabilitation in Switzerland

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Summary

PURPOSE: Smartphone-based health interventions (mHealth) offer the potential to overcome barriers to accessibility of cardiac rehabilitation. We aimed (1) to examine patients' interest in mHealth as part of the outpatient cardiac rehabilitation (phase II) and long-term aftercare (phase III) and (2) to identify the influence of sociodemographic and clinical patient characteristics on interest in mHealth.

METHODS: A questionnaire was consecutively handed out to 2041 patients concluding outpatient cardiac rehabilitation between March 2013 and December 2018 at the University Hospital Bern. Multivariate logistic models were used to identify influencing factors (age, sex, smartphone ownership, year, compliance with cardiac rehabilitation, physical fitness, body mass index, diabetes mellitus, German speaking) for mHealth interest.

RESULTS: The questionnaire was returned by 1025 patients (50.2% response rate). Seventy-one percent of the responding patients preferred the cardiac rehabilitation as offered with three weekly centre-based sessions, whereas 12% preferred and 17% considered replacing two out of the three centre-based sessions per week with mHealth. Forty-eight percent were interested in continuing exercise training using mHealth after completion of cardiac rehabilitation. Smartphone ownership was the most important indicator for patient interest in mHealth (odds ratio [OR] 2.54, 95% confidence interval [CI] 1.53–4.23), whereas age (per year) was not independently associated with mHealth interest for phase II (OR 0.99, 95% CI 0.98–1.01) and only weakly associated with phase III (OR 0.98, 95% CI 0.96–0.99).

CONCLUSION: In a Swiss urban region with easy access to cardiac rehabilitation, patients who participated in a centre-based cardiac rehabilitation programme between 2013 and 2018 showed little interest in mHealth during phase II. However, almost half of them expressed interest in continuing training with mHealth during phase III.

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Introduction

Cardiac rehabilitation after an acute cardiovascular event is traditionally differentiated into the following three phases: phase I, early mobilisation to prevent complications of immobilisation; phase II, comprehensive structured in- or outpatient cardiac rehabilitation with medical treatment and exercise, as well as nutritional, psychological and physical activity counselling; phase III, a long-term outpatient programme in an individual or community-based setting [1].

Despite the fact that cardiac rehabilitation is endorsed by the European Association for Preventive Cardiology and the American Heart Association [1, 2], only 44.8% of patients in Europe were referred to cardiac rehabilitation after a coronary event or revascularisation, of whom only 80% decided to participate in cardiac rehabilitation [3]. A systematic review and meta-synthesis of qualitative data identified physical barriers such as lack of transport and financial cost as some of the key reasons for not attending cardiac rehabilitation [4]. Alternatives to conventional cardiac rehabilitation using tele-monitoring (patient-provider contact is mostly established by internet and/or telephone) have been developed to overcome these barriers and were found to be as effective as traditional cardiac rehabilitation in improving exercise capacity and physical activity level [5, 6].

The increasing digitalisation of healthcare services and the growing popularity of smartphone applications enhance the potential for tele-rehabilitation. A recent randomised clinical trial found smartphone based real-time remote exercise monitoring and coaching noninferior to traditional centre based cardiac rehabilitation in improving exercise capacity, but cheaper to deliver [7].

The use of mobile technology for health interventions (mHealth) seems to improve participation and adherence to cardiac rehabilitation; however, the implementation of mHealth in cardiac rehabilitation is still in the early phase [8].

The development of tele-medicine has focused mainly on new possibilities due to advances in technology, rather than on patients' needs and wishes [9]. Nevertheless, a previous study concluded that automated text messages with exer-

cise prescriptions are well accepted but further tailoring to individual needs would be desirable [10]. A combination of modern tele-rehabilitation (including training monitoring and recommendations via smartphone) and traditional centre-based cardiac rehabilitation may have the potential to reduce some of the barriers (i.e., transport difficulties, time constraints) without sacrificing the close supervision of cardiac rehabilitation patients by specialists. Nevertheless, little is known about the interest of cardiac rehabilitation patients in replacing some of the face-to-face training sessions with mHealth. Prior to the implementation of mHealth into clinical practice, it is of interest if and which patients would welcome mHealth as part of the traditional cardiac rehabilitation.

