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# A 12-week cardiac telerehabilitation programme does not prevent relapse of physical activity levels: long-term results of the FIT@Home trial

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## Keywords

Cardiac rehabilitation • Cardiac telerehabilitation • Coronary artery disease • Physical activity • Relapse prevention

Cardiac telerehabilitation (CTR) is a cost-effective alternative to centre-based cardiac rehabilitation (CR) for patients with coronary artery disease (CAD)<sup>1</sup> and as such, widespread implementation of CTR programmes is increasingly being supported. Unfortunately, physical activity levels (PAL) of patients decline after completion of CR<sup>2</sup> and many CAD patients do not adhere to physical activity guidelines.<sup>3</sup> It is plausible that CTR is more effective than centre-based CR in sustaining long-term PAL and exercise capacity, by encouraging patients to exercise in their home environment and the development of self-management skills to remain physically active. However, follow-up periods of recent trials were too short to demonstrate these effects.<sup>4,5</sup> The aim of the current study was to evaluate the long-term effectiveness of the CTR intervention applied in the FIT@Home trial<sup>6</sup> on PAL, physical fitness and quality of life (QoL) after 4 years of follow-up, as compared with centre-based CR.

FIT@Home was a randomized controlled trial evaluating the clinical and cost-effectiveness of 12 weeks of CTR, applying home-based training with a heart rate monitor, web application, and weekly telephone coaching (intervention group), compared with 12 weeks of centre-based CR (control group) in 90 low-to-moderate risk patients with clinically manifest CAD (i.e. secondary prevention).<sup>7</sup> Both groups were equally effective in improving their physical fitness from baseline to 1 year, whereas PAL and QoL did not change in either group.<sup>6</sup> For the current study, outcome measures at 4 years of follow-up were physical fitness (peakVO<sub>2</sub> assessed on a cycle ergometer), PAL (assessed using tri-axial accelerometry and heart rate data), and QoL

(assessed using the MacNew questionnaire). We performed linear mixed regression analyses to assess between-group differences in responses over time and paired-sample *t*-tests to analyse within-group differences.

Patients were predominantly male (92.7%; similar to other CTR trials), with a mean age of 60.6 ± 8.2 years at inclusion, and 81.8% had undergone coronary revascularization before the start of CR. After 4 years, 35 patients were lost to follow-up, leaving 55 patients for analysis (27 in the intervention group and 28 in the control group). Patients lost to follow-up were similar to patients available for analysis in terms of age, sex, and prior treatment of CAD. We did not observe between-group differences in responses over time for peakVO<sub>2</sub> (*P* = 0.940), PAL (*P* = 0.997), and QoL (*P* = 0.839; *Figure 1*). From 1 to 4 years of follow-up, peakVO<sub>2</sub> declined in both groups (both *P* < 0.001; *Table 1*). Physical activity levels appeared to decrease at 4 years of follow-up as well, but due to the low number of valid PAL measurements (*n* = 15 and *n* = 12 in the intervention and control group, respectively), we were not able to detect significant changes. In both groups, PAL and peakVO<sub>2</sub> decreased to baseline levels. Quality of life increased in both groups compared with 1 year of follow-up (*P* = 0.005 and *P* = 0.002). With regards to depression and anxiety, only the Hospital Anxiety and Depression Score depression subscale (*Table 1*) improved between 1 and 4 years of follow-up in the control group (*P* = 0.001).

Despite an initial improvement in physical fitness and sustainment of PAL, patients showed a relapse in both of these outcome measures

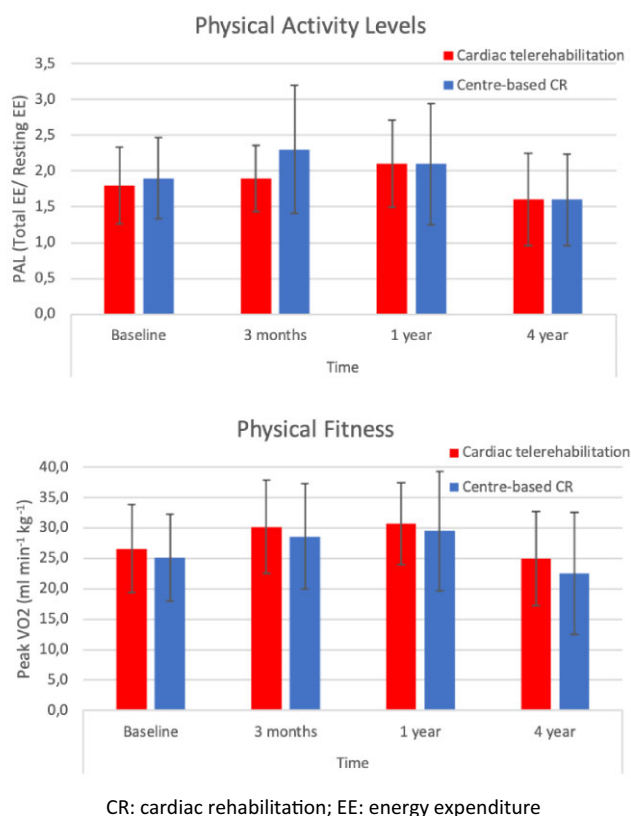
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- Regardless of the initial cardiac rehabilitation strategy, patients with coronary artery disease showed a relapse in physical activity levels and physical fitness at 4-year follow-up
- In both groups, physical activity levels and physical fitness decreased to baseline levels



**Figure 1** Physical activity levels and physical fitness after cardiac telerehabilitation and centre-based cardiac rehabilitation. CR, cardiac rehabilitation; EE, energy expenditure; PAL, physical activity level.

