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Letter to the editor

Remote telerehabilitation to maintain adherence to home-based exercise therapy in people with musculoskeletal disorders: A pilot study

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Dear Editor

Exercise therapy can reduce pain and activity limitations in people with chronic musculoskeletal disorders [1,2]. Adherence to exercise impacts treatment efficacy [3]. However, adherence is poor in the medium and long term [4,5]. Exercise supervision, personalization and regular follow-up could enhance adherence [6,7]. Furthermore, identifying individual barriers and facilitators may be useful to tailor exercise therapy and enhance adherence [8,9].

Recently, remote communication technologies have raised intense interest in the assessment and management of health conditions [10]. Telerehabilitation allows supervised exercises to be performed and monitored at home [11] and may produce similar clinical outcomes as rehabilitation delivered face-to-face [12]. Telerehabilitation was authorized in France in April 2020 to help physiotherapists adapt their clinical practice during the COVID-19 pandemic.

The objective of the current study was to assess adherence to a personalized home-based exercise program over 6 months in participants with chronic degenerative musculoskeletal disorders.

We conducted a prospective, mixed-methods, single-center pilot study with a 6-month follow-up. We reported our study in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist [13] and the Template for Intervention Description and Replication (TIDieR) [14].

Participants had chronic musculoskeletal disorders and had been prescribed outpatient exercise therapy by their treating physicians (senior specialists in physical and rehabilitation medicine and/or rheumatology from Cochin Hospital, Paris, France but did not require hands-on therapy or face-to-face sessions [2,6,15]. Inclusion and non-inclusion criteria are detailed in Appendix A.

All participants received a single, supervised face-to-face rehabilitation session and 3 follow-up telerehabilitation sessions were scheduled according to participants' availability at 1 week and 1 and 3 months. Additional telerehabilitation sessions could be scheduled as needed (Appendix B).

Participants completed self-administered questionnaires and answered open-ended questions by using the Lime Survey software hosted on the AP-HP's secure server.

The primary outcome was the mean change from 1 week in the total score for the self-administered Exercise Adherence Rating Scale (EARS: six questions, 4 points per question; 0 = no adherence and 24 = maximal adherence) at 1, 3 and 6 months after the face-to-face rehabilitation session [16]. The first item of the EARS ("I do my exercises as often as prescribed") was chosen as an anchor (Appendix B). Participants with a score $\geq$ 3/4 points were considered adherent to their home-based exercises [17].

Secondary outcomes were 1) pain intensity at 1 week and 1, 3 and 6 months measured on a self-administered numerical rating scale (0 = no pain and 100 = maximal pain); 2) activity limitations at 3 and 6 months measured with self-administered location-specific questionnaires: Roland-Morris Disability Questionnaire (RMDQ) (0 = no back pain limitations, and 24 = maximal back pain limitations), Neck Pain and Disability Scale (NPDS) (0 = no neck pain limitations and 100 = maximal neck pain limitations) and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) function subscale (0 = no knee limitations and 96 = maximal knee limitations); and 3) the burden of exercise therapy at 1, 3 and 6 months measured with the self-administered Exercise Therapy Burden Questionnaire (ETBQ), (0 = no burden and 100 = maximal burden). Acceptability and satisfaction were collected at 6 months by a self-administered numerical rating scale (0 = not acceptable and 100 = maximal acceptability; 0 = minimal satisfaction and 100 = maximal satisfaction, respectively).

At the end of their participation in the study, all participants were asked 3 open-ended questions: 1) "How did the telerehabilitation sessions help you?", 2) "Would you like to modify the rehabilitation program?", and 3) "Would you like to participate in a similar rehabilitation program in the future?" In addition, the least and most adherent participants (scores = 0 and 4, respectively, for the first item of the EARS at 6 months) were contacted by phone by an investigator (DMY), a resident in physical and rehabilitation medicine, to collect their feedback on the rehabilitation program (Appendix C).

