The Additional Effect of Lifestyle Coaching to the Regular Cardiac Rehabilitation Program On Lifestyle Improvements: A study on the additional effect of 'lifestyle coaching' to the regular cardiac rehabilitation (CR) components 'FIT' and 'PEP' on eight lifestyle factors in the short and long term – The BENEFIT study

Nederhorst, Rosephine

Universiteit Leiden

Psychologie
Faculteit der Sociale Wetenschappen

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Rosephine Félice Nederhorst

Master Thesis Clinical Health and Medical Psychology
Faculty of Behavioral and Social Sciences – Leiden University
June, 2025
Student number: s2738767
First Examiner: Linda Breeman; Health, Medical and Neuropsychology Unit; Leiden University
Second Examiner: Antoinette van Laarhoven; Health, Medical and Neuropsychology Unit; Leiden University

Abstract

Lifestyle-focused cardiac rehabilitation (CR) is recognized as one of the most effective strategies of secondary prevention for cardiovascular disease (CVD) patients. Therefore, optimizing this approach is essential to mitigate the impact of CVD and improve patients' outcomes. Hence, the research question for this thesis is: 'What is the additional effect of lifestyle coaching on top of the regular CR program on eight lifestyle factors in the short and long term?' It is hypothesized that the addition of lifestyle coaching to the regular CR program will have a positive effect on lifestyle improvements among CR participants, lifestyle coaching will have a larger effect on increasing physical activity than on the other lifestyle elements and that the effects of lifestyle coaching on physical activity will remain at the one-year follow-up. This thesis is part of a larger research project: the BENEFIT study. The research design of the study is longitudinal. Participants were 587 cardiac patients, referred to rehabilitation centres, who filled in an online questionnaire at three different moments. Furthermore, the design is factorial and tested sixteen hierarchical multiple regression analyses; the addition of lifestyle coaching on the eight lifestyle factors separately at two measurements. The results showed that the addition of lifestyle coaching to the regular CR program only significantly reduced participants' alcohol consumption, both in the short (*F change* = 3.879, (1, 333), β = -.070, p =.049) and long term (*F change* = 10.050, (1,219), β = -.136, p =.002). Moreover, the addition of lifestyle coaching did not lead to a greater effect on physical activity compared to the other lifestyle factors, in either the short (β = -.084, p = .136) and long term (β = .112, p = .985). In conclusion, lifestyle coaching in addition to the regular CR program did not have an additional effect on the lifestyle factors in this study, except for alcohol consumption, in both the short and long term. Contrary to the expectation, the addition of lifestyle coaching did not have a significant effect on improving physical activity. A possible explanation may be the pre-existing effectiveness of the regular CR program in improving physical activity through the FIT sessions. Additional research could further investigate how to elevate lifestyle improvements through CR to minimize the burden of secondary CVD.

Layman's Abstract

Heart diseases cause patients a lot of suffering and are very expensive to treat. After someone has a heart incident, like a heart attack, they can take part in a program called cardiac rehabilitation (CR). This program helps patients recover from their condition by encouraging regular exercise and giving them mental support. It helps them to prevent future heart problems as well.

Research has already shown that the CR program works well. But in this study, we wanted to see if adding 'lifestyle coaching' could help patients improve their health habits even more. Lifestyle coaching involves working with a trained coach that helps patients set goals and make healthy changes. These changes might include being more physically active, quitting smoking, drinking less alcohol, eating better, reducing stress, and sleeping better.

The study involved 587 heart patients who followed the regular CR program with lifestyle coaching added to it. They filled in a questionnaire at three moments, before starting the program, right after finishing it and one year after the start of it. We wanted to see whether adding lifestyle coaching made a bigger difference in improving healthy habits than the regular CR program alone, especially for physical activity.

The results were different than expected. Adding lifestyle coaching did not lead to more improvements in exercise, smoking, diet, stress or sleep compared to the regular program. However, due to the addition of lifestyle coaching to the CR program heart patients drank less alcohol, right after the program and also one year later. Even though adding lifestyle coaching did not improve the overall results as much as expected, it still shows potential in helping patients improve their health habits

In short, this study found that adding lifestyle coaching to the regular CR program did not lead to important, overall improvements in the lifestyle areas, except for small differences in drinking alcohol. Probably the regular CR program is already effective enough as it is without lifestyle coaching. More research could search for further ways to increase healthy habits even more, to prevent future heart problems among CVD patients.