**Table 1** Main outcome measures at baseline, discharge (3 months) and follow-up at 1 and 4 years after cardiac telerehabilitation and centre-based cardiac rehabilitation

|                                                               | Cardiac telerehabilitation |              |              |                           | Centre-based CR |              |              |                           |
|---------------------------------------------------------------|----------------------------|--------------|--------------|---------------------------|-----------------|--------------|--------------|---------------------------|
|                                                               | Baseline                   | Discharge    | 1 year       | 4 years                   | Baseline        | Discharge    | 1 year       | 4 years                   |
| PAL (TEE/REE)                                                 | 1.8 ± 0.5                  | 1.9 ± 0.5    | 2.1 ± 0.6    | 1.6 ± 0.6                 | 1.9 ± 0.6       | 2.3 ± 0.9    | 2.1 ± 0.9    | 1.6 ± 0.6                 |
| Peak VO <sub>2</sub> (mL min <sup>-1</sup> kg <sup>-1</sup> ) | 26.6 ± 7.2                 | 30.2 ± 7.6   | 30.7 ± 6.7   | 25.0 ± 7.7 <sup>a</sup>   | 25.1 ± 7.2      | 28.6 ± 8.6   | 29.5 ± 9.9   | 22.5 ± 10.0 <sup>a</sup>  |
| Peak workload (watt)                                          | 195.9 ± 54.8               | 216.2 ± 53.8 | 218.1 ± 54.5 | 197.9 ± 50.6 <sup>a</sup> | 183.2 ± 40.2    | 212.0 ± 58.3 | 214.6 ± 62.4 | 197.3 ± 53.1 <sup>a</sup> |
| BMI (kg/m <sup>2</sup> )                                      | 27.8 ± 3.6                 | 27.3 ± 3.3   | 27.2 ± 3.1   | 27.9 ± 3.6 <sup>a</sup>   | 28.2 ± 3.5      | 28.2 ± 3.8   | 28.3 ± 3.5   | 28.4 ± 3.6                |
| Waist (cm)                                                    | 103.0 ± 10.1               | 101.5 ± 8.6  | 101.6 ± 9.3  | 101.3 ± 10.4              | 106.1 ± 9.4     | 104.7 ± 9.7  | 105.4 ± 10.0 | 105.0 ± 9.7               |
| HRQoL total score                                             | 5.9 ± 0.7                  | 6.1 ± 0.5    | 5.8 ± 0.4    | 6.2 ± 0.5 <sup>a,b</sup>  | 5.6 ± 0.8       | 6.1 ± 0.7    | 5.6 ± 0.8    | 6.2 ± 0.7 <sup>a,b</sup>  |
| HADS anxiety                                                  | 3.3 ± 2.4                  | 3.3 ± 2.2    | 2.0 ± 1.8    | 3.0 ± 2.7                 | 2.8 ± 3.1       | 2.5 ± 2.2    | 2.5 ± 2.8    | 2.4 ± 2.0                 |
| HADS depression                                               | 1.5 ± 1.9                  | 2.1 ± 2.9    | 3.3 ± 2.6    | 2.0 ± 2.6                 | 1.5 ± 1.8       | 1.3 ± 1.5    | 2.8 ± 2.3    | 1.0 ± 1.5 <sup>a</sup>    |
| PHQ-9 score                                                   | 2.7 ± 3.1                  | 2.2 ± 3.5    | 2.0 ± 3.2    | 2.0 ± 2.6                 | 2.5 ± 2.3       | 1.8 ± 2.2    | 2.6 ± 3.7    | 2.0 ± 2.2                 |

Values reported as mean ± standard deviation.

BMI, body mass index; CR, cardiac rehabilitation; HADS, Hospital Anxiety and Depression Score (higher scores indicate higher risk of anxiety or depression); HRQoL, Health-Related Quality of Life (higher scores indicate better quality of life); PAL, physical activity level; PHQ-9, Patient Health Questionnaire 9-item score (higher scores indicate higher risk of depression); REE, resting energy expenditure; TEE, total energy expenditure.

<sup>a</sup>Significant difference between 1 and 4 years of follow-up ( $P < 0.05$ ).