We therefore aimed to (1) assess the interest in mHealth as part of the outpatient cardiac rehabilitation (phase II) and long-term aftercare (phase III) and (2) identify the influence of sociodemographic and clinical patient characteristics on their interest in mHealth.

Materials and methods

Study design and setting
This study was a cross-sectional study, wherein a simple questionnaire was handed out to patients at the completion visit of the 3-month exercise-based outpatient cardiac rehabilitation programme at a large tertiary cardiovascular referral centre.

Participants
Consecutive patients with different aetiologies (coronary artery disease, chronic heart failure, born with congenital heart disease, diabetes, cancer, stroke, peripheral artery disease) who concluded the programme between March 2013 and December 2018 were included in the study. Patients who refused to provide the hospitals' general informed consent were excluded. The study was approved by the Ethics Commission of the Canton of Bern.

Variables
The questionnaire was self-designed, available in the German language only, distributed in paper form and contained the questions shown in table 1. The questionnaire was distributed and generally completed during the patients' cardiac rehabilitation concluding visit, which usually took place during or following the week of their final cardiac rehabilitation session. If patients attended the cardiac rehabilitation programme multiple times during the study period, only data from the first time were used for analyses.

Data sources
Sociodemographic and clinical information of all patients who participated in cardiac rehabilitation during the study duration were derived from the hospital's electronic patient management system.

Study size
Since this study was purely descriptive, sample size was not predetermined. In order to assess time trends over the study duration, we estimated that data needed to be sampled over at least 5 years. We aimed at collecting data from as many of our cardiac rehabilitation patients as possible.

Quantitative variables
Variables extracted from the hospital database included sex, age, smoking status (current smoking versus never/previous smoking), diagnosed with diabetes mellitus, German speaking (yes/no), completion of cardiac rehabilitation programme (yes/no), compliance with cardiac rehabilitation programme (in % of planned sessions), type of cardiac rehabilitation programme (cardiovascular / diabetic / neurological / oncological / congenital heart disease), body mass index (BMI) at cardiac rehabilitation end, change in BMI from cardiac rehabilitation start to end, power output of as percentage of predicted at end of cardiac rehabilitation, change in power output of as percentage of predicted from start to end of cardiac rehabilitation (in % of baseline value).

Statistical analyses
All statistics were performed with R (Version 3.5.1, R Core Team, 2017).

Patient characteristics were described as frequencies or median and interquartile range and compared between patients who did or did not complete the questionnaire using two-sample Wilcoxon tests (package exactRankTests) for continuous and chi-square tests (package stats) for binary variables. The p-values were adjusted for multiple comparisons according to the Holm-Bonferroni method. We used logistic models (ordinal for phase II) and (binary for phase III), adjusted for age, sex, BMI, year, compliance, power output, diabetes and language, in order to identify predictors for patient acceptance of mHealth in rehabilitation phase II and phase III separately. As additional sensitivity analyses, multivariate logistic models were used to identify predictors for not answering the questions to phase II and III and for owning a smartphone. Odds ratios (ORs) and 95% confidence intervals (CIs) for each predictor were reported. Alpha was set at 0.05 for all analyses.

Table 1: Questionnaire.

1. Do you own a smartphone?		
	? yes	? no
2. What type of ambulatory cardiac rehabilitation programme would suit you best?		
	? I prefer the currently offered cardiac rehabilitation programme with three centre-based sessions per week	
	? I would consider performing a cardiac rehabilitation programme with one centre-based session per week and two sessions with smartphone application	
	? I would definitely prefer performing a cardiac rehabilitation programme with one centre-based session per week and two sessions with smartphone application	
3. Would you like to continue with exercise training at home using a smartphone eHealth application?		
	? yes	? no

Results

Overall, 2041 patients were included in the study of whom 1025 (50.2%) returned the questionnaire. Table 2 shows the comparison of the patient population who returned the questionnaire (returners) and the population who did not return the questionnaire (non-returners). We found a significantly greater proportion of patients with German as native language, a lower proportion of patients with diabetes mellitus and a better compliance with cardiac rehabilitation in returners than in non-returners (table 2).