Following the results of a pilot study reporting adherence to home-based exercises at 3 months in people with chronic low-back pain [18], we predicted a mean (SD) variation of 4 (3.5) points for the EARS total score at 6 months. With an α-risk of 5%, power of 90% and potential loss to follow-up of 20%, we sought to include 42 participants. For the descriptive analyses, qualitative data were expressed as absolute and relative frequencies (n/N,%) and quantitative data as mean (SD) or absolute difference (mean of the absolute value of the differences after excluding missing data) and SD or 95% confidence interval (CI). The Kolmogorov–Smirnov test (Lilliefors correction) was used to evaluate the normality of the distribution of the EARS

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Table 1
Demographic and clinical characteristics of participants (n = 43).

Age (years), mean (SD)	49.1 (15.6)
Female, n (%)	27 (63)
Body mass index (kg.m^{-2}), mean (SD)	25.0 (3.3)
Higher education, n (%)	25 (58)
Employed, n (%)	42 (98)
Musculoskeletal disorders, n (%)	
• Non-specific chronic low-back pain	33 (77)
• Non-specific chronic neck pain	7 (16)
• Knee osteoarthritis	3 (7)
Sick leave related to musculoskeletal disorders in the previous 3 months (yes), n (%)	16 (37)
Sick leave days related to musculoskeletal disorders in the previous 3 months, mean (SD)	15.3 (25.8)
Pain duration (years), mean (SD)	9.5 (12.4)
Pain intensity on numeric rating scale (1–100), mean (SD)	44.2 (25.2)
• Non-specific chronic low-back pain intensity[a]	43.3 (24.5)
• Non-specific chronic neck pain intensity[b]	50.0 (31.6)
• Knee osteoarthritis pain intensity[c]	40.0 (30.0)
Activity limitations, mean (SD)	
• Roland-Morris Disability Questionnaire score (0–24)[a]	8.0 (5.3)
• Neck Pain Disability Scale score (0–100)[b]	41.5 (18.6)
• WOMAC function subscale score (0–96)[c]	15.7 (14.5)
SF-12, mental component score, mean (SD)	41.6 (10.3)
SF-12, physical component score, mean (SD)	39.4 (9.6)
HAD scale, depression score (0–21), mean (SD)	5.5 (3.4)

HAD: Hospital Anxiety Depression; SF-12: Medical Outcomes Study Short-form 12; WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index.
[a] n=33
[b] n=7.
[c] n=3.

total score. The parametric Student paired t-test or non-parametric Wilcoxon test was used, as appropriate, to compare the EARS total score at each time assessed: 1 week and 1, 3 and 6 months. Given the number of comparisons prespecified for the primary outcome (8 comparisons), $p < 0.006$ was considered statistically significant. We classified the answers to the semi-structured interview by key themes illustrated by participants' verbatims. All analyses were performed with SYSTAT13 for Windows software.

The study protocol was approved by our institutional review board (CERAPHP Center#00011928, reference 2020-07-09).

In total, 52 participants were invited to participate, and 43 participants were included (Appendix D): 33/43 (77%) had low-back pain, 7/43 (16%) neck pain and 3/43 (7%) knee osteoarthritis; 27/43 (63%) were women. At baseline, mean (SD) age was 49.1 (15.6) years and mean pain intensity 44.2/100 (25.2) (Table 1). In total, 33/43 (77%) participants had at least 3 telerehabilitation sessions; 1/43 (2%) participants had an additional telerehabilitation session between 1 and 3 months after the face-to-face rehabilitation session and 7/43 (16%) had an additional session between 3 and 6 months.

The mean EARS total score decreased from 16.1/24 (95% CI 14.5;17.8) at 1 week to 15.6/24 (13.6;17.6) at 1 month (absolute difference 0.5 [−1.2;2.2], p = 0.8), 13.6 (7.2;20.0) at 3 months (absolute difference 0.2 [−1.5; 1.8], p = 0.004) and 12.7 [10.4; 15.0] at 6 months (absolute difference 3.7 [1.5;5.8], p = 0.004) (Table 2A). The maximal decrease in mean EARS total score occurred between 1 and 3 months (Fig. 1). At 6 months, 15/35 (43%) participants reported performing exercises as often as prescribed (Appendix D).