<sup>b</sup>Significant difference between baseline and 4 years of follow-up ( $P < 0.05$ ).

at 4 years of follow-up, regardless of the initial CR strategy. It is possible that patients lost to follow-up were less motivated than patients available for analysis. In that case, an even larger relapse in physical fitness and PAL might have been observed if all patients had completed the 4 years of follow-up. The relapse in PAL is, however, consistent with findings of other studies that evaluated long-term effects of CTR in CAD patients.<sup>8–10</sup> Relapse in physical fitness was observed in previous studies as well, though the extent of relapse differed and could be explained by differences in the type (CTR *instead of or in addition to* centre-based CR) and duration of the intervention (3–7 months), and variation in follow-up duration (2–6 years).<sup>8–10</sup> Although our analysis at 1 year of follow-up did not demonstrate relapse, at 4-years of follow-up a relapse is clearly visible irrespective of CR strategy. This indicates that patients did not make sustainable changes in physical activity behaviour and highlights the need for long-term guidance beyond 1 year of follow-up.

Our results demonstrate that a 12-week CTR programme was not successful in preventing a decline in physical fitness and PAL over time, even in low-to-moderate risk CAD patients. This indicates that such relapse cannot be averted by the mere implementation of CTR programmes, but that future CR and CTR interventions should be thoroughly redesigned to create sustainable behavioural change and long-term adherence to a physically active lifestyle.

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## Data availability

The data underlying this article will be shared on reasonable request to the corresponding author.

**Conflict of interest:** The authors declare that there is no conflict of interest.

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## References

1. Scherrenberg M, Falter M, Dendale P. Cost-effectiveness of cardiac telerehabilitation in coronary artery disease and heart failure patients: systematic review of randomized controlled trials. *Eur Heart J - Digit Health* 2020;**1**:20–29.
2. Bock BC, Carmona-Barros RE, Esler JL, Tilkemeier PL. Program participation and physical activity maintenance after cardiac rehabilitation. *Behav Modif* 2003;**27**: 37–53.
3. Kotseva K, De Backer G, De Bacquer D, Rydén L, Hoes A, Grobbee D, Maggioni A, Marques-Vidal P, Jennings C, Abreu A, Aguiar C, Badariene J, Bruthans J, Castro Conde A, Cifkova R, Crowley J, Davletov K, Deckers J, De Smedt D, De Sutter J, Dilic M, Dolzhenko M, Dzerve V, Erglis A, Frasc Z, Gaita D, Gotcheva N, Heuschmann P, Hasan-Ali H, Jankowski P, Lalic N, Lehto S, Lovic D, Mancas S, Mellbin L, Milicic D, Mirrahimov E, Oganov R, Pogossova N, Reiner Z, Störck S, Tokgozoglu L, Tsioufis C, Vucic D, Wood D; on behalf of the EUROASPIRE Investigators. Lifestyle and impact on cardiovascular risk factor control in coronary patients across 27 countries: results from the European Society of Cardiology ESC-EORP EUROASPIRE V registry. *Eur J Prev Cardiol* 2019;**26**: 824–835.
4. Claes J, Buys R, Budts W, Smart N, Cornelissen VA. Longer-term effects of home-based exercise interventions on exercise capacity and physical activity in coronary artery disease patients: a systematic review and meta-analysis. *Eur J Prev Cardiol* 2017;**24**:244–256.
5. Brouwers RWM, Kraal JJ, Regis M, Spee RF, Kemps HMC. Effectiveness of cardiac telerehabilitation with relapse prevention: SmartCare-CAD randomized controlled trial. *J Am Coll Cardiol* 2021;**77**:2754–2756.
6. Kraal JJ, Van den Akker-Van Marle ME, Abu-Hanna A, Stut W, Peek N, Kemps HMC. Clinical and cost-effectiveness of home-based cardiac rehabilitation compared to conventional, centre-based cardiac rehabilitation: results of the FIT@Home study. *Eur J Prev Cardiol* 2017;**24**:1260–1273.
7. Kraal JJ, Peek N, Van den Akker-Van, Marle ME, Kemps HMC. Effects and costs of home-based training with telemonitoring guidance in low to moderate risk patients entering cardiac rehabilitation: the FIT@Home study. *BMC Cardiovasc Disord* 2013;**13**:82.
8. Smith KM, McKelvie RS, Thorpe KE, Arthur HM. Six-year follow-up of a randomised controlled trial examining hospital versus home-based exercise training after coronary artery bypass graft surgery. *Heart* 2011;**97**:1169–1174.
9. Frederix I, Solmi F, Piepoli MF, Dendale P. Cardiac telerehabilitation: a novel cost-efficient care delivery strategy that can induce long-term health benefits. *Eur J Prev Cardiol* 2017;**24**:1708–1717.
10. Claes J, Buys R, Avila A, Cornelis N, Goetschalckx K, Cornelissen VA. Lifelong changes in physical activity behaviour through phase II cardiac rehabilitation? Still steps to take! *Eur J Prev Cardiol* 2021;**28**:e17–e19.