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ORIGINAL ARTICLE

Exploring factors related to non-adherence to exergaming in patients with chronic heart failure

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Abstract

Aims This study aimed to explore factors related to non-adherence to exergaming in patients with heart failure.
Methods and results Data from patients in the exergame group in the HF-Wii trial were used. Adherence to exergaming was defined as playing 80% or more of the recommended time. Data on adherence and reasons for not exergaming at all were collected during phone calls after 2, 4, 8, and 12 weeks. Logistic regression was performed between patients who were adherent and patients who were non-adherent. Secondly, a logistic regression was performed between patients who not exergamed at all and patients who were adherent to exergaming. Finally, we analysed the reasons for not exergaming at all with manifest content analysis. Almost half of the patients were adherent to exergaming. Patients who were adherent had lower social motivation [odds ratio (OR) 0.072; 95% confidence interval (CI) 0.054–0.095], fewer sleeping problems (OR 0.84; 95% CI 0.76–0.092), and higher exercise capacity (OR 1.003; 95% CI 1.001–1.005) compared with patients who were non-adherent. Patients who not exergamed at all had lower cognition (OR 1.18; 95% CI 1.06–1.31) and more often suffered from peripheral vascular disease (OR 3.74; 95% CI 1.01–13.83) compared with patients who were adherent to exergaming. Patients most often cited disease-specific barriers as a reason for not exergaming at all.
Conclusions A thorough baseline assessment of physical function and cognition is needed before beginning an exergame intervention. It is important to offer the possibility to exergame with others, to be able to adapt the intensity of physical activity.

Keywords Adherence; Exergame; Heart failure; Physical activity; Serious game

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Introduction

Non-adherence is often mentioned as the underlying reason for the lack of success of physical activity interventions in patients with heart failure (HF).[1,2] Adherence to physical activity in patients with HF is low; for example, adherence in a major exercise trial—the HF-ACTION study—was less than 50%.[3] Patients reporting barriers to cardiac rehabilitation are significantly less likely to enrol in cardiac rehabilitation programmes and are more likely to dropout.[4] Home-based and centre-based cardiac rehabilitation provide similar benefits in terms of clinical and health-related quality of life for patients with HF.[5] Patients experience more barriers to home-based cardiac rehabilitation compared with centre-based cardiac rehabilitation. Home-based participants reported significantly greater cardiac rehabilitation barriers compared with site-based participants, but only the barriers experienced during centre-based rehabilitation were significantly and negatively related to rehabilitation completion and physical activity. This suggests that barriers experienced with home-based rehabilitation are easier to overcome compared with the barriers experienced during centre-based rehabilitation.[6]

To overcome several barriers, we previously set out to use a novel home-based intervention, namely, exergaming, which is recognized as having much to offer in the fields of prevention and rehabilitation, and as promising in terms of increasing physical activity.[7,8]

A recent editorial written by Coats,[9] an expert in HF and exercise, described exergaming as a 'really conceptually attractive intervention to increase habitual physical exercise activity at home in HF patients' that can 'make it an enjoyable part of the daily life so the chance of prolonged participation is increased'. In the HF-Wii study, we found that, despite a proportion of patients describing exergaming as enjoyable, even after an introduction, an installation at home, and access to technical and motivational support, a considerable number of the study participants did not adhere to the exergaming intervention.[10,11] To increase our understanding of adherence to the exergame intervention in order to improve future interventions, we set out to explore factors related to non-adherence to exergaming in patients with HF.

Methods

Study design and patients

Data from patients in the exergame group in the HF-Wii trial were used. The HF-Wii trial is an international randomized controlled trial aiming to improve the exercise capacity of HF patients with exergaming (clinicaltrial.gov, identifier: NCT01785121).[10] The patients were recruited between September 2013 and April 2017.

The eligibility criteria were having a diagnosis of HF in New York Heart Association (NYHA) functional classes I–IV, independent from the ejection fraction; older than 18 years; and able to speak/understand the language in which the study took place. The exclusion criteria were unable to use the exergame platform; unable to fill in data collection material; and a life expectancy shorter than 6 months.

