Adherence to a blended intervention for patients with hip- and/or knee osteoarthritis, a mixed methods study

Masterthesis

Physiotherapy Science

Program in Clinical Health Sciences

Utrecht University

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"ONDERGETEKENDE

Herman Jaap de Vries

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Masterthesis, Physical Therapy Sciences, Program in Clinical Health Sciences, Utrecht University, Utrecht, 2016

SAMENVATTING

Doelstelling: eHealth interventies kunnen bijdragen aan betere toegankelijkheid, zelfmanagement en lagere zorgkosten. Gebruik van eHealth interventies is goed gedocumenteerd maar kennis over het gebruik van blended interventies die eHealth en een-op-een begeleiding door een professional combineren ontbreekt. Dit onderzoek verkent welke patiënt-, interventie- en omgeving-gerelateerde factoren determinanten zijn van gebruik van e-Exercise, een blended fysiotherapie interventie voor patiënten met heup- en/of knieartrose.

Methode: Een convergerend mixed methods ontwerp werd gebruikt waarvoor data van patiënten uit de interventiegroep van een trial naar de (kosten)effectiviteit van e-Exercise beschikbaar waren. Het aantal weken met een geëvalueerde module werd gebruikt om het gebruik te meten. Patiënten die minimaal acht van de twaalf weken evalueerden werden gecategoriseerd als gebruiker. Negatief binomiale regressieanalyse werd uitgevoerd om te bepalen welke patiënt gerelateerde factoren determinanten zijn voor gebruik. Daarnaast werden semigestructureerde interviews met patiënten over het gebruik van e-Exercise geanalyseerd voor met name interventie- en omgevingsgerelateerde factoren.

Resultaten: Negentien patiënten waarvoor het programma niet gestart werd zijn geëxcludeerd. In totaal werden 81.1% van de negentig patiënten gecategoriseerd als gebruiker. Het gebruik kon worden voorspeld door opleiding, artrose duur en wervingswijze voor het onderzoek. Tijdens interviews werden internetvaardigheden, motivatie, discipline, beschikbare tijd en fysieke bekwaamheid als determinanten van gebruik genoemd. Ook de bruikbaarheid, flexibiliteit, benodigde tijd, meerwaarde en het persuasieve ontwerp van het programma kunnen gebruik beïnvloeden. Tenslotte beïnvloedden participatie in onderzoek en weersomstandigheden het gebruik.

Conclusie: De grote meerderheid van de patiënten heeft e-Exercise veel gebruikt. Hieraan gerelateerde factoren waren de bruikbaarheid, flexibiliteit, benodigde tijd, meerwaarde en het persuasieve ontwerp van het programma, maar ook de fysiotherapeut lijkt een stimulerende rol te hebben. Desondanks startten enkele fysiotherapeuten het programma van hun patiënt niet, wat illustreert dat het gebruik verbeterd kan worden door fysiotherapeuten optimaal te scholen.

Klinische relevantie: Dit is het eerste onderzoek dat determinanten voor gebruik van een blended fysiotherapie interventie beschrijft. Implementatie van e-Exercise dient zich te richten op het optimaal integreren van de eHealth component in het behandelregime van de fysiotherapeut. Fysiotherapeuten kunnen e-Exercise aanbieden aan iedere geïndiceerde patiënt, maar moeten overwegen om patiënten met beperkte internetvaardigheden en fysieke beperkingen aanvullende therapie te bieden.

ABSTRACT

Aim: eHealth interventions can increase healthcare access, empower self-management and lower healthcare costs and are more effective for adherent patients. Adherence to eHealth interventions is well-documented, but knowledge on adherence to blended interventions that combine eHealth with face-to-face treatment is lacking. This study aims to explore which patient-, intervention- and environment-related are determinants of adherence to e-Exercise, a twelve-week blended physiotherapeutic intervention for patients with hip and/or knee osteoarthritis.

Methods: A convergent mixed methods design was used. Negative binomial regression analysis was performed re-using quantitative data of a (cost)effectiveness trial on e-Exercise for independent variables. The number of weeks with an evaluated module were used to measure adherence. Patients that evaluated at least eight out of twelve weeks were considered adherent. Additionally, semi-structured interviews with patients on their adherence to e-Exercise were performed and analyzed.

Results: Nineteen patients for which the program was not started were excluded. In total, 81.1% of the ninety patients that started were adherent. Adherence to e-Exercise could be predicted by education, osteoarthritis duration and the used recruitment strategy. During interviews, internet-skills, motivation, discipline, available time and physical ability were described as determinants of adherence. The intervention's usability, flexibility, required time, persuasive design and added value, as well as environmental factors like participating in research and weather conditions can also influence adherence. Finally, participation in research and weather conditions influenced adherence.

Conclusion: While some patient-related determinants were identified, the vast majority of the patients were adherent. The eHealth components' usability, flexibility, time required, persuasive design and added value were linked to adherence, but the physiotherapist appears largely responsible for the high adherence rate. However, some physiotherapists didn't start their patients' program, illustrating that patient adherence can be further improved by optimally integrating the physiotherapist.