Of the 1025 questionnaire returners, 819 answered the question on phase II, 861 the question on phase III, and 757 patients answered all questions. Seventy-one percent of the responding patients preferred to keep the current programme with three weekly centre-based cardiac rehabilitation sessions in phase II, whereas replacement of the three offered in-house sessions by two mHealth sessions per week was preferred by 17% and considered by 12%. With regard to phase III, 48% of patients were interested in a continuation of exercise training using mHealth. In the multivariate logistic models, smartphone ownership was found to be the most important indicator for patients' mHealth interest for phase II (OR 2.54, p = 0.0003) and for phase III (OR 6.10, p <0.0001, table 3). Correspondingly, the proportion of patients with an interest in mHealth was higher in those owning a smartphone than in those not owning a smartphone (fig. 1).

Sensitivity analyses on missing answers in the returned questionnaires are summarised in table 4. They revealed that smartphone owners were significantly more likely to answer the questions on phase II and phase III whereas older patients were, independent of smartphone ownership, more likely to omit the question on phase II (table 4). Since ownership was the most important predictor of interest in mHealth and answering the questions on mHealth, we additionally identified predictors for smartphone ownership (table 4). Age, time (year during which cardiac rehabilitation was performed) and power output at cardiac rehabilitation end were significantly associated with increased smartphone ownership. Smartphone ownership increased from 58% to 79% between 2014 and 2018 with a Pearson correlation coefficient of 0.89 (p = 0.038).

Table 2: Comparison of patients with and without a completed questionnaire.

	Completed questionnaire				Adjusted p-value
	Yes n = 1017		No n = 1024		
Male sex	783	(77%)	764	(75%)	1.0000
Age	59.6	(51.5; 67.6)	60.9	(52.2; 68.4)	0.1818
Smoker	312	(31%)	304	(30%)	1.0000
German speaking	954	(94%)	884	(87%)	<0.0001
Completed programme					0.2209
– Cardiovascular	803	(79%)	790	(77%)	
– Diabetic	30	(4%)	37	(4%)	
– Neurological	89	(9%)	99	(10%)	
– Oncological	89	(9%)	78	(8%)	
– GUCH	33	(3%)	13	(1%)	
BMI at cardiac rehabilitation start (kg/m^2)	26.5	(23.5; 29.7)	26.8	(24.2; 30.3)	0.1090
BMI at cardiac rehabilitation end (kg/m^2)	26.4	(23.7; 29.8)	26.8	(24.2; 30.1)	0.5552
Change in BMI (kg/m^2)	0.00	(-0.54; 0.67)	0.00	(-0.44; 0.63)	1.0000
Diabetes mellitus	171	(17%)	246	(24%)	0.0004
Power output of predicted (%) at start of cardiac rehabilitation (Jones)	77.9	(61.1; 95.8)	74.0	(55.4; 93.8)	0.0955
Power output of predicted (%) at end of cardiac rehabilitation (Jones)	93.8	(73.7; 112)	91.9	(70.9; 114)	1.0000
Change in power output (in % of baseline)	13.6	(4.94; 23.1)	13.26	(4.87; 23.1)	1.0000
Compliance (%)	97.2	(83.3; 100)	88.9	(54.9; 100)	<0.0001
Owning a smartphone	669	(66%)		Unknown	

BMI = body mass index; GUCH = grown-up with congenital heart disease; Data are presented as median and interquartile range for continuous variables and n (%) for categorical variables. The p-values for group comparisons are derived from Wilcoxon and chi-square tests with Bonferroni-Holm adjustment for multiple comparisons

Table 3: Multivariate logistic models for smartphone application interest in phase II and phase III respectively.