Procedures

In total, 605 patients in the HF-Wii study were randomized to an exergame group (n = 305) or a motivational support group (n = 300). Patients in the exergame group were introduced to an exergame computer during a 2 h group-based introduction lesson. After this session, the exergame platform was installed at home, and they received a sports game together with two remote consoles, which made multi-play possible. In previous research with stroke patients, the mean energy expenditure when playing Nintendo Wii Sports game was 3.7 metabolic equivalents (± 0.6).[12] We did not measure the energy expenditure during exergaming in this study.

Most patients were instructed to exergame for 30 min a day, 5 days a week. This advice was adapted according to the patient's individual physical condition. During the first 3 months from inclusion, patients were contacted by telephone after 2, 4, 8, and 12 weeks to discuss the frequency and duration of playing and to solve any problems with the computer game. After 3 months, the active support ended, but patients could keep the exergame computer. Patients also received a diary, in which they could report their frequency of exergaming.

Study outcomes

In this study, adherence to physical activity is defined as 'the extent to which a person's physical activity corresponds with agreed recommendations from a health care provider'.[13] Data on exergame adherence came from self-reports during a protocolized phone call after 2, 4, 8, and 12 weeks. Patients reported the number of days and minutes they used the exergame. If patients could not be reached for a telephone follow-up to assess the frequency and duration of exergaming, data from the patient diaries were used.

Previous studies[2,14] classified physical activity adherence as meeting at least 80% of the recommended physical activity dose. Therefore, in this study, patients who exergamed for 80% or more of the advised time on installation of the exergame platform at home were defined as being adherent to the physical activity intervention. Patients who exergamed for less than 80% of the advised time were defined as non-adherent. Of the non-adherent patients, there were patients who played 0% of the time recommended; we define those patients as not exergaming at all.

Data on demographic and clinical variables were collected from medical charts and questionnaires. Depression and anxiety were assessed using the Hospital Anxiety and Depression Scale,[15] motivation using the Exercise Motivation Index,[16] cognition using the Montreal Cognitive Assessment,[17] sleeping problems using the Minimal Insomnia Symptom Scale,[18] self-efficacy using the Exercise Self-efficacy Scale,[19] and symptoms of fatigue and shortness of breath using a Likert scale from 0 (none) to 10 (worst possible). Submaximal exercise capacity was assessed using the 6 min walking test.[20] Muscle function was assessed with unilateral isotonic heel-lift, bilateral isometric shoulder abduction, and unilateral isotonic shoulder flexion.[21]

During the protocolized telephone follow-up (*Figure 1*), patients were asked if they had experienced difficulties or any injuries during exergaming. The information from these telephone interviews was written down during the follow-ups.

Data analysis

We imputed missing data on adherence based on logical algorithms. When data were only missing only at 12 weeks, these missing data were replaced with the lowest time playing from that patient during the other weeks. If data

Figure 1 Protocolized telephone follow-up for patients in the exergame group.

Have you been playing on the Nintendo Wii as advised?		□ No □ Yes
On average, how many times per week have you been playing the Nintendo Wii?		
Did you experience difficulties using the Wii computer		□ No □ Yes
If Yes	What kind of difficulties	
Did you experience any injuries while playing the Wii computer?		□ No □ Yes
If Yes	What kind of injuries	

were only available for Weeks 2 and 4, the missing values for Weeks 8 and 12 were replaced with 0 min of exergaming. If patients had two measurement points (which were not Weeks 2 and 4) and the rest of the weeks were missing, these missing values were replaced with the mean of the other two measurement points. If patients only had data for one measurement point, the other measurement points were set at 0 min of exergaming.

In the descriptive analyses, means and standard deviations were calculated for continuous data, and absolute numbers and percentages were computed for nominal variables.

First, univariate analysis was performed between patients who were adherent (≥80%) and patients who were non-adherent (<80%) using the χ^2 tests and the Student's *T*-test. Logistic regression analysis was performed to describe factors that were independently related to non-adherence. Variables with a *P*-value smaller than 0.15 in the univariate analyses were entered into the logistic regression.

Second, we were specifically interested in patients who not exergamed at all, and the same analyses were performed between patients who not exergamed at all and patients who were adherent to exergaming. The same analyses were carried out between patients who not exergamed at all and patients who were adherent to exergaming.

Finally, we analysed the telephone follow-ups for possible difficulties or injuries, with a summative approach to qualitative content analysis[22] in patients who not exergamed at all. After being translated into English, the data from the telephone follow-up (*Figure 1*) were searched for occurrences of the identified words by the last author (M. v. d. W.) using manifest content analysis and summarized into four categories.[22] These categories were discussed among all authors.