Clinical Relevance: This is the first study to describe determinants of adherence to a blended physiotherapeutic intervention. Implementation of e-Exercise should focus on optimally integrating the eHealth component in the physiotherapists' treatment regimen. Physiotherapists can offer e-Exercise to every indicated patient that is open to use it, but should consider offering patients with insufficient internet-skills and physical disabilities additional therapy.

Keywords: eHealth, Osteoarthritis, Physical Therapy Specialty, Patient Adherence

INTRODUCTION

eHealth interventions use information and communication technology to enable or improve health or healthcare[1] and have potential to increase healthcare access,[2] empower patient self-management[3] and lower healthcare costs.[4, 5] eHealth interventions are an acceptable treatment option for multiple patient populations[6-11] and are (cost)effective for several somatic diseases.[4] eHealth interventions are more effective for patients that adhere,[12, 13] meaning their behavior coincides with the given advice.[14, 15] Low adherence rates are common in eHealth intervention trials.[16, 17] Hence, understanding which patients adhere and why patients (do not) adhere is essential for successful implementation.[18]

Patient-related factors that have been linked to better eHealth intervention adherence (i.e. the number of completed assignments) are female gender,[19, 20] older age,[20-25] higher education,[20] unemployment,[22] being a native speaker in the intervention's language,[20] in a relationship,[22] physically active,[19] having a healthy lifestyle,[23, 24] higher income,[23] social ties[26] and not having comorbidity.[21] Furthermore, patients tend to be more adherent to interventions with a shorter duration[12] and more frequent intended usage.[17] Another factor increasing adherence to the eHealth intervention is contact with a therapist.[16, 17, 27] The combination of eHealth and face-to-face care is called 'blended care', also known as technology guided care.[28] Since blended care is a new, upcoming delivery treatment option, little is known about which patients adhere to blended interventions.

An example of a blended intervention is e-Exercise Osteoarthritis, a twelve-week physical activity program for patients with hip and/or knee osteoarthritis.[29] Its development was based on Join2Move, a web-based program for patients with hip and/or knee osteoarthritis without professional guidance.[30] Join2Move has significant effects on physical function, physical activity and self-perceived effect.[31] However, only 46.0% of the participants evaluated their weekly assignments during at least six out of nine weeks and were therefore considered adherent.[21] To improve adherence, Join2Move was adapted by integrating physiotherapeutic treatment, which led to the development of e-Exercise. The (cost)effectiveness of e-Exercise is currently being studied.[29] Understanding which patients adhere and what intervention- and environment-related factors influence adherence will contribute to implementation of e-Exercise and improving future versions. Therefore, this study aims to explore what patient-, intervention- and environment-related factors are determinants of adherence to e-Exercise.

METHODS

Study Design

A convergent mixed methods study design was used, combining deductive and inductive research methods. Quantitative analysis mostly targeted patient-related factors and qualitative analysis was expected to particularly yield intervention- and environment-related factors. Both sources were therefore complementary and are compared in the discussion section. Quantitative data of a cluster-randomized controlled trial on the (cost)effectiveness of e-Exercise were used.[29] For qualitative analysis, semi-structured interviews were performed. The e-Exercise trial was approved by the Medical Ethical Committee of the St. Elisabeth hospital Tilburg (NL 46358.008.13).[29]

Participants

Participants were recruited in Dutch primary care physiotherapy practices or through advertisements from September 2014 to March 2015. Patients were eligible for participation in the trial when they (i) were aged 40-80 years and (ii) had osteoarthritis of the hip and/or knee according to the clinical criteria of the American College of Rheumatology.[29] Patients were excluded for the trial when they (i) were on a waiting-list for a hip or knee replacement surgery, (ii) were being contra-indicated for physical activity without supervision, (iii) were sufficiently physically active based on Dutch physical activity guidelines,[32] (iv) had participated in a physical therapy and/or physical activity program in the last six months, (v) did not have internet-access or (vi) were unable to understand the Dutch language.[29] Quantitative data of all included participants were available. To limit recall bias during semi-structured interviews, which were executed in October and November 2015, the twenty last included patients were invited. Additional participants were recruited based on purposeful and theoretical sampling until optimal variability in patient characteristics and data saturation in two consecutive interviews were achieved.