	Phase II		Phase III	
	OR	95% CI	OR	95% CI
Age (years)	0.99	(0.98; 1.01)	0.98	(0.96; 0.99)[**]
Female sex	1.32	(0.82; 2.13)	0.94	(0.59; 1.50)
Smartphone user	2.54	(1.53; 4.23)[***]	6.06	(3.73; 9.83)[***]
Year of cardiac rehabilitation	0.98	(0.87; 1.12)	0.95	(0.84; 1.08)
Compliance (%)	0.98	(0.97; 0.99)[***]	0.99	(0.98; 1.00)[*]
Power output at end of cardiac rehabilitation (watt)	1.00	(1.00; 1.01)	1.00	(1.00; 1.01)[**]
Body mass index at end of cardiac rehabilitation (kg/m^2)	1.01	(0.97; 1.04)	1.00	(0.96; 1.03)
Diabetes mellitus	0.88	(0.52; 1.49)	0.98	(0.59; 1.63)
German speaking	0.81	(0.41; 1.61)	0.98	(0.50; 1.93)

CI = confidence interval; OR = odds ratio * p <0.05, ** p <0.01, *** p <0.001

Discussion

To the best of our knowledge, this is the first study investigating patient factors such as sociodemographic, health, and treatment-related variables influencing mHealth interest in cardiac rehabilitation patients in Switzerland for rehabilitation phase II and III. Amongst patients who completed an outpatient cardiac rehabilitation programme in our urban Swiss centre with easy access, we found little interest in replacing part of the face-to-face cardiac rehabilitation programme by training sessions using smartphone applications. For phase III rehabilitation, however, nearly half of the patients considered mHealth for training assistance. These results indicate that our patients have little incentive to partly replace the centre-based outpatient cardiac rehabilitation programme in our Swiss urban setting with short travel distances and an excellent public trans-

port system. MHealth was considered as a training option for phase III rehabilitation by most of our patients.

We found that the majority of patients who completed our outpatient cardiac rehabilitation programme did not consider mHealth as a desirable alternative to the current face-to-face training. This is somewhat contradictory to the findings of Buys et al. (2016), who found a high interest in technology-enabled rehabilitation in cardiac patients [11]. The different finding may be explained by the higher proportion of respondents owing a smartphone (97%) in the study of Buys et al. compared with our study (67%), since smartphone ownership was the strongest factor related to mHealth interest in the present study. The high proportion of smartphone owners in the former study suggests a selection bias, namely the inclusion of technology-minded patients. According to the Swiss Federal Statistical Office, only 63% of the general population in Switzerland used smartphones for internet access in 2017 [12], suggesting that our study population largely reflected the gen-