Data were analysed using SPSS (Version 25).

Results

The mean age of the 305 patients was 66 ± 12 years. Seventy-two per cent were male, and most of the patients (69%) were in NYHA functional classes I–II. The mean left ventricular ejection fraction was 38%, and 25% reported depressive symptoms at baseline (*Table 1*). At baseline, patients walked on average 412 ± 139 m on the 6 min walking test (*Table 1*).

Adherence to exergaming

Forty-six per cent (n = 139) of the patients were adherent to recommendations regarding exergaming during the 12 observed weeks, while 17% of the patients (n = 52) not exergamed at all. In *Figure 2*, the percentages of adherence to exergaming during the 12 weeks are presented.

During the first 2 weeks, patients exergamed for an average of 119 min/week; 159 patients (52%) played at least the advised 150 min/week. The total exergaming time decreased from 119 to 98 min after 8 weeks and then stayed at the same level until the end of the study period at 12 weeks (*Figure 3*).

Factors associated with adherence to exergaming

Patients who were adherent to exergaming were more often in NYHA class I or II (76% vs. 63%; $P < 0.01$) suffered from peripheral vascular disease (5% vs. 12%; P = 0.04) and diabetes (21% vs. 31%; P = 0.05) less often and had a lower body mass index compared with non-adherent patients (27.5 vs. 28.8; P = 0.04). Patients who were adherent had a higher

Table 1 Demographic, clinical, and exercise characteristics at baseline in patients who were adherent and non-adherent with exergaming

	All patients (n = 305)	Non-adherent < 80% (n = 166)	Adherent 80–100% (n = 139)	P-value
Demographics				
Age	66 ± 12	67 ± 12	66 ± 12	NS
Gender male	72% (220)	72% (120)	72% (100)	NS
Married/relationship	70% (214)	67% (111)	74% (103)	NS
Education				NS
Primary school	21% (63)	23% (39)	17% (24)	
Secondary school	44% (133)	41% (68)	47% (65)	
University	35% (108)	35% (58)	36% (50)	
Having grandchildren	64% (196)	66% (110)	62% (86)	NS
Clinical				
NYHA I/II	69% (211)	63% (105)	76% (106)	0.003
Systolic blood pressure	123 ± 18	121 ± 16	125 ± 19	0.03
Diastolic blood pressure	72 ± 11	72 ± 11	74 ± 12	NS
Heart rate/minute	70 ± 12	71 ± 13	67 ± 11	0.01
ACE-inhibitor/ARB	85% (259)	77% (128)	94% (141)	0.000
Beta-blocker	86% (263)	83% (138)	90% (125)	NS
MRA	48% (147)	45% (75)	52% (72)	NS
Comorbidities				
Peripheral vascular disease	9% (27)	12% (20)	5% (7)	0.04
COPD	17% (53)	21% (35)	13% (18)	NS
Diabetes	26% (80)	31% (35)	21% (29)	0.05
Stroke	10% (29)	11% (18)	8% (11)	NS
HF symptoms				
Fatigue	4.8 ± 2.5	5.1 ± 2.6	4.4 ± 2.4	0.013
Shortness of breath	4.6 ± 2.7	4.6 ± 2.9	4.4 ± 2.4	NS
Cognition	24.6 ± 4.0	23.9 ± 4.5	25.3 ± 3.0	0.001
Sleeping problems (MISS)	4.3 ± 3.2	5.0 ± 3.3	3.5 ± 2.8	0.000
BMI	28.2 ± 5.3	28.8 ± 5.5	27.5 ± 5.1	0.037
LVEF	38 ± 12	39 ± 12	37 ± 12	NS
Depression cut-off (≤7)	75% (229)	70.5% (117)	80.6% (112)	0.02
Anxiety cut-off (≤7)	69% (210)	67.4% (112)	70.5% (98)	NS
Exercise				
Exercise motivation	2.3 ± 0,9	2.4 ± 0.9	2.2 ± 0.8	0.027
Physical motivation	2.6 ± 0.9	2.8 ± .09	2.5 ± 0.9	0.013
Social motivation	1.8 ± 1.1	1.9 ± 1.1	1.6 ± 1.0	0.007
Psychological motivation	2.5 ± 0.9	2.6 ± 0.9	2.4 ± .09	NS
Self-efficacy	5.1 ± 1.9	5.0 ± 1.9	5.2 ± 1.8	NS
Muscle function				
Heel-rise right (repetitions)	14.8 ± 9.5	15.4 ± 9.8	14.4 ± 9.3	NS
Heel-rise left (repetitions)	14.1 ± 9.2	14.4 ± 9.3	13.7 ± 9.1	NS
Bilateral shoulder abduction (s)	85.2 ± 51.4	89.2 ± 53.5	89.2 ± 48.6	NS
Shoulder flexion right (repetitions)	20.9 ± 17.3	20.7 ± 20.8	21.2 ± 11.7	NS
Shoulder flexion left (repetitions)	19.1 ± 11.9	18.4 ± 12.5	19.8 ± 11.2	NS
Exercise capacity (6MWT)	412 ± 139	382 ± 145	448 ± 121	0.000