Intervention

The eHealth component of e-Exercise consists of (i) a twelve-week incremental physical activity program based on graded activity, (ii) strength and stability exercises and (iii) information on osteoarthritis, physical activity, pain-management, weight-management, motivation, medication and social influences on pain.[29] The offline component consists of up to five face-to-face physiotherapy sessions[29] that comply with the Dutch guideline for hip- and knee osteoarthritis.[33]

In the first session, the physiotherapist created an account, instructed the patient on how to use it and selected strength and stability exercises. During the first week, patients submitted their baseline capacity for the central activity through an online form. In the second session, the physiotherapist and patient used this baseline value to set a goal for on

the short- and long term. After the physiotherapist pressed the 'start the program' button, the system automatically created an individual activity scheme that gradually increased to the patients' short term goal. Patients received automated weekly e-mails that informed them about new content on the website and reminded them to evaluate activity and exercise modules. During follow-ups, the physiotherapist used these evaluations for discussing patient's progress and, if necessary, change the intensity or type of exercises.[29]

Quantitative Data Collection and Analysis

Outcome variable

Adherence to e-Exercise was operationalized as the number of weeks (0-12) that the patient evaluated either a graded activity or exercise module. The number of weeks logged in were initially considered but were discarded as these would only indicate that the patient engaged to the eHealth component. While the number of weeks with an evaluated module could also overestimate the extent to which the program was actually executed due to social desirability bias,[34] it was considered a more valid measure of adherence than weeks logged in because modules could only be evaluated if the patient also logged in. Evaluation of modules was important for adherence because this generated automatically tailored feedback and thus created an interaction between the technology and the user, contributing to its effectiveness.[17] Also, the physiotherapist used the evaluations during face-to-face sessions, supporting the integration of eHealth within face-to-face treatment.[28] Patients were considered adherent when they evaluated a module in at least eight out of twelve weeks, using the same ratio as the study on Join2Move.[21]

Independent variables

Since this is the first study to explore which factors are related to adherence to a blended intervention, a wide range of potential related factors were selected from the available baseline demographics. While the quantitative analysis therefore has an inductive approach, some deduction was done by including variables that were linked to adherence to fully web-based eHealth interventions in prior research. These associations based on literature, as well as the used measuring instrument, categories and value range of included variables are described in Table 1. More detailed information on how these independent variables were measured can be found in the trial's study protocol.[29]

Table 1: Description of the used measurement instrument, categories, value ranges and association with adherence for independent variables used in quantitative analysis.

Independent variable	Measurement instrument	Categories	Value range	Better adherent if
Patient-related factors				
Gender	Demographic survey	Male, female	-	Female[19, 20]
Education	Demographic survey	Low, middle, high	-	Higher[20]
Osteoarthritis location	Demographic survey	Knee, hip, both	-	-
Osteoarthritis duration	Demographic survey	<1 year, 1-5 years, >5 years	-	-
Comorbidity	Demographic survey	None, 1, >1	-	None[21]
Age	Demographic survey	-	0-∞	Older[20-25]
Body Mass Index (BMI)	Self-reported height, weight	-	0-∞	-
Physical mobility	Timed Up and Go (TUG)[35]	-	0-∞	-
Pain	Numeric Rating Scale (NRS)	-	0-10	-
Tiredness	Numeric Rating Scale (NRS)	-	0-10	-
Activities in Daily Life (ADL) functioning	ADL subscale of the Hip disability and Osteoarthritis Outcome Score (HOOS)[36, 37] or Knee disability and Osteoarthritis Outcome Score (KOOS)[38, 39]	-	0.0-100.0	-
Sedentary time	ActiGraph tri-axial accelerometer*	-	0.0-1,440.0	-
Moderate-to-Vigorous Physical Activity (MVPA)	ActiGraph tri-axial accelerometer*	-	0.0-1,440.0	More active[19]
Perceived health status	EQ-5D[40] Health Index score	-	0.0-100.0	-
Self-efficacy for pain	Arthritis Self-Efficacy Scale (ASES)[41, 42]	-	0.0-5.0	-
Self-efficacy for symptoms	ASES[41, 42]	-	0.0-5.0	-
Intervention-related factors				
Treatment sessions	Physiotherapist-reported	-	0-∞	-
Environment-related factors				
Recruitment strategy	Demographic survey	Physiotherapist, advertisement	-	-

* Patients wore the ActiGraph during at least eight hours per day for at least three days. The physical activity thresholds of Freedson et al.[43] were used as cut-off points for physical activity intensity.

Quantitative Data Analysis

Descriptive statistics for observed independent and outcome variable data were calculated using SPSS 23 (SPSS Inc., Chicago, Illinois, United States). Depending on distribution, percentage (categorical), mean and standard deviation (normal) or minimum, maximum and median (non-normal) were described. Missing data were analyzed based on nonresponse patterns,[44] Little's Missing Completely At Random (MCAR) Test[45] and tests on differences between participants with and without missing outcome data, using the Independent-Samples T-Test, Chi-Square Test for Association or Mann-Whitney U test depending on the variable's distribution. If missing data were MCAR, complete cases were analyzed. Otherwise, multiple imputations were executed to limit missing data bias.[46, 47]

Negative binomial regression analysis was performed on the inversed outcome data.[48] First, univariate analyses were performed for each independent variable to screen for potential determinants using a p-value of ≤.2. Second, multivariate analysis was performed using these variables in a backward stepwise procedure,[49] excluding variables with p-value of p≥.1). To determine the maximum number of independent variables in the final model, a rule-of-thumb was applied that the ratio of patients to independent valuables needed to be 10:1.[50, 51] If necessary, the variable with the highest p-value was excluded until this ratio was met. The final model's Goodness of Fit was evaluated using the Omnibus Test[52, 53] and the ratio of the deviance and Pearson Chi-Square values to the degrees of freedom (Value/df), which ideally should be close to 1.

