Peer Community In
Health & Movement Sciences

A prospective observational study examining changes in exercise capacity, physical activity, and motivation for physical activity 12 months after a cardiac rehabilitation programme in patients with coronary heart disease

Franco Milko Impellizzeri *based on peer reviews by* ***Géraldine Escriva-Boulley****,* ***Baraa Al-Khazraji*** *and 1 anonymous reviewer*

Paul Da Ros Vettoretto, Anne-Armelle Bouffart, Youna Gourronc, Anne-Charlotte Baron, Marie Gaumé, Florian Congnard, Bénédicte Noury-Desvaux, Pierre-Yves de Müllenheim (2024) Change in exercise capacity, physical activity and motivation for physical activity at 12 months after a cardiac rehabilitation program in coronary heart disease patients: a prospective, monocentric and observational study. HAL, ver. 4, peer-reviewed and recommended by Peer Community in Health and Movement Sciences.
https://hal.science/hal-04510104v4

Submitted: 22 March 2024, Recommended: 17 November 2024

Cite this recommendation as:
Impellizzeri, F. (2024) A prospective observational study examining changes in exercise capacity, physical activity, and motivation for physical activity 12 months after a cardiac rehabilitation programme in patients with coronary heart disease. *Peer Community in Health and Movement Sciences*, 100113. 10.24072/pci.healthmovsci.100113

Published: 17 November 2024

Exercise capacity is recognised as a strong predictor of mortality and cardiovascular morbidity in both healthy individuals and patients with coronary heart disease (Novaković et al., 2022). Accordingly, exercise-based cardiac rehabilitation is recommended as an effective secondary preventive intervention (Task Force Members et al., 2016; Anderson et al., 2016). While earlier studies generally focused on changes in exercise capacity during or immediately after rehabilitation (Uddin et al., 2016), recent research has emphasised the importance of physical activity trajectories on mortality in patients with coronary heart disease (Gonzalez-Jaramillo et al., 2022). This highlights the need to understand changes in exercise capacity and physical activity following the rehabilitation phase.

This study specifically explored changes in exercise capacity (assessed using the six-minute walking test) and physical activity (assessed using the International Physical Activity Questionnaire-Short Form) one year after a cardiac rehabilitation programme in patients with coronary heart disease. Additionally, the authors examined changes in motivation for physical activity over the 12 months following rehabilitation.

Within the limitations of its observational and monocentric nature, the study presents important findings that can inform future research, generate hypotheses, and guide the design of targeted trials aimed at improving or maintaining exercise capacity and physical activity levels after rehabilitation. The exploration of potential barriers to physical activity 12 months after rehabilitation could inform strategies to increase participation in physical activity post-rehabilitation, thereby improving survival (Moholdt et al., 2018).

This study is well-conducted and clearly presented. The authors' interpretation is balanced and consistent with the study's design and analysis. As noted by one of the reviewers, retention in cardiac rehabilitation studies is challenging, and the authors have done a commendable job in retaining participants. They have also addressed all the reviewers' concerns properly and accurately. I am pleased to recommend this preprint.

References:

- Novaković M, Novak T, Vižintin Cuderman T, Krevel B, Tasič J, Rajkovič U, Fras Z, Jug B. Exercise capacity improvement after cardiac rehabilitation following myocardial infarction and its association with long-term cardiovascular events. Eur J Cardiovasc Nurs. 2022;21(1):76-84. https://doi.org/10.1093/eurjcn/zvab015

- Task Force Members, Piepoli MF, Hoes AW, et al. 2016 European Guidelines on cardiovascular disease prevention in clinical practice: The Sixth Joint Task Force of the European Society of Cardiology and Other Societies on Cardiovascular Disease Prevention in Clinical Practice (constituted by representatives of 10 societies and by invited experts): Developed with the special contribution of the European Association for Cardiovascular Prevention & Rehabilitation (EACPR). Eur J Prev Cardiol. 2016;23(11):NP1-NP96. https://doi.org/10.1177/2047487316653709