6MWT, 6 min walking test; ACE, angiotensin-converting enzyme; ARB, angiotensin receptor blocker; BMI, body mass index; COPD, chronic obstructive pulmonary disease; HF, heart failure; LVEF, left ventricular ejection fraction; MISS, Minimal Insomnia Symptom Scale; MRA, mineralocorticoid receptor antagonist; NS, not significant; NYHA, New York Heart Association functional class.

score in the Montreal Cognitive Assessment test (25.3 vs. 23.9; $P < 0.01$), reflecting a higher level of cognitive function. Adherent patients also reported less fatigue (4.4 vs. 5.1; P = 0.01) and fewer sleeping problems (Minimal Insomnia Symptom Scale) (3.5 vs. 5.0; $P < 0.001$), had a higher exercise capacity (6 min walking test) (472 vs. 432; P = 0.01), had higher total motivation (2.4 vs. 2.2; P = 0.03), and in particular had higher social motivation (1.9 vs. 1.6; $P < 0.01$) compared with non-adherent patients (*Table 1*).

In a multivariable logistic regression analysis, lower social motivation [odds ratio (OR) 0.072; 95% confidence interval (CI) 0.054–0.095], fewer sleeping problems (OR 0.84; 95% CI 0.76–0.092), and higher exercise capacity (OR 1.003; 95% CI 1.001–1.005) were independently related to adherence to exergaming (*Table 2*).

Patients who not exergamed at all

A total of 52 patients (17%) not exergamed at all during the study period. They had a mean age of 70 ± 11; 69% were male, and 60% were in NYHA classes I–II. Fifty-eight per cent of the patients lived alone. See Supporting Information, *Table S1*.

Compared with patients who were adherent to exergaming, patients who not exergamed at all were

Figure 2 Number of patients and their percentage of adherence to exergaming.

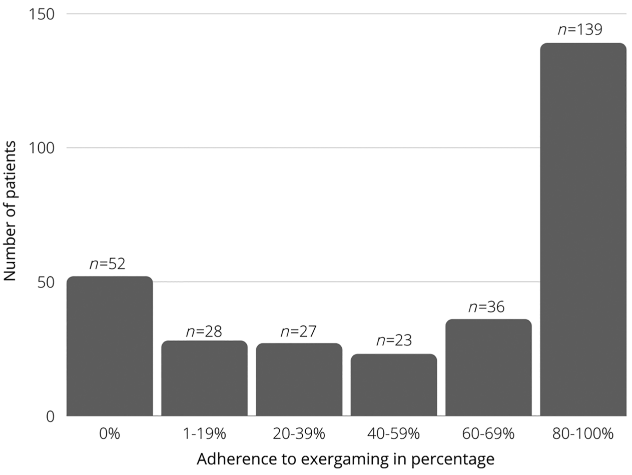

Figure 3 Number of minutes per week that the patients used the exergame.