Qualitative Data Collection and Analysis

Initial inductive, semi-structured interviews were performed by two research assistants using a topic-list (Appendix 1) that was based on (i) implementation literature[54] and (ii) interviews with physiotherapists on adherence to e-Exercise.[55] CK observed three interviews to increase understanding of the participants' experiences and assure internal reliability. Interview audiotapes were transcribed a verbatim using NVivo 10 (QSR International, Melbourne, Australia) by HdV. To increase internal validity and reliability, HdV and CK performed open coding independently.[56, 57] Investigator triangulation was applied by performing axial and selective coding in co-operation by constant comparison of codes within and between interviews.[56, 57] Codes expressing related concepts were grouped to create themes that link codes across interviews. Respondent validation was performed through member-checks by e-mailing participants a summary of the interview. If necessary based on maximum variation and/or theoretical sampling, additional telephonic interviews were taken by HdV and analyzed by HdV and CK. An audit trail including theoretical memos was tracked during data analysis and inspected through peer-review to increase internal and external reliability.[55]

RESULTS

A flowchart of the included participants is depicted in Figure 1.

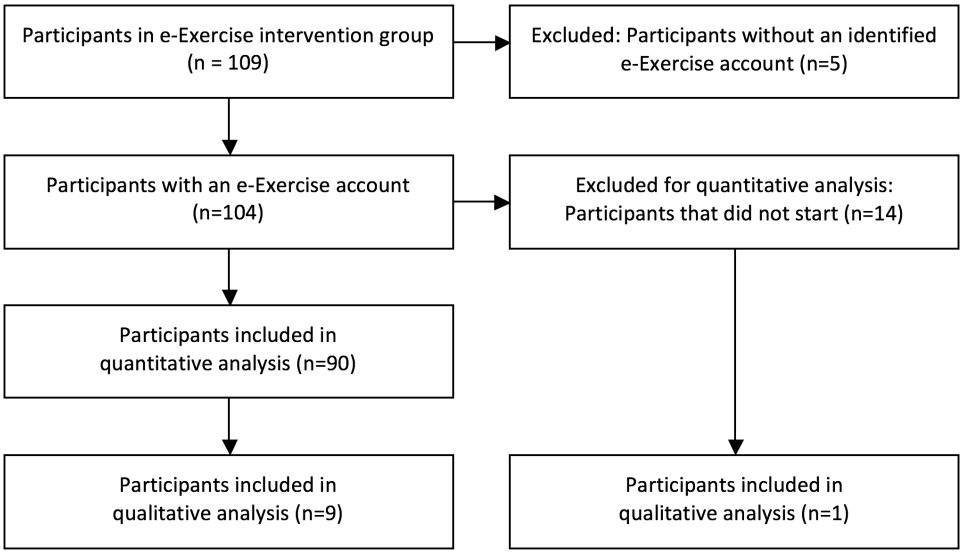

Figure 1: Flowchart of included participants.

Quantitative results

Missing Data

For five participants (4.6%) who were treated by four different physiotherapists, no account was identified and data for the number of treatment sessions were missing. Also, for fourteen participants (12.8%) that were treated by thirteen different physiotherapists, the program was not started. Furthermore, for eight of these fourteen participants with an account that did not start the program, data for the number of treatment sessions was missing. It is therefore unknown if these eight participants did not start the program because they dropped out or because their physiotherapist did not start the program. For ninety (82.6%) participants that started, 25.6% of the values for physical mobility and 12.2% of the values for both sedentary time and MVPA were missing. Missing data were considered MCAR based on analysis of nonresponse patterns, Little's test (p=.996) and non-significant tests on differences between the participants that received full-access and those who did not (Table 2). Therefore, a complete case analysis was performed without imputation of missing data, excluding participants that did not receive full-access.

Descriptive Statistics

In total, 81.1% of the analyzed (which are 67.0% of the recruited) participants evaluated a module in at least eight weeks and were considered adherent (Table 2). This resulted in substantial negative skewness in outcome data (Figure 2), causing violation of assumptions for multivariate linear regression analysis[49] and log linear Poisson regression analysis.[58]

Table 2: Descriptive statistics for independent and outcome variables for patients in- and excluded for quantitative analysis, all patients and p-values for between-groups effects.