- Anderson L, Oldridge N, Thompson DR, et al. Exercise-Based Cardiac Rehabilitation for Coronary Heart Disease: Cochrane Systematic Review and Meta-Analysis. J Am Coll Cardiol. 2016;67(1):1-12. https://doi.org/10.1016/j.jacc.2015.10.044

- Uddin J, Zwisler AD, Lewinter C, et al. Predictors of exercise capacity following exercise-based rehabilitation in patients with coronary heart disease and heart failure: A meta-regression analysis. Eur J Prev Cardiol. 2016;23(7):683-693. https://doi.org/10.1177/204748731560431

- Gonzalez-Jaramillo N, Wilhelm M, Arango-Rivas AM, Gonzalez-Jaramillo V, Mesa-Vieira C, Minder B, Franco OH, Bano A. Systematic review of physical activity trajectories and mortality in patients with coronary artery disease. J Am Coll Cardiol. 2022;79:1690-1700. https://doi.org/10.1016/j.jacc.2022.02.036

- Moholdt T, Lavie CJ, Nauman J. Sustained physical activity, not weight loss, associated with improved survival in coronary heart disease [published correction appears in J Am Coll Cardiol. 2018;71(13):1499. doi: 10.1016/j.jacc.2018.03.013]. J Am Coll Cardiol. 2018;71(10):1094-1101. https://doi.org/10.1016/j.jacc.2018.01.011

- Da Ros Vettoretto P, Bouffart AA, Gourronc Y, Baron AC, Gaumé M, Congnard F, Noury-Desvaux B, de Müllenheim PY (2024) Change in exercise capacity, physical activity and motivation for physical activity at 12 months after a cardiac rehabilitation program in coronary heart disease patients: a prospective, monocentric and observational study. HAL, ver.3, peer-reviewed and recommended by PCI Health & Movement Sciences. https://hal.science/hal-04510104v3

Reviews

Evaluation round #2

DOI or URL of the preprint: https://hal.science/hal-04510104
Version of the preprint: 2

Authors' reply, 07 November 2024

Download author's reply
Download tracked changes file

Decision by Franco Milko Impellizzeri, posted 31 October 2024, validated 31 October 2024

Dear Authors,
as confirmed by both reviewers, the authors have done an excellent job incorporating and addressing the suggestions. I kindly ask for one final effort to make a few additional minor changes from one of the reviewers, which are reasonable, though not substantial. Upon receiving the revised version, I will proceed immediately with the recommendation.

Regards,
Franco Impellizzeri

Reviewed by Baraa Al-Khazraji, 07 October 2024

Dear Authors,
Thank you for taking the time to consider and incorporate the suggestions. Your revisions and feedback address all my concerns. Congratulations on completing an excellent study.

Reviewed by Géraldine Escriva-Boulley, 29 October 2024

The authors did a really great job of responding to my comments and adding relevant information and analyses.

I have only minor comments regarding the self determination theory.

In the second paragraph of the introduction, when presenting this theory, the main authors of this theory (Deci & Ryan) may be cited.

In the sentence "In particular, analysing motivation for physical activity could be here an appropriate approach supported by the well-established self-determination theory framework stating that the adoption and maintenance of physical activity behaviour is dependent on the form of motivation (autonomous vs. controlled) and regulation (integrated, identified, introjected, external) related to physical activity, with a particular positive influence of autonomous (identified and intrinsic) regulations (Teixeira et al., 2012) ".

- The part "physical activity behaviour is dependent on the form of motivation (autonomous vs. controlled) and regulation" is not entirely correct. It is better to distinguish form of motivation and regulation in this sentence. For instance : "physical activity behaviour is dependent on the form of motivation (autonomous vs. controlled) and**/or on** regulation**s**"

In the sentence "Moreover, to our knowledge, very few studies [...] (Kim, Crane, et al., 2021)." as the authors only cited one study, it may be more precise to write "Moreover, to our knowledge, **only one study** [...] (Kim,

Crane, et al., 2021)." if relevant.

The motivational profils cannot be named as "controlled motivation" if only the introjected regulation is high or moderate, but it is possible to name the profil after the regulation (high autonomous and high or moderate introjected regulation).