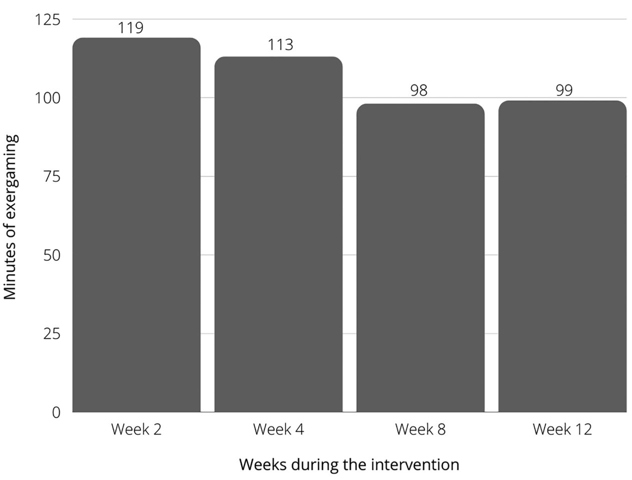

Table 2 Variables independently related to adherence with exergaming (n = 305)

	Odds ratio (95% CI)	*P*-value
Social motivation	0.072 (0.45–0.95)	0.018
Sleeping problems	0.84 (0.76–0.92)	<0.01
Exercise capacity	1.003 (1.001–1.005)	0.016

CI, confidence interval.

significantly older (70 vs. 66; P = 0.025), less often in a relationship or married (58% vs. 72%; P = 0.03), and suffered from peripheral vascular disease (19% vs. 5%; $P < 0.01$) and depressive symptoms (33% vs. 19%; $P < 0.05$) more often. They also reported more fatigue (5.7 vs. 4.4; $P < 0.01$) and shortness of breath (5.3 vs. 4.4; $P < 0.05$) and less exercise capacity (360 vs. 448; $P < 0.01$) compared with adherent patients. Finally, they had more sleeping problems (5.2 vs. 3.5; $P < 0.01$) and lower cognition (22.4 vs. 25.3; $P < 0.01$).

In a logistic regression analysis, being more fatigued (OR 0.80; 95% CI 0.67–0.96), living alone (OR 0.37; 95% CI 0.16–0.89), having peripheral vascular disease (OR 3.74; 95% CI 1.01–13.83), having more sleeping problems (OR 0.86; 95% CI 0.75–0.98), and having lower cognition (OR 1.18; 95% CI 1.06–1.31) were associated with not exergaming at all (Supporting Information, *Table S2*). A sensitivity analysis was performed for peripheral artery disease because this can be influence exergaming. No different results were found (results not shown).

Reasons for not exergaming at all

Of the 52 patients who not exergamed at all during the study, 41 described one or more difficulties and/or experienced injuries during exergaming. The total of 76 reasons were summarized into four categories that explained difficulties or injuries in connection with not exergaming at all: (i) 33 times (43% of the reason given) patients experienced health-related factors (e.g. hospitalization, chemotherapy, or depressive feelings) that prevented them from exergaming; (ii) 17 times (22% of the reason given) patients experienced technical challenges with exergaming (e.g. too difficult, not confident with technology, or instructions too difficult); (iii) 13 times (17% of the reason given) patients preferred to be active in another way than exergaming (e.g. walking, gardening, or being physically active outside); and (iv) 13 times (17% of reasons given) patients expressed low interest in exergaming (e.g. lack of time, low enjoyment, or thought it was useless).

Discussion

Almost half of the patients with HF were adherent to exergaming (defined as playing for 80% or more of the recommended 30 min a day, 5 days a week). Patients who were non-adherent had lower exercise capacity, more often lived alone, had lower social motivation to be physically active, and more often experienced sleeping problems compared with patients who were adherent. Patients who not exergamed at all had lower cognition and more often suffered from peripheral vascular disease compared with patients who were adherent to exergaming. Patients who not exergamed at all most often cited disease-specific barriers as a reason for not exergaming.

Almost half of patients with HF were adherent to exergaming, which is comparable with other physical activity interventions. One study[23] that compared exergaming with a conventional exercise group found that adherence was comparable but slightly higher in the conventional exercise group.

Over a 10 day period, adherence gradually decreased in the exergame group, while it increased in the conventional exercise group.