Variable	**Analyzed**	**Excluded**	**p**
Patient-related factors	*n=90*	*n=19*	
Gender			.956†
Male; % (n)	32.2 (29)	31.6 (6)	
Female; % (n)	67.8 (61)	68.4 (13)	
Age, mean ± sd (n)	63.6 ± 8.3 (90)	64.6 ± 9.9 (19)	.261*
Education			.985†
Low education; % (n)	24.4 (22)	26.3 (5)	
Middle education; % (n)	37.8 (34)	36.8 (7)	
High education; % (n)	37.8 (34)	36.8 (7)	
BMI; mean ± sd (n)	27.8 ± 4.4 (90)	27.9 ± 3.5 (19)	.101*
Osteoarthritis location			.718†
Knee; % (n)	66.7 (60)	56.9 (11)	
Hip; % (n)	18.9 (17)	21.1 (4)	
Both; % (n)	14.4 (13)	21.1 (4)	
Osteoarthritis duration			.443†
Less than one year; % (n)	17.8 (16)	26.3 (5)	
One to five years; % (n)	41.1 (37)	26.3 (5)	
More than five years; % (n)	41.1 (37)	47.4 (9)	
Comorbidity			.265†
None, n (%)	53.5 (48)	73.7 (14)	
One, n (%)	20.0 (18)	10.5 (2)	
More than one, n (%)	26.7 (24)	15.8 (3)	
Physical mobility; range, median, min-max (n)	8.3, 4.0-13.9 (67)	8.3, 6.8-9.5 (5)	.965‡
Pain; median, min-max (n)	5, 0-10 (90)	5, 1-8 (19)	.633‡
Tiredness; median, min-max (n)	5, 0-9 (90)	7, 0-8 (19)	.750‡
ADL functioning; mean ± sd (n)	60.6 ± 18.1 (90)	64.5 ± 19.3 (19)	.474*
Sedentary time; mean ± sd (n)	497.4 ± 6.0 (79)	466.0 ± 79.1 (16)	.097*
MVPA; median, min-max (n)	21.4, 0.0-107.6 (79)	13.4, 3.2-95.0 (16)	.680‡
Perceived health status; median, min-max (n)	71.0, 0.0-97.8 (90)	75.0, 12.8-100.0 (19)	.692‡
Self-efficacy for pain; median, min-max (n)	3.6, 1.2-5.0 (90)	4.0, 1.8-5.0 (19)	.677‡
Self-efficacy for symptoms; median, min-max (n)	3.7, 1.5-5.0 (90)	4.0, 2.0-4.8 (19)	.202‡
Intervention-related factors			
Treatment sessions; range, median (n)	1-16, 5 (90)	2-7, 5 (6)	.708‡
Environment-related factors			
Recruitment strategy			.968†
Physiotherapist; % (n)	68.9 (62)	68.4 (13)	
Advertisement; % (n)	31.1 (28)	31.6 (6)	

Outcomes			
Weeks evaluated; median, min-max (n)	11, 2-12 (90)	1, 0-1 (14)	.000‡
Percentage of (non-)adherent patients			.000†
Adherent; % (n)	81.1 (73)	0.0 (0)	
Non-adherent; % (n)	18.9 (17)	100.0 (19)	

* Assessed using the Independent-Samples T-Test

† Assessed using the Chi-square Test for Association

‡ Assessed using the Mann-Whitney U Test

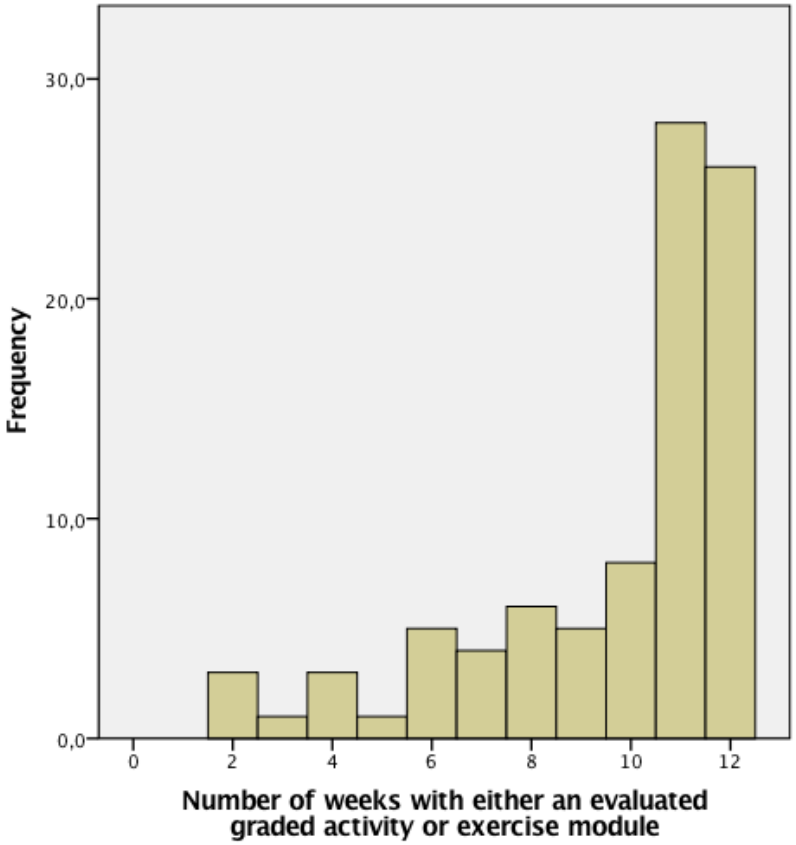

Figure 2: Histogram for the number of weeks that the participant evaluated either a graded activity or exercise module, illustrating substantial negative skewness that favors adherence.