For all participants, mean (SD) pain intensity decreased from 44.2/100 (25.5) at baseline to 36.6 (23.0) at 6 months (absolute difference, 7.8 [23.9]) and mean burden of exercise therapy from 29.0/100 (15.9) at 1 week to 27.3/100 (16.6) at 6 months (absolute difference 1.7 [14.2]). For participants with chronic low-back pain, mean pain intensity decreased from 43.3/100 (24.5) at baseline to 40.0/100 (22.9) at 6 months (absolute difference 2.1 [22.8]) and mean RMQD score from 8.0/24 (5.3) at baseline to 5.0/24 (4.6) at 6 months (absolute difference 3.2 [4.2]). For participants with chronic neck pain, mean pain intensity decreased from 50.0/100 (31.6) at baseline to 30.0/100 (15.8) at 6 months (absolute difference 30.0 [18.7]) and mean NPDS from 41.5/100 (18.6) at baseline to 29.6/100 (20.3) at 6 months (absolute difference 18.4 [17.6]). For participants with knee osteoarthritis, mean pain intensity decreased from 40.0/100 (30) at baseline to 16.7/100 (28.9) at 6 months (absolute difference 23.3 [15.3]) and mean WOMAC function subscale from 15.7/96 (14.5) at baseline to 12.8/96 (22.1) at 6 months (absolute difference 2.9 [7.8]), (Tables 1, 2B). At the end of the program, 35/43 (81%) participants completed the satisfaction and acceptability questionnaires. Mean satisfaction was 64% and mean acceptability was 67%.

Among the participants who answered the open-ended questions, 18/23 (78%) found telerehabilitation sessions positive and 18/23 (78%) declared that telerehabilitation helped them perform their home-based exercise program, but 16/27 (59%) would have liked more face-to-face sessions. A total of 16/26 (62%) declared they would like to participate in the same rehabilitation program in the future.

At 6 months, 6 participants had a score = 4 (most adherent) and 4 had a score = 0 (least adherent) on the first item of the EARS and were contacted to be interviewed: 3 participants in each group agreed (Appendix E). Four key themes emerged. Both adherent and non-adherent participants acknowledged that telerehabilitation could facilitate follow-up. However, both groups valued face-to-face follow-up rehabilitation sessions. Non-adherent participants reported that the program did not help enhance their adherence to home-based exercises. Two of 3 participants in the adherent group reported that they were already familiar with supervised and unsupervised exercise therapy (Appendix F).

In the present study, despite remote telerehabilitation sessions, adherence to home-based exercises decreased over 6 months in people with musculoskeletal disorders. The variations observed were numerically small. Qualitative assessments showed that participants valued face-to-face follow-up rehabilitation sessions.

In our sample, the mean EARS total score decreased by 3.4/24 points at 6 months. Because the minimal clinically meaningful difference in the EARS total score has not yet been determined, the clinical relevance of this change is unclear. In a longitudinal study of 108 participants with chronic low-back pain followed for 5 weeks, a change in the EARS total score ≥ 5.5/24 points reflected a meaningful change in exercise adherence [17]. The detailed scores of the EARS at 6

Table 2A
Primary outcome: adherence to home-based exercises.

	One week n = 42	One month n = 41	Three months n = 41	Six months n = 35
Exercise Adherence Rating Scale (EARS) total score (0–24)	16.1 (14.5;17.8)	15.6 (13.6;17.6)	13.6 (7.2;20.0)	12.7 (10.4;15.0)
I do my exercises as often as prescribed (0–4)	2.8 (2.4;3.2)	2.4 (1.0;3.8)	2.2 (0.8;3.6)	2.2 (1.7;2.7)
I forget to do my exercises (0–4)	3.3 (3.0;3.6)	3.0 (2.6;3.4)	2.4 (2.0;2.8)	2.3 (1.8;2.8)
I do less exercise than advised by my healthcare professional (0–4)	2.3 (1.8;2.8)	2.2 (1.7;2.7)	1.7 (1.2;2.2)	1.8 (1.3;2.3)
I have made the exercises part of my daily living (0–4)	2.3 (1.8;2.8)	2.4 (1.9;2.9)	2.1 (1.6;2.6)	2.2 (1.7;2.7)
I don't manage to do my exercises (0–4)	2.9 (2.5;3.3)	3.2 (2.8;3.6)	3.0 (2.6;3.5)	2.4 (1.9;2.9)
I do all or almost all my exercises (0–4)	2.6 (2.1;3.0)	2.4 (2.0;2.9)	2.2 (1.7;2.7)	1.9 (1.4;2.4)