Content

Introduction

In the United States, cardiovascular diseases (CVD) are the main cause of death and carry countless clinical and financial costs (Duscha et al., 2018). In addition, people with CVD face the risk of disabilities and a poorer quality of life. They suffer from their symptoms, experience impairments in breathing and sleeping, higher risk of distress and depression, and can experience complications in their participation in society (Ojala et al., 2020). Cardiac rehabilitation (CR) focused on lifestyle improvements is considered one of the most effective methods to prevent secondary CVD. Thus, lifestyle-focused CR is extremely important to prevent the clinical burden and accompanied costs of CVD (Duscha et al., 2018). Despite its positive effects, cardiac rehabilitation remains underutilized in clinical practice (Van Engen-Verheul et al., 2012).

Cardiac Rehabilitation programs are designed for individuals who have experienced a cardiac event and it regularly consists of 'fitness sessions under the guidance of a physiotherapist (FIT)' and 'psycho-educational prevention (PEP) sessions' (De Nederlandse Hartstichting, n.d.). During the FIT sessions, patients perform exercises under the supervision of a physiotherapist who also provides them with exercises to do at home (*Inhoud Revalidatieprogramma | Cardiovitaal*, n.d.). PEP sessions are group courses in which patients learn how to cope with their life after a cardiac event, for example, by using stress management techniques and making lifestyle improvements through education and sharing experiences (*Hartrevalidatie: PEP Module*, n.d.). Numerous studies have proven the significant positive outcomes of the regular CR program. For example, the meta-analysis by Janssen et al. (2012) provided evidence that programs like CR promote positive lifestyle changes, reduce risk factors for secondary CVD, enhance patient quality of life, and lower rates of morbidity and mortality. Another meta-analysis showed that eHealth CR increases cardiac patients' healthy lifestyle, their quality of life, and decreases the risk of a new hospital admission (Su et al., 2019). In addition, the study of Mikkelsen et al. (2019) showed an increase in physical activity after CR in an elderly cardiac population, especially when their internal motivation was high.

This study, which is part of the larger BENEFIT project (Breeman et al., 2024), will focus on the differential effects of the cardiac rehabilitation components in promoting lifestyle improvements among cardiac patients. The cardiac patient group

primarily consists of individuals who have experienced a Percutaneous Coronary Intervention (PCI), Coronary Artery Bypass Grafting (CABG), heart valve surgery or another cardiac abnormality such as conservatively treated ACS and arrhythmia. In addition to the ordinary CR elements FIT and PEP, as part of the BENEFIT eHealth intervention patients also received individual 'lifestyle coaching'. Lifestyle coaching should help patients to achieve and maintain behavioral changes in their lifestyle. It involves behavioral guidance, setting goals, and enhancing motivation. The lifestyle improvements aimed at in the BENEFIT study are physical activity, smoking cessation, alcohol consumption, diet, stress management, and quality of sleep. Engaging in healthy lifestyle behaviors is necessary to decrease the risk on and the burden of CVD. Therefore, the effects of the CR program on lifestyle changes are important to identify to prevent subsequent cardiac trauma (Kaminsky et al., 2021). The importance of each lifestyle domain varies between patients as their current lifestyles differ. For example, non-smokers will not focus on smoking cessation during their CR program.

The positive effects of FIT and PEP on lifestyle improvements have already been shown in several studies. A meta-analysis of Meiring et al. (2020), for example, found that people who followed an exercise-based CR program increased- and sustained their increased physical activity in the long term. A study about PEP found that information and psychoeducation within the CR program improved the lifestyle element 'diet' through an enhanced eating pattern (Brügemann et al., 2006). In addition, Strid et al. (2012) have found that the CR program is most effective on lifestyle improvements when the duration and intensity of the intervention are high and when information, knowledge, practical training, self-activity, and behavioral change are included. Lifestyle coaching is a relatively new component within CR programs. However, some studies have indicated a positive effect of lifestyle coaching on lifestyle improvements. Powley et al. (2022) for example found that people who followed digital health coaching to enhance their self-efficacy and lifestyle showed lifestyle improvement on exercise, nutrition, and sleep. However, it remains unclear to what extent lifestyle coaching provides an additional effect beyond the impact of FIT and PEP on lifestyle improvements.