Regression Analysis

Based on univariate negative binomial regression analyses, education (p=.092), osteoarthritis symptom duration (p=.109), recruitment strategy (p=.096) and self-efficacy for symptoms (p=.138), were included for multivariate analysis. Participants were more likely to evaluate a graded activity or exercise module if they had a middle educational level, were recruited by a physiotherapist or did not experience osteoarthritis symptoms for less than one year (Table 3). The final model fits the negative binomial distribution well (deviance Value/df 1.010 and Pearson Chi-Square Value/df 0.839) and significantly (Omnibus Test p=.015) predicts the number of weeks with an evaluated module.

Table 3: P-values and β-coefficients of patient- and environment-related determinants of adherence. Because inversed outcome data were used, negative β-coefficients indicate higher adherence, while positive β-coefficients indicate lower adherence.

Determinant	β-coefficient	p-value
Patient-related factors		
Intercept	1.030	.008
Education		.064
Lower education	- (indicator)	- (indicator)
Middle education	-.397	.264
Higher education	.316	.352
Osteoarthritis symptoms duration		.049
Less than one year	- (indicator)	- (indicator)
One to five years	-.873	.023
More than five years	-.340	.373
Environment-related factors		
Recruitment strategy		.032
Physiotherapist	- (indicator)	- (indicator)
Advertisement	.627	.032

Qualitative results

Of the twenty invited patients, eight responded and were interviewed. Data saturation appeared after six interviews. All participants confirmed the validity of the results. Two more interviews were performed to obtain optimal variation in patient characteristics (age, comorbidity, number of weeks with an evaluated module) but no new themes were found. Interviewed participants were mostly female (70%), without comorbidity (60%), between 51-79 (median: 60) years old, received 0-6 (median: 5) treatment sessions and evaluated a module in 1-12 (median: 10.5) weeks. These characteristics were similar to those of the total sample (Table 2) and were therefore considered representative.

Patient-related determinants

From the qualitative data five patient-related determinants of adherence could be identified, namely: (i) internet skills, (ii) discipline (iii) time available, (iv) motivation and (v) physical ability. Sufficient internet skills was described as a prerequisite to use the eHealth component. To adhere, discipline and available time were also considered required. Finally, two important determinants of adherence were the patients' motivation and physical ability to execute the physical activity program and exercises. A patient that achieved optimal adherence to explained how she was motivated to keep adhering because of her experienced treatment effect: "Life just becomes better by participating in the program. There is not a single reason why I would say you shouldn't engage; it just helps you."

Intervention-related determinants

Six intervention-related determinants of adherence were identified: (i) website usability, (ii) persuasive design, (iii) flexibility of the exercise schedule, (iv) added value, (v) time required, and (vi) the physiotherapist. Besides being usable, participants described that the persuasive design of the website enticed them to keep adhering. Described examples were the received prompts/cues (weekly email reminders) and needing to monitor their behavior (evaluating modules), particularly because this was accessible by their physiotherapist. One participants described that she wanted the exercise schedule to be more flexible to adjust to her needs. Also, participants described that the eHealth component needed to have added value over regular therapy options and require little time. Receiving a program that includes videos with information and home exercises that they could access at any time and any place that can help save time and limit healthcare costs were described examples of added value of e-Exercise. A well-travelled patient explained: "That's why I brought it, particularly for holidays. We went to America for three weeks and I exercised every morning and evening."

The physiotherapist's role was mostly described as facilitating but as restricting by one patient, as her program was never started: "I think it's a shame that the physiotherapist was not informed on how the program worked." For others, the physiotherapist had a positive influence by tailoring the program to their needs, offering additional therapy, monitoring progress and enhancing self-efficacy. Perhaps most important, patients felt obliged to adhere because of the anticipated rewards or judgement for (non-)adherence by their physiotherapist during follow-ups. One participant explained: "This whole program just uses a carrot-and-stick approach. I think a lot of people – not just me – need that."

Environment-related determinants

Several participants were extra motivated because they participated in a study. As one optimally adherent patient described: "You participate in research, so you have to do it." Also, some patients described they would not perform outdoor activities during bad weather conditions. All themes describing all determinants of adherence are summarized in Table 4.

Table 4: Themes describing determinants of adherence to e-Exercise.

Patient-related factors	**Intervention-related factors**	**Environment-related factors**
Internet skills	Website usability	Participating in research
Discipline	Persuasive design	Weather conditions
Time available	Flexibility of exercise schedule	
Motivation	Added value	
Physical ability	Time required	
	The physiotherapist	

DISCUSSION

This convergent mixed methods study explored what patient-, intervention- and environment-related factors determine patient adherence to e-Exercise. Aside from the identified determinants, a very important finding is that the majority (81.1%) of the patients for which the physical activity program was started were adherent. This confirms e-Exercise's feasibility in the treatment of patients with hip and/or knee osteoarthritis[30] and shows promise for clinical practice if it proves to be (cost)effective based on upcoming trial results.[29] Nevertheless, several nuances can be made regarding which patients are most likely to adhere and intervention- and environment-related reasons why patients were (not) adherent.