Figure 1: Interest in a smartphone application as part of the traditional cardiac rehabilitation (phase II, panel A) and for the long-term aftercare (phase III, panel B) overall and grouped by smartphone users and non-users.
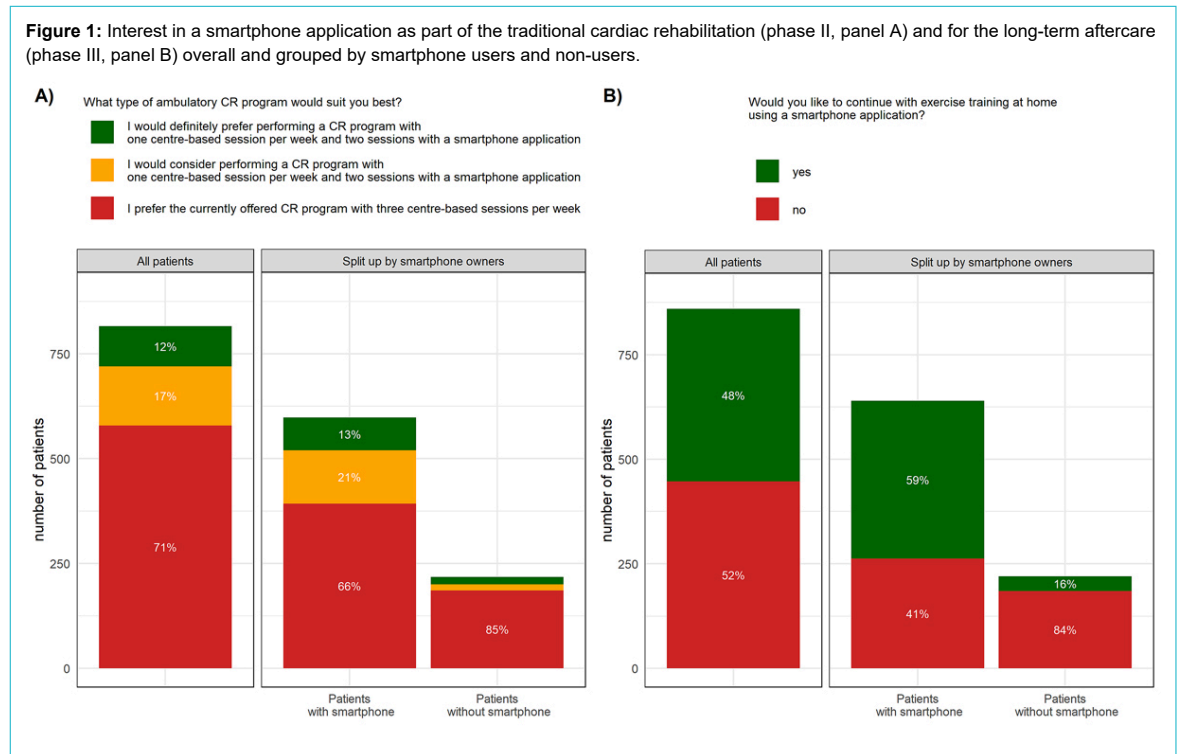
Table 4: Multivariate logistic models for answering questions to phase II and III and for smartphone ownership.

	Answer to Phase II		Answer to Phase III		Smartphone user	
	OR	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Age (years)	0.96	(0.94; 0.98)***	0.98	(0.96; 1.00)*	0.94	(0.93; 0.96)***
Female sex	0.78	(0.49; 1.23)	0.99	(0.57; 1.72)	0.96	(0.61; 1.49)
Smartphone user	2.92	(1.92; 4.45)***	8.71	(5.12; 14.81)***		
Year of cardiac rehabilitation	1.06	(0.91; 1.24)	1.25	(1.03; 1.51)*	1.33	(1.16; 1.52)***
Compliance (%)	1.01	(1.00; 1.02)	1.00	(0.99; 1.01)	1.00	(0.99; 1.01)
Power output at end of cardiac rehabilitation (watt)	1.00	(0.99; 1.01)	1.00	(0.99; 1.01)	1.01	(1.00; 1.01)***
Body mass index at end of cardiac rehabilitation (kg/m^2)	1.03	(0.99; 1.08)	0.99	(0.95; 1.03)	0.99	(0.95; 1.02)
Diabetes mellitus	0.99	(0.56; 1.75)	1.12	(0.59; 2.13)	1.23	(0.77; 1.96)
German speaking	1.63	(0.79; 3.37)	2.04	(0.89; 4.68)	0.82	(0.41; 1.61)

CI = confidence interval; OR = odds ratio * p <0.05, ** p <0.01, *** p <0.001

eral Swiss population in terms of smartphone ownership. It is not surprising that patients in our cohort who owned a smartphone showed a higher interest in mHealth. This finding is in line with previous studies on patient acceptance of health information technology and emphasises the fact that technical know-how and previous experience with the use of smartphones are key factors for the acceptance of mHealth [13]. The usage of smartphone seems to increase in Switzerland. Compared with 63% in 2017, only 52% of the people used smartphones for internet access in 2014. Swiss smartphone usage has increased particularly in the older age groups, namely from 59% to 73% in the age group of 30–39 years and from 14% to 31% within the 60+ age group [12]. From the increase of smartphone owners in the aged population, an increase of mHealth popularity in cardiac rehabilitation patients may be expected.