Data are mean (95% CI). Total score: 0, no adherence to 24, maximal adherence; for each question: 0, completely agree to 4, completely disagree; scoring is reversed for questions 1, 4 and 6.

Table 2B
Secondary outcomes: evolution of pain, activity limitations and burden of home-based exercises.

	One week *n*=42	One month *n*=41	Three months *n*=41	Six months*n*=35
Pain intensity numeric rating scale (0-100)				
All musculoskeletal disorders	40.1 (22.9)	40.6 (23.9)	33.3 (25.9)	36.6 (23.0)
Chronic low-back pain	42.2 (22.0)	40.6 (21.4)	34.4 (25.0)	40.0 (22.9)
Chronic neck pain	44.3 (28.2)	50.7 (32.8)	34.3 (34.1)	30.0 (15.8)
Chronic knee pain	20.0 (10.0)	16.7 (11.6)	20.0 (17.3)	16.7 (28.9)
Activity limitations				
Roland-Morris Disability Questionnaire score (0-24)	Not applicable	Not applicable	5.4 (4.1)[a]	5.0 (4.6)[b]
Neck Pain Disability Scale score (0-100)	Not applicable	Not applicable	33.3 (24.5)[c]	29.6 (20.3)[d]
WOMAC function subscale score (0-96)	Not applicable	Not applicable	14.2 (20.9)[e]	12.8 (22.1)[e]
Burden of home-based exercises				
Exercise Therapy Burden Questionnaire total score (0-100)	29.0 (15.9)	27.2 (16.7)	27.8 (16.0)	27.3 (16.6)
The exercises cause me pain (0-10)	4.6 (2.9)	4.5 (3.1)	3.2 (3.1)	2.6 (2.5)
The exercises cause me fatigue (0-10)	3.4 (2.7)	3.3 (3.2)	3.0 (3.2)	3.1 (3.2)
I get bored when I exercise (0-10)	3.3 (3.2)	3.1 (3.1)	3.9 (3.4)	3.7 (3.7)
The exercises in my program are too difficult (0-10)	2.1 (2.3)	1.3 (2.0)	1.2 (2.1)	1.3 (2.1)
I waste too much time exercising (0-10)	2.8 (2.7)	2.6 (2.9)	2.4 (2.8)	1.8 (2.6)
Exercising reminds me of my condition (0-10)	2.5 (3.5)	2.4 (3.1)	2.9 (3.5)	2.3 (3.4)
I lack support to exercise (0-10)	3.1 (3.6)	2.7 (3.2)	3.4 (4)	4.4 (4.3)
I lack motivation to exercise (0-10)	3.7 (3.2)	3.5 (3.3)	4.0 (3.5)	5.0 (3.8)
The exercises that I am asked to do are not adapted to my physical activity objectives (0-10)	1.4 (2.0)	1.4 (2.3)	1.5 (2.1)	1.2 (1.9)
I feel that exercising is not efficient in my case (0-10)	2.2 (2.5)	2.3 (2.6)	2.3 (3.0)	1.9 (2.8)

Data are mean (SD). WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index.
[a] *n*=32.
[b] *n*=27.
[c] *n*=7.
[d] *n*=5.
[e] *n*=3.