Patient-related determinants

High educated patients were less adherent than low and particularly middle educated patients. This contradicts a previous study that described better adherence for higher educated patients.[20] Two high educated patients explained that lack of added value was the reason why they stopped using the program. An explanation therefore might be that patients with a different educational level might have different needs regarding the detail in which information and assignments are given or methods to stimulate them to adhere. However, no conclusive evidence to support this explanation was found, which should therefore be interpreted cautiously and await validation in a different sample during future research. Furthermore, patients that were diagnosed with osteoarthritis less than one year ago were less likely to adhere. Further research is needed to investigate possible dose-response relationships. It might be possible that patients with a shorter osteoarthritis duration benefit equally from a shorter intervention and that a part of the modules was enough to have the same effect. Some interviewed patients described how perceived necessity for action played a role in their motivation to adhere. It might be possible that patients with a shorter osteoarthritis duration perceived less necessity and were therefore less motivated to adhere. However, as with education, this determinant and its interpretation should first be validated in future research before being used for clinical implementation. Also, most patients adhered well, illustrating that the need to distinguish which patients will adhere to e-Exercise during implementation is lower than was expected based on prior literature.[16, 21] The qualitative results introduced several new factors that were not tied to adherence in prior research: sufficient internet skills, discipline, available time, motivation and being physically able to perform the exercises.

Intervention-related determinants

Qualitative results showed that an easily usable website that requires little time to use and has an adjustable exercise schedule can help optimize adherence. In addition, the intervention needs to have added value, which was also concluded in prior research.[59] Another influential aspect of the intervention is it's persuasive design.[17] For e-Exercise, two Behavior Change Technique's (BCT's) of the CALO-RE taxonomy were identified as influential

based on qualitative findings: monitoring of outcomes of behavior without feedback (evaluating modules) and prompts/cues (e-mail reminder).[60] Closely related to the persuasive design was the role of the physiotherapist, who enticed some patients to adhere because of perceived rewards or judgement by their physiotherapist. An interaction between the physiotherapist and physical ability also appears to be present, as the physiotherapist could adjust the treatment plan if the patient perceived difficulties executing it. Unfortunately, the the physiotherapist can also restrict patient adherence, as one interviewed patient never received full-access because the physiotherapist did not start it. Of the nineteen (17.4%) patients without an account or program start, six (5.5%) underwent two or more treatment sessions. For these participants, who were all treated by different physiotherapists, it appears likely that the physiotherapist was unaware that he needed to press the start button himself. For the remaining thirteen (11.9%) participants, it is unknown whether the patient dropped out or the physiotherapist was also responsible. Nonetheless, the findings illustrate that dropouts can be limited by removing the start-button or better training the physiotherapists.

Environment-related determinants

Besides the role in the blended intervention, the physiotherapist also appears to have influence on patient adherence through recruitment, as physiotherapist-recruited patients were more adherent. Although this finding might be inflated through social desirability bias,[34] it can be explained by the qualitative findings, as several participants described how the perceived rewards of judgement by the physiotherapist stimulated them to adhere. Therefore, the therapeutic alliance between the patient and physiotherapist appears to play an important role in patient adherence in blended care, resembling the well-confirmed link between therapeutic alliance and treatment adherence in mental healthcare.[61-69] In a similar way, some patients described to be more adherent because they participated in research. Increased adherence due to research participation is a known influential factor,[25] particularly for trials.[17] Finally, bad weather conditions were described as a reason not to exercise outdoors, influencing adherence.

Comparison with Join2Move

e-Exercise was based on Join2Move but integrated face-to-face treatment and home-exercises and lasted three weeks longer.[21, 30, 31] In total, more recruited patients adhered to e-Exercise (67.0%) than to Join2Move (46.0%),[21] despite the longer intervention duration that usually leads to lower adherence.[12] While the physiotherapist is the most notable difference between both programs, e-Exercise's e-mail prompts/cues and enriched information characteristics (video's) also might have contributed to the higher adherence. Furthermore, patient recruitment provides an explanation for the improved adherence. Patients for Join2Move were only recruited through advertisements, while 68.9% of e-Exercise's patients were recruited by physiotherapist, which was found to improve adherence.

Strength and limitations

To the authors' knowledge, this study is the first to explore what factors determine patient adherence in blended care. Due to the convergent mixed methods design and large number of available variables, various patient-, intervention- and environment-related determinants could be described. The inductive quantitative analysis provided new but somewhat inexplicable determinants of adherence. These determinants might have been better understood if an explanatory mixed methods design was used, which was not possible for the current study due to practical and time bound reasons. Also, re-using trial data introduced limitations, as known determinants of increased adherence to web-based interventions like unemployment,[22] in a relationship,[22] having a higher income[23] and social ties[26] could not be included. Nonetheless, several recommendations for implementation and further development of e-Exercise can be made.