Research objectives

The aim of this study is to examine whether the CR component lifestyle coaching has a beneficial effect in addition to the effects of FIT and PEP on lifestyle

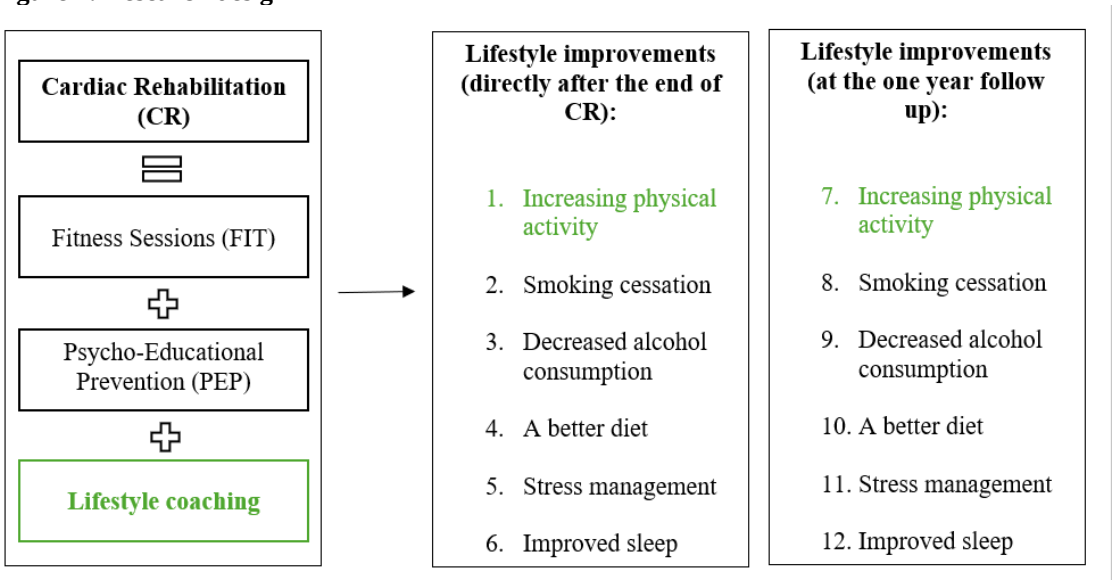
improvements, especially with regard to improving physical activity in both the short and long term. Research has shown that physical activity reduces the risk of CVD incidences, even moderate physical activity appears to have beneficial effects compared to inactivity among adults. Therefore, improving physical activity is of high importance to reduce the risk of a sequent cardiac event (Tambalis et al., 2016). Although participants in the CR program may have personal lifestyle goals, the standard CR program emphasizes physical activity for all participants through the FIT component. Hence, it is anticipated that this lifestyle factor will show greater improvement than the other seven lifestyle domains when adding lifestyle coaching to the program (De Nederlandse Hartstichting, n.d.). Currently, research has mainly focused on the overall impact of cardiac rehabilitation. However, this study will focus on the differentiated effects of the CR elements on lifestyle changes, in order to explore potential areas for improvement within CR.

The first research question of this thesis is: 'Does the CR element lifestyle coaching have a significant effect on improving the eight lifestyle domains, on top of the effects of FIT and PEP?' The CR program aims at several lifestyle domains which patients can improve to prevent a subsequent heart event, but it is important to know how to target them. This study examines the distinct effects of lifestyle coaching in addition to the effects of FIT and PEP, to identify where lifestyle coaching may add value to the regular CR program, in order to optimize CR and reduce the risk of subsequent cardiac events. The second research question is: 'Does lifestyle coaching have a more positive effect on physical activity compared to the other seven lifestyle domains?' This thesis specifically aims to investigate the additional effect of lifestyle coaching to the regular CR program on improving physical activity, given its beneficial effect on CVD. Moreover, this lifestyle factor has primarily been addressed in the CR program through its FIT sessions and is therefore relevant to all patients (Breeman et al., 2024). Since all patients in the regular CR program already focus on physical activity, the addition of lifestyle coaching may enhance this domain more than the other seven lifestyle factors. The final research question is: 'Does the effect of lifestyle coaching on physical activity persist after the CR program ends?' The final aim of this study is to examine if the lifestyle changes provided by the addition of lifestyle coaching will also remain one year after the CR program started.

The first hypothesis for this thesis is: 'The CR element lifestyle coaching has a positive effect on lifestyle improvements among CR participants, on top of the effects

of FIT and PEP'. This hypothesis is supported by a study of a brief self-regulation lifestyle intervention with sessions from a health psychologist. The program in the study helped patients to start and maintain healthy lifestyle modifications and reduced CVD risk factors (Janssen et al., 2012). The second assumption is: 'Lifestyle coaching will have a larger effect on increasing physical activity among CR participants than on the other seven lifestyle elements.' This hypothesis is based on the primary focus of the CR program on improving physical activity, rather than the other lifestyle domains, due to its historical emphasis (Breeman et al., 2024). The third expectation is: 'The effects of lifestyle coaching on improving physical activity will remain at the one-year follow-up'. The short-term effects of the CR program on lifestyle improvements are promising, yet less studies are done about the long-term effects. A study by Janssen et al. (2013), however, found that a self-regulation lifestyle intervention during the CR program provided significant changes in physical activity that remained at two follow-up measurements.