Patients who were non-adherent to exergaming more often had a lower social motivation to be physically active, which can be explained by the fact that they reported preferring physical activities with others to being active alone. This was also found in another study where only 22% of patients with HF had social motivation towards physical activity and women wanted to be active in groups more often than men.[24]

Patients who not exergamed at all more often lived alone compared with patients who were adherent to exergaming. These results highlight the importance of patients being able to choose the intensity of exergaming and to exergame in a group, for example, with family and friends, or maybe even online with other patients. Offering both cooperation and competition in exergaming is one possibility that may affect physiological and psychosocial changes. Competitive play has been found to increase energy expenditure and aggression, and cooperative exergaming has been found to increase motivation, promote continued play, enhance self-efficacy, and increase pro-social behaviours.[25] Research on elderly people who participated in social exergaming (both competitive and cooperative) showed a reduction in loneliness and an increase in social connections and positive attitudes towards others.[26]

In our study, we also found one-third of patients who were non-adherent suffered from insomnia, compared with 12% of patients who were adherent to exergaming. In a study including 548 elderly individuals, they found a prevalence of insomnia of 22%,[27] which is comparable of the prevalence found in the present study (24%). It is known that sleep and physical activity influence each other[28] and that sleep disturbances can impair a patients' capacity for exercise. On the other hand, being physically active is important for patients who experience sleeping problems, as regular physical activity can have a beneficial effect on sleep.[28,29] Therefore, assessing and treating sleeping problems in HF patients can be important before encouraging them to be physically active.

Patients who were non-adherent also had a lower exercise capacity at baseline compared with patients who were adherent to exercise. To encourage these patients to become more physically active, starting with low-intensity physical activity, such as walking or exergaming, could be a good first step.[30] Another study showed that elderly people experienced high levels of enjoyment from exergaming during the first few days, but this decreased over time,[23] which was also seen in the interviews conducted with the exergame group.[31] In the interviews, patients expressed that they perceived that bowling was the least physically intensive game in the exergame platform, whereas tennis and boxing were experienced as physically intensive.[31] The low intensity of exergaming could also be a reason why some patients preferred other activities that involve vigorous exercise. A literature review including older adults and exergaming found that adhering to exergaming was relatively high and may be related to the enjoyment and convenience of this form of physical activity.[32] These results highlight the importance of the possibility for patients to choose exergames that they enjoy and the physical intensity of exergaming.

Patients in our study who not exergamed at all had lower cognition compared with patients who were adherent to exergaming. Cognition and physical activity influence each other. A decrease in physical activity predicts cognitive dysfunction.[33,34] On the other hand, cognitive dysfunction may affect decision-making capacity and interfere with patients' ability to adhere to physical activity recommendations. Cognitive dysfunction such as deficits in attention, memory, executive function, and psychomotor speed could partly explain the technical problems experienced with exergaming (e.g. finding instructions for the exergame or the exergaming itself too difficult).[35] Familiarization with exergaming is important[31] but may be even more important for patients with cognitive decline. Furthermore, in clinical practice, it is important to assess cognition in patients with HF before encouraging them to become more physically active.

Regarding comorbidities, we found that patients who not exergamed at all suffered from peripheral vascular disease more often than patients who were adherent to exergaming. This could be because these patients experience intermittent claudication symptoms,[36] such as leg induced by pain physical activity, that prevent them from being physically active.

It is known that fluctuating health and comorbidity affect engagement in physical activity.[2] In this study, problems with health were the most common reason (47%) for not exergaming at all in the intervention group. Patients reported that fluctuating health and comorbid conditions affected their engagement in exercise, although patients differed in terms of their willingness to persist with activity despite symptoms.

In our study, we found no sex difference in adherence to exergaming.

A potential limitation of our study was the inclusion of patients with HF with preserved functional capacity, most of whom were in NYHA class I or II. It could well be that low-intensity physical activity interventions, such as exergaming, should be offered to patients with HF with significantly impaired functional capacity, and only to patients who are physically less active. Another limitation in the study was that we did not collect data on how much each of the different sports in the exergame was played. As the exergame platform was installed at home, the whole household was able to exergame, which made it hard to collect patient data from the platform. In future studies, it is advised to collect more data on the intensity of exergaming.

Conclusions

Determined factors that predict adherence to exergaming (or not exergaming at all) have important implications for future studies including exergaming as a form of physical activity in patients with HF. Our results highlight the importance for a thorough baseline assessment of physical function and cognition before starting an exergame intervention. It is important to offer the possibility to exergame with others and to be able to adapt the level of physical activity intensity.

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Conflict of interest

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Supporting information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Table S1. Baseline characteristics and differences between patients who never exergamed and adherent patients >80% (N = 191) (supplement).
Table S2. Variables independently related to not exergaming (N = 191) (Supplement).

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