Evaluation round #1

DOI or URL of the preprint: https://hal.science/hal-04510104
Version of the preprint: 1

Authors' reply, 03 September 2024

Download author's reply
Download tracked changes file

Decision by Franco Milko Impellizzeri, posted 15 June 2024, validated 15 June 2024

Change in exercise capacity, physical activity and motivation for physical activity at 12 months after a cardiac rehabilitation program in coronary heart disease patients - Revision Required

Dear Authors,

Thank you for considering our journal for your preprint. I apologise for the longer-than-usual review process. We have finally received all the reviewers' comments. I agree with the reviewers that this is a well-written and methodologically sound study examining the changes in exercise capacity, physical activity, and motivation for physical activity 12 months after a cardiac rehabilitation program in coronary heart disease patients.

Overall, the reviewers are positive but have provided suggestions that can further improve the manuscript and are worth considering. I would like to invite the authors to consider these suggestions and submit a revised version with a point-by-point response to their comments.

Regards,

Franco Impellizzeri

Reviewed by Baraa Al-Khazraji, 15 June 2024

Review for: Change in exercise capacity, physical activity and motivation for physical activity at 12 months after a cardiac rehabilitation program in coronary heart disease patients: a prospective, monocentric and observational study

Study authors: Paul Da Ros Vettoretto, Anne-Armelle Bouffart, Youna Gourronc, Anne-Charlotte Baron, Marie Gaumé, Florian Congnard, Bénédicte Noury-Desvaux, Pierre-Yves de Müllenheim

Thank you for putting together a well-written manuscript. The study objectives are clearly outlined, and the study's findings hold great promise in helping us understand how to implement lasting changes in cardiac rehab participants, and to prevent future cardiovascular events.

The researchers should be particularly commended for executing a difficult study, as retention with cardiac rehab-based studies is difficult, and particularly to acquire such success in retention with the 1-year follow-up. Congratulations on your efforts.

Below I have some comments that may be of interest to you, hopefully to further showcase the impact of your hard work.

METHODS/RESULTS

1. Great work highlighting and incorporating a minimal clinically important difference (MCID) of 50m into the sample size justification.
2. How soon after the cardiac event were people enrolled into the 4-week cardiac rehab program? (e.g., 3 weeks post-MI, etc.).
3. As part of standard intake/CR, what were the VO2max values for these patients at the start and end of the 4 week CR? How did these values relate to the 6MWT data that were collected during the 4 week CR? It's understandable that VO2max was not collected at the 1-year follow-up, but it is good to see how 6MWT relates to the VO2max values where these data are available.
4. Please change to LIKERT not LICKERT
5. What medications were these patients on during CR, but most importantly in the 1 year post CR.
6. For the women in your study, how many were on hormone therapy and/or can you provide any menopausal information (e.g., duration) available for these women?

DISCUSSION

1. Please talk about the lack of women enrolled in your study – why do you think this is? Talk about it as a future direction and why women in general have barriers to cardiac rehab/less like to participate.
2. Why aren't medications discussed or even provided in results?
3. Nowhere in the discussion is the comparison with VO2max made.
4. Context of the differences in 6MWT values and minimal clinically important difference (MCID)?
5. Unclear how the barriers to PA ended up relating to the 6MWT outcomes at 1 year. How do we know which of the deciles from the functional data were related to which of the barriers to PA? The data are there and could provide further context and deepen the discussion on 6MWT values 1-year postCR. This provides even more impact to their work, and circles back to a line in the Introduction "…but also the evolution over time of motivation for physical activity as it could be related to physical activity behaviour in cardiac patients after a CR program (Russell & Bray, 2009)."
6. Please speak to the lack of time control – i.e., in a given year, what do you anticipate 6MWT to change by for a non-exercising group? Or a non-CR group? Please speak to how "time" affects anticipated change (if any) for 6MWT values and the reproducibility in measures of 6MWT as we are assuming that CR, and 1-year postCR are the main exposures that are contributing to 6MWT values 1-year postCR.