Figure 1: Research design



Methods

Design

This study was part of the larger research project: the BENEFIT study. The BENEFIT study aims to empower patients who have experienced one or more cardiovascular events to adhere to healthy lifestyle improvements learned during the CR program (Breeman et al., 2024). The research design was longitudinal, involving three measurements over time with the same participants. The first measurement took place before starting the CR program, the second immediately after completing the CR program and the final one year after the start of the CR program. The participants had to fill in the same questionnaire at these three moments. The longitudinal research design has been selected to assess the short- and long-term effectiveness of the different cardiac rehabilitation components on lifestyle improvements by comparing participants' lifestyle before and after the CR program. Participants were cardiac patients referred to rehabilitation centers in the Netherlands.

Participants and procedure

Before the start of the BENEFIT study, cardiac patients were referred by doctors to one of the seven participating rehabilitation centers throughout the Netherlands. The inclusion criteria to participate in the study were (1) that the patients had sufficient knowledge of the Dutch language and (2) that they had sufficient technological knowledge, since the CR platform was online. When patients did not give informed consent to use their data, this data was excluded from the study (Breeman et al., 2024). The intervention group, which consisted of 587 participants, received FIT, PEP, and lifestyle coaching. All the participants completed the CR program, however, not everyone completed the two follow-up questionnaires. Immediately after the CR program ended, 338 participants responded to the second questionnaire. Only 224 patients provided additional data about lifestyle outcomes one year after the start of the program. Of the participants, one-third were female and two-thirds were male, with a mean age of approximately 62 years. This distribution closely resembles the demographic profile of the Dutch CR population, indicating that the sample was representative (De Vries et al., 2017). The participants came from both urban and rural areas throughout the Netherlands.

Before the referred participants had their intake for the CR program, they had to fill in an online questionnaire module with several questions about their demographics,

mental health disorders (Patient Health Questionnaire (PHQ)), anxiety (GAD-7), quality of life (RAND SF20), lifestyle (physical activity, smoking, alcohol use, diet, stress and sleep), cholesterol, blood pressure, motivation, goals, and social support. The patients were able to answer the questions at their own pace using online modules on several topics. Their consent had been requested in advance. Subsequently the intake took place, after which they could start the CR program. During the CR program, the patients followed FIT, PEP, and lifestyle coaching. In general, patients attended a similar number of CR sessions, however, the exact number varied depending on individual needs, with some patients receiving fewer or more sessions. During the intervention period, participants were able to monitor their individual progress via a personalized online dashboard. Once they completed the CR program, mostly after ten to twelve FIT sessions and one to three PEP sessions, participants had to fill in the same online questionnaire for a second time (T2). Questions about their process and their satisfaction about their process were added. Finally, one year after the start of the CR program they filled in this questionnaire one last time (T3). The BENEFIT study, of which this research is part of, has been approved by the Psychology Research Ethics Committee (registration number 2020-04-14-A.W.M.Evers-V2-2271) and the BMS Ethics Committee (registration number BCE18142).

Measures

The independent variables of this study were the three CR elements FIT, PEP, and lifestyle coaching. FIT was aimed at increasing patients' physical activity. The goal of the PEP group sessions was to educate patients about their unhealthy lifestyle behaviors and improve healthy lifestyle changes. Lifestyle coaching was incorporated into the regular CR program to support and guide patients in achieving their individual goals. The overarching goal of the CR program was to reduce patients' risk of a subsequent cardiac event. The three CR elements were measured based on agenda setting, so how many times patients participated in FIT, PEP, or lifestyle coaching sessions. The dependent variables were the eight lifestyle domains: exercising, smoking, alcohol consumption, diet (fruit & vegetables), stress management (home & work), and sleep quality. These were measured based on a self-report questionnaire. The self-report questionnaire used in this study is the 'Personal Health Check' developed by &NIPED, a Dutch institute of prevention and E-health development. It is a widely used scale in the Netherlands (Breeman et al., 2024). Lifestyle aspects, as

much as possible, were defined based on (inter)national lifestyle recommendations from, among others, the Dutch government. Questions about lifestyle behavior in the Personal Health Check varied by domain and included both open- and closed-ended questions, as well as raw and normalized scores (Breeman et al., 2024).