Age was previously found to be negatively related to mHealth [11], but without taking the potentially reduced access to smartphones in the higher age groups into account. Age was inversely related to smartphone ownership in our study (table 3), but age itself was not independently associated with interest in mHealth for phase II and only weakly associated with reduced interest in mHealth for phase III (table 3). Therefore, older age may not be a predictor for reduced interest in mHealth of cardiac rehabilitation patients *per se*, but rather be explained by the, to date, reduced access to smartphones.

The negative association between age and smartphone ownership was pointed out by a recent structural literature review of Reiners et al. (2019), who concluded that older people often do not own devices to access electronic healthcare services (eHealth), or if they do, they lack the skills to use them properly [14]. Therefore, elderly people need special encouragement and support [15].

Consistently with a previous study assessing determinants of the acceptance of using the internet in healthcare services, we did not find sex to be associated with mHealth interest [16]. However, we detected a significant inverse association between patients' mHealth interest and compliance with the centre-based programme. Patients with low compliance may have experienced difficulties attending centre-based cardiac rehabilitation due to transportation difficulties, time constraints, or other barriers. The high average compliance rate of 97.2% observed in our study indicates that barriers for patients who chose to complete a centre-based cardiac rehabilitation programme were small. This may have been based on the special situation in Switzerland, where centres offering out- or inpatient cardiac rehabilitation are plentiful in the more populated areas. Therefore, traveling distances are generally small, and public transport is excellent, making these cardiac rehabilitation programmes readily accessible for most patients. In the more remote areas of the mountains, interest may be greater; however, this population was poorly represented in the current study.

We performed some further sensitivity analyses on the return rate of our questionnaire. Patients who returned the questionnaire less often had diabetes and were more compliant to the centre-based cardiac rehabilitation, however, they did not differ with regard to age compared to patients who did not return the questionnaire (table 2). Nevertheless, older patients were more likely to not answer the question on interest in mHealth for phase II when they returned the questionnaire. This may have led to an underestimation of the association between age and mHealth interest in our study, as elderly patients who were potentially not interested may not have answered the questions at all. Similarly, patients who did not own a smartphone were more likely to not answer the questions on mHealth interest in phase II or III, and if they did, they were more likely to have no interest in mHealth. Therefore, the overall interest in mHealth in our study may have been overestimated.

The main limitation of this study was the study population, which was limited to patients who performed centre-based cardiac rehabilitation. It would have been very interesting to know whether patients who declined phase II cardiac rehabilitation would have considered or preferred mHealth. Further, not all patients received the questionnaire; however, whether patients received a questionnaire depended mostly on staff availability and less on the patients themselves, so it was likely random. We compared the non-responding to the responding population and consequently know that our results apply mainly to the German speaking, exercise compliant, and non-diabetic group of our patients. Also, there was no standardised introduction to mHealth for all patients, rather apps were presented to patients by the physiotherapists during phase II on an individual basis. The present study reflects mHealth interest of cardiac rehabilitation patients of one large tertiary referral centre, which may be applicable to other urban centres of Switzerland, but is unlikely to be transferable to other countries. Last but not least, our study reflects mHealth interest of the years 2013 to 2018. MHealth popularity may increase once today's young technology users are the cardiac rehabilitation patient population of tomorrow [11].

Conclusion

In a Swiss urban region with good access to cardiac rehabilitation, patients who participated in a conventional centre-based cardiac rehabilitation programme between 2012 and 2018 showed little interest in mHealth during phase II. However, almost half of them expressed interest in continuing training with mHealth during phase III. Interest in mHealth for phase II and phase III cardiac rehabilitation may increase in the future as a consequence of a more widespread use of smartphones also in the more aged population.

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