Reviewed by Géraldine Escriva-Boulley, 04 June 2024

Based on the knowledge that in CHD patients, mortality risk is associated with exercise capacity and physical activity, and that the evolution of these variables could predict health maintenance, the present study aims to investigate the change in mean exercise capacity of CHD patients 12 months after completing a CR program compared to the end of the program. The second aim is to explore how the distributions of exercise capacity, physical activity level and motivation for physical activity evolve between the end of the CR program and 12 months after the program, as well as the typical individual changes in these outcomes over this period of time.

The study is interesting because it investigates variables after a CR program (follow up measure) and examine change of mean and distribution. This kind of studies is scarce. The code used for the analyses is available.

General comments

Introduction :

Although, the aim of the main objective of the study is clearly justified based on results from previous studies, the introduction could be strengthened adding details:

1) First of all, hypotheses are missing

2) What the authors mean by physical activity level (intensity? MET? EE? By day? By week?)§1 L5? by exercise capacity (how it is measured? Is there specific results for this population?)§2 L1

3) Links about physical activity and motivation are well documented. More explanations about why motivation could be an interesting variable to investigated could help to understand how and why the authors choose the variables. §2 L10 The same suggestion worth also to barriers to physical activity.

4) The authors listed some previous studies but the reader could need information about the results founds and/or the tools used and/or the participants recruited in these studies. Doing this the authors could stress even more why this study is important.

Methods:

5) Details are given to facilitate replications but some are missing (e.g., what were the exercises proposed, what was the intensity of the exercises, what was the duration of the CR program session? The way and the tool used to assess barriers to PA is not clear (it seems to be a questionnaire in the method section-"For each of the items, the participant had to indicate whether the item was considered as a barrier or not", then an interview –"most frequently evocated"- in method, result sections and NCT).

6) In the statistical analysis part, it is strange to have a lot of variables able to explain/predict the evolution of exercise capacity or PA (e.g., sociodemographic, motivation, barrier, patient knowledge, treatment, benefits and risk of PA, PA) but no analysis about it. May be Cluster analysis? Regression? Path analysis? Cross-lagged? Mediation/moderation? Could be interesting, if it is feasible.

Why analysed change in mean AND distribution only for exercise capacity?

Specific comments

Title and abstract:

The title and the aim of the study is clear.

7) The method is well summed and the results are clear but 2 or 3 sentences at the end of the abstract to help the reader to better understand the implication of these results could be of added value.

Introduction:

8) It could be clearly stated since the introduction that investigating the evolution between the beginning of the program and the end of the program is not the aim of the study (and then remove all reference of the measure performed before the CR program or explain why this measure is not included, e.g., "The test performed at the end of the CR program actually was the second test experienced by the participants after the first one performed at the beginning of the CR program").

9) The authors could add the word "negatively associated" in "In CHD patients, mortality risk is associated with exercise capacity as assessed using cardiopulmonary (Ezzatvar et al., 2021) " to be more precise.

10) There is at least one study about change in motivation for PA over time in cardiac patient after CR: Kim, Young Joo; Crane, Patricia A.; Houmard, Joseph A.; Swift, Damon L.; Wu, Qiang. Minor Improvement in Activity and Participation and Decline in Physical Activity Motivation After Cardiac Rehabilitation Discharge. https://doi.org/10.1097/HCR.0000000000000586

Methods:

11) The process of subject selection is quite clear (the word “a” could be replace by “the” in “has completed a CR program”)

12) Except for IPAQ-SF, the variables are measured and presented appropriately. For IPAQ-SF before seeing result it is not clear what was the measure chosen (MVPA? LPA? Min/week? Met-min/week?)

In the statistical analysis part the list of packages used could be in suppl. Material to ease the reading.

13) The authors stated the only participants who had data at both the time point were considered. Is there differences between those who complete both measure and the others?

14) It is not clear at this point why the measurement of the IPAQ at the end of the program could not be used in the analysis alike for the other variables. The explanation gave in the discussion section could be presented in this part. Nevertheless, the decrease of PA between the end of the program and the follow up is what happen in general, and could be an interesting result to analyse to better understand the evolution of the PA.