The first lifestyle element, physical activity, is measured with two open-ended questions: “How many days per week do you exercise moderately to vigorously?” (0 = Never, 0.5 = Less than one day, 1 = one day, 2 = two days, 3 = three days, 4 = four days, 5 = five days, 6 = six days and 7 = seven days) and “On days that you exercise moderately to vigorously, how many minutes do you exercise?” (maximum 5 hours per day, 7 days per week = 35 hours per week). Responses to these questions were combined to determine the total amount of physical activity in minutes per week, whereby a higher score is desirable. Smoking behavior was evaluated with the dichotomous question: “Do you ever smoke?” (yes = 0 and no =10). In addition, this domain was assessed with the open-ended questions: “On how many weekdays (Monday to Thursday) do you smoke on average?” (0 = Never on weekdays, 0.5 = Less than one weekday, 1 = one weekday, 2 = two weekdays, 3 = three weekdays, 4 = four weekdays), “How many cigarettes/roll-ups/cigars/pipes do you smoke on average on such a weekday?” (maximum 60 products), “On how many weekend days (Friday to Sunday) do you smoke on average?” (0 = Never on weekend days, 0.5 = Less than one weekend day, 1 = one weekend day, 2 = two weekend days, 3 = three weekend days) and “How many cigarettes/roll-ups/cigars/pipes do you smoke on average on such a weekend day?” (maximum 60 products). These questions were combined as well to come to the number of products per week, whereby a lower number is beneficial. For alcohol consumption the same procedure was utilized with the initial question: “Do you ever drink alcohol?” (yes = 0 and no = 10), followed by the questions; “On how many weekdays (Monday to Thursday) do you drink alcoholic beverages on average?” (0 = Never on weekdays, 0.5 = Less than one weekday, 1 = one weekday, 2 = two weekdays, 3 = three weekdays, 4 = four weekdays), “How many glasses do you drink on average on such a weekday?” (maximum 20 drinks), “On how many weekend days (Friday to Sunday) do you drink alcoholic beverages on average?” (0 = Never on weekend days, 0.5 = Less than one weekend day, 1 = one weekend day, 2 = two weekend days, 3 = three weekend days) and “How many glasses do you drink on average on such a weekend day?” (maximum 20 drinks), to measure the amount of drinks per week. A lower number of drinks per week is favorable. To measure participants’ diet, questions

were divided into two categories: vegetables and fruits. For each category, people were questioned on how many pieces of vegetables/fruit they consume; “How many days a week do you usually eat vegetables?” (0 = Never, 0.5 = Less than one product per day, 1 = one product per day, 2 = two products per day, 3 = three products per day, 4 = four products per day, 5 = five products per day, 6 = six products per products per day and 7 = seven products per day), “On the days you eat vegetables, how many serving spoons do you usually eat?” (maximum 15 spoons), “How many days a week do you usually eat fruit?” (0 = Never, 0.5 = Less than one product per day, 1 = one product per day, 2 = two products per day, 3 = three products per day, 4 = four products per day, 5 = five products per day, 6 = six products per products per day and 7 = seven products per day) and “On the days you eat fruit, how many pieces do you usually eat?” (maximum 15 spoons). Higher scores indicated more favorable outcomes. The measurement of the lifestyle element stress is divided in two categories as well, stress at home and stress at work. The questions were: “Do you ever suffer from stress at home? If so, how often over the past year?” (1 = Never, 2 = Once in a while, 3 = Several times, 4 = Always) and “Do you ever suffer from stress at work? If so, how often over the past year?” (1 = Never, 2 = Once in a while, 3 = Several times, 4 = Always). Hereby, a lower score is advantageous. Finally, sleep quality is measured with the open-ended question: “How many hours do you sleep per day (on average)?” (minimum = 4 hours; maximum 15 hours). The lifestyle elements were measured by number of minutes per week (physical activity), number of products per week (smoking, alcohol consumption), number of products per day (vegetables and fruit), expanse per year (stress management), and hours per night (sleep).