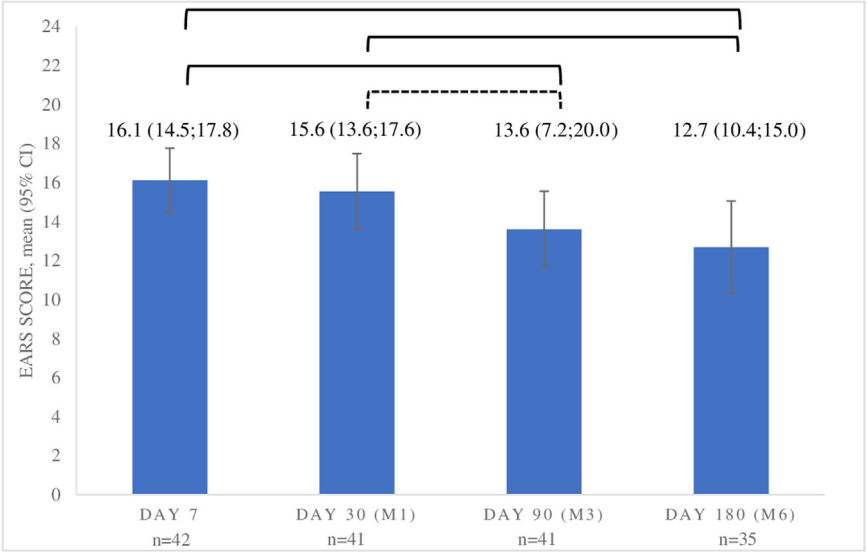

Fig. 1. Trajectory of adherence. Brackets in dotted line: $p = 0.005$, brackets in solid lines: $p = 0.004$ EARS: Exercise Adherence Rating Scale. CI: confidence interval. Data are mean (95% CI) EARS total score. Vertical bars are 95% CI. Horizontal brackets represent the time periods compared.

months showed that participants found it difficult to do some of their exercises and did fewer exercises than prescribed. According to our anchor question, 43% of our participants were adherent to their home-based exercises at 6 months. This percentage is higher than that previously reported, estimated at approximately 30% [4,5]. The decrease in adherence could have been influenced by the lockdown during the COVID-19 pandemic [19]. In our study, exercise dropout was concomitant with the end of the lockdown. One can assume that participants resumed their work and social participation and may have had less time for exercising.

The burden of exercise therapy was stable over the 6 months and the mean total ETBQ score remained < 30/100 points. Exercises were considered easy to do, not time-consuming and adapted but not sufficiently personalized or motivating. The same barriers to exercise therapy were previously reported in people with musculoskeletal disorders (lack of motivation, support and boredom) [17,20]. Telerehabilitation did not seem to reduce this burden. Most participants considered that the physical presence of the therapist was non-replaceable.

Our study has limitations. We included participants consecutively. Telerehabilitation may benefit selected participants, with fewer chronic symptoms who are already users of new technologies. Our single face-to-face session did not reflect usual care. Our sample was small and the subgroups of musculoskeletal conditions were unbalanced. The overrepresentation of employees and the fact that a specific sample of participants was interviewed reduces the representativeness of our results.

Our pilot study provides information on adherence to remote telerehabilitation over 6 months for people with musculoskeletal disorders. Adherence decreased over time. However, changes were

numerically small. Most participants valued face-to-face follow-up rehabilitation sessions. Our results will now be used to optimize and consolidate our rehabilitation program and assess its efficacy.

Contributorship statement

Conception and design of the study. AR and CN.
Drafting of the original protocol. AR, CN and CT.
Acquisition of data. DMY, CT, AR, MMLC and.FR
Coordination of the study. CN and AR.
Design of the statistical analysis plan. CN and AR.
Data analysis and interpretation. AR, DMY, CT and CN.
Drafting of the present manuscript. AR and DMY, CT and CN.
Final approval. AR, DMY, CT, MMLC, FR and CN.

Additional material

Appendix A. Inclusion and non-inclusion criteria
Appendix B. Content of the face-to-face rehabilitation session and of the telerehabilitation sessions
Appendix C. Interview chart
Appendix D. Figures: Flow diagram and participant adherence
Appendix E. Demographic and clinical characteristics of participants interviewed (n = 6).
Appendix F. Examples of participants' verbatims.

Data Availability

Data will be made available on request.

Declaration of Competing Interest

None.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.rehab.2022.101723.

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