Results:

15) Results are presented for specialists : the results are presented but their meaning in not clear.

16) Table 1 could be improved by replacing “descriptive statistics” by “ mean and SD” and “surgery history” could be removed or add a space before “angioplasty” and bypass”

Discussion:

17) In the discussion the authors emphasized that they did not used the same measurement tools as previous studies. It could be stated only once in the “limits part”. The tools used in the present study could have been used in similar pathological contexts (even if it is not in CHD). This could help to discuss the results.

18) If not tested or referenced the sentence “The absence of statistically significant changes in physical activity in the present study might have parallels with the absence of significant individual changes in most of the forms of motivation for physical activity (EMAPS scores), but this link remains for now highly speculative” could be remove because as said it is only speculative.

19) In the paragraph before the strengths paragraph the authors used the words “positive responses” It is not clear what positive response mean in this case.

In my opinion, the fact that environmental factors do not have the same importance when comparing studies led in different town, city, country or continent is not so surprising.

Some references that could be useful:

Intensity matters: protocol for a randomized controlled trial exercise intervention for individuals with chronic stroke. https://doi.org/10.1186/s13063-02

Physical activity and sedentary behaviour changes during and after cardiac rehabilitation: Can patients be clustered? https://doi.org/10.2340/jrm.v55.4343

Reviewed by anonymous reviewer 1, 06 May 2024

Thank you for the opportunity to review this manuscript that investigates the change in exercise capacity, physical activity, and motivation for physical activity by examining individual and group trajectories in patients

following completion of a cardiac rehabilitation program. Overall, the manuscript is well written. It's a nice demonstration of the idiosyncrasy of people's journeys, although more is needed to clarify the interpretation of the results so that the message is not only clear to those who know the methodological approach. Please see below my comments and suggested revisions.

Abstract:

1. The aims, methods, and results of the study are well covered in the abstract. However, the abstract could benefit from a sentence or two that provides the background/rationale for the study, along with concluding sentences that summarise the implications of the study findings.

Introduction:

1. It is stated that cardiac rehabilitation programs which include exercise training and physical activity counselling are recommended for CHD patients with appropriate indications. However, it is not clear what these indications are. Some examples would be useful to provide context.
2. Clear rationale is provided for investigating the change in exercise capacity and physical activity over time in the introduction. However, the rationale for analysing the change in motivation for physical activity over time is less clear. Please include more about the concepts of the self-determination theory and its components and some expectations based on past findings about how it may or may not change across rehabilitation programs.

Methods:

1. Please specify the sampling method used to recruit participants.
2. The rehabilitation program seems like a much more intensive dosage than is common (although maybe that's country specific). If I understand it correctly, it seems they had 10 or more sessions per week? This dosage will have a different impact on outcomes than others like once per week. More on that in the discussion would be good.
3. Please include the wording used for the measures. Were patients asked to focus exclusively on physical activity done in the rehab setting, outside the rehab setting or all inclusive?
4. The description of the scoring of the exercise capacity and motivation measures is a bit unclear. Please clarify.
5. I appreciate the description of the analytic method and approach. There are a few different ways to test the research questions, but the one elected is acceptable. I personally don't see the added value of the bivariate plots and description as it seems to be a bit redundant with the trajectory analyses, but if the authors can clarify the added interpretation and practical significance of it, that would be suitable.

Results:

1. Please clarify how descriptive statistics are presented in the footnote of table 1 (e.g., mean±SD) so that the table can be understood without having to read the main text.
2. Given the rare application of this analytic approach for the field, it would be valuable to include a few sentences in the results that provide a clearer 'lay person' interpretation of the findngs. Eg., "This means that of the 75 people whose data were analysed for this, X amount experienced a change of Y units…"

Discussion:

1. Further discussion about the self-determination theory is needed. Specifically, how these findings align or contrast with other similar studies and what the implications are about patients' motivation throughout this process.
2. It would be interesting to consider a bit about how motivation may be expected to shift from focusing on rehab adherence to focusing more on sustained lifestyle physical activity.