Implications

Both the current findings and prior literature[28] underline the importance of the therapeutic role in blended care and that optimal integration is essential to achieve patient adherence. Therefore, the physiotherapist should be the focal point of implementation. Although all physiotherapists underwent a half day of training,[29] some physiotherapists still appeared unaware how to correctly use the intervention. A prior study described reasons why participating physiotherapists (did not) use e-Exercise,[55] of which recommendations can be distracted on how to improve the physiotherapists' adherence. Training should involve the working environment, e.g. through in-company training. It should also emphasize the intervention's added value for the physiotherapist, instruct how to use it as time-efficient as possible and how to use it without sacrificing professional autonomy, which are all important for physiotherapists.[55] These should also be kept in mind when developing a new blended intervention. To facilitate patient adherence, the eHealth component should have added value for the patient, should be flexible and easy to use in limited time. The intervention's persuasive design should preferably include BCT's that are known to influence adherence, such as e-mail prompt/cues and monitoring behavior in e-Exercise. Because of the high adherence to e-Exercise, physiotherapists should make e-Exercise available to every indicated patient. However, they can consider offering patients with insufficient internet-skills and increased physical disabilities more extensive face-to-face treatment.

CONCLUSION

The vast majority (81.1%) of the patients that started the program were adherent. e-Exercise could therefore be made available to every indicated patient that is open to use it, but physiotherapists can consider offering patients with insufficient internet-skills and physical disabilities additional face-to-face treatment sessions. While the eHealth components' usability, flexibility, time required, persuasive design and added value were linked to adherence, the physiotherapist appears largely responsible for the high adherence rate due to his role in recruitment, personalizing the program and motivating the patient. However, some physiotherapists didn't start their patients' program, illustrating that patient adherence can be further improved by training the physiotherapist to optimally integrate the eHealth component in his/her treatment regimen.

ACKNOWLEDGEMENTS

The author thanks all trial participants and the ten patients that were interviewed for their cooperation. Research assistants Michelle Eem and Dianne van der Eijk are thanked for their efforts in collecting qualitative data and Dr. Daniël Bossen for inspecting the audit trail. Finally, Prof. Dr. Cindy Veenhof, Drs. Corelien Kloek and Dr. Martijn Pisters are thanked for their guidance during the course of the design, execution and reporting of the current study.

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APPENDIX 1

Introduction

You participated in the e-Exercise program. We would like to know how you experienced the program. We would like you to describe your experiences with regard to the use of e-Exercise and present your ideas on how the program can be improved. There are no right or wrong answers, this is about your opinion. All information in this interview will be anonymously processed in our study. The information derived from this interview will be used for writing a scientific article.

Before we start with the interview I would like to ask if you mind if I audiotape this interview. By doing so, I can replay the interview and optimally process the information. Do you have any questions before we commence with the interview?

General

1. What was your motivation to participate in the e-Exercise study?

2. How often have you used the online component of e-Exercise??

3. Are your current physical activity and exercise habits different than before participating in e-Exercise?

Internet

1. Have you ever used the internet for healthcare resources before you participated in e-Exercise?

2. If so, how often do you use the internet, and in what form?

3. How did you experience the online component of e-Exercise?

Physiotherapist

1. What role did your physiotherapist have in your use of e-Exercise? (For instance: a motivational, instructional or passive role?)

2. How did you experience the face-to-face contact with your physiotherapist?

3. What have you discussed during face-to-face contact with your physiotherapist? (For instance: exercises, questions, postures, information?)

4. Were you well informed on how e-Exercise worked? (Were you instructed well?)

5. Did you reach your treatment goals after the physiotherapy treatment sessions and e-Exercise?

e-Exercise

1. What was the reason you wanted to use e-Exercise?

2. How often did you use e-Exercise?

3. What benefits does e-Exercise offer according to you? Why do you think so?

4. What downsides does e-Exercise have according to you? Why do you think so?

5. Can you describe what e-Exercise brought you, as an osteoarthritis patient?

6. What are your tips to improve e-Exercise?

7. Would you recommend e-Exercise to other osteoarthritis patients? Why?

8. Was e-Exercise easy to use? If not, what did you find difficult? Where the assignments easy to fit into your daily life?

9. Did you see the fact that you visited the physiotherapist practice relatively little as a benefit or downside?

10. What do you think about the number of 4-5 sessions with the physiotherapist in 12 weeks?

11. What do you think of the home exercises that are included in e-Exercise?

12. How enthusiastic was your physiotherapist about the program? Did that influence how much you used it?

13. What do you think about the information that is included in e-Exercise?

Conclusion

This is the end of the interview. Is there something else you would like to add that was not already discussed?

We would like to thank you for your outspoken and extensive answers and your participation to this study. May we send you an e-mail if we have any additional questions?