Statistical Analyses

In this thesis, questionnaire data was processed using IBM SPSS Statistics version 27. For all the hypotheses, hierarchical multiple regression analyses were used as statistical tests. The assumptions for conducting this statistical test were: (1) measurement level of interval or ratio, (2) linearity among the predictor variables (3) independence of residuals, (4) normality of residuals, (5) homoscedasticity of residuals, (6) no multicollinearity (Vakgroep Theorie Methode en Statistiek, Faculteit Psychologie, Open Universiteit, 2024), and (7) no outliers (Parke C., 2013). The first assumption will be met if the variables are categories with a ranking and with equal intervals. In case of a ratio level, the variables require a meaning zero point as well. All

the variables in this study met these criteria. Linearity is tested by a scatterplot of the standardized residuals (Y) and standardized predictors (X). The points in the scatterplot should form an approximately linear pattern to satisfy the assumption of linearity. All the sixteen tests met this criterion. The third assumption, independence of residuals, will be met if there is the belief that the responses of one participant does not influence the responses of another participant. This assumption was met since participants filled in the questionnaire independent of each other. The assumption of normality was tested by making a histogram and a P-P plot of the residuals. If the histogram is distributed normally, and the line in the P-P plot matches the linear line in the figure, the assumption will be met. For all the sixteen statistical tests the figures were approximately normally distributed. Homoscedasticity was measured using the same scatterplot (of the standardized residuals (Y) and standardized predictors (X)) as for the assumption of linearity. This assumption will be met if the dots in the scatterplot will be evenly distributed around zero. The dots in the scatterplot were approximately normally distributed and did not have a funnel shape in all the sixteen tests, so this assumption was met as well. Multicollinearity was checked by requesting tolerance values and variance inflation factors (VIF) in SPSS for all predictors. If the tolerance values were zero point one or less, or if the VIF's were greater than ten, this indicates multicollinearity. The tolerance for all the tests were above zero point one and the VIF's were below ten so there was no multicollinearity. Finally, outliers were checked by making a 'casewise diagnostic' table in SPSS which displayed all the extreme cases (>3SD). In total of the sixteen tests, there were 41 outliers, based on the standard deviation of three. All of them were real scores, for example physical activity of 720 minutes per week (higher bound) or sleeping four hours per night (lower bound) (Parke C., 2013) (Field, 2009).

The design was factorial as it measured the effects of different independent variables; the three different CR elements, on various dependent variables; the eight lifestyle factors. To test the hypothesis, sixteen statistical tests were needed: the added effect of lifestyle coaching on the eight lifestyle factors separately at two different measurements. Since the amount of the statistical tests, the chance for findings to be significant was increased. Therefore, a multiple testing correction could be performed. The most commonly used correction is the Bonferroni correction (Armstrong, 2014). When applying the Bonferroni correction, a new significant p-value will be determined by the corrected p-value = α / T; where α is the determined significant p-value and T

the number of statistical tests. In case of this thesis, the new significance would be 0.05/16 = 0.003 (Field, 2009). However, this practice would be too strict, so the correction for multiple testing was not applied in this thesis.

The p-value considered as statistically significant in this study was $p \leq 0.05$. The used effect size was the standardized Beta coefficient, interpreted based on the rule of thumb of the Cohen's guidelines; small (β = 0.10–0.29), medium (β = 0.30–0.49), and large ($\beta \geq 0.50$) (Nieminen, 2022).

Missing data and outliers

In research, particularly studies involving human participants, it is rare to collect a complete dataset. Given the three measurement moments in this study, chances were that participants did not complete all questionnaires. Therefore, it was essential to identify and assess the missing data to determine whether this was random or systematic, allowing an appropriate approach to deal with it. Several methods are available for handling missing data. In this thesis, the 'pairwise deletion' method was utilized, as this approach was compatible with the use of IBM SPSS in the current study. This approach excludes cases from analyses in which they lack information, but maintains them for analyses where they provide sufficient data (Pallant, 2020).

In addition, as in nearly all research, this study encounters some outliers. One approach of dealing with outliers is removing them, arguing that extreme scores do not fit within the dataset. An alternative approach to cope with outliers is to modify their values, which reduces their impact on the dataset while still retaining them (Leary, 2014). In this thesis, it was beneficial to include all the data and examine outliers individually, as a respondent may genuinely exhibit atypical scores, for instance, exercising much more or sleeping substantially less hours per night than average. Such data should not be removed without careful consideration. Therefore, after evaluating them individually, all 41 outliers in this study were retained in the dataset. Previous outliers were determined in the overall BENEFIT study before and removed in advance. (Breeman et al., 2024).

Results

Participant- and CR characteristics

The dataset included 885 participants. Of them, 298 participants were part of the control group and 587 participants were the intervention group. Only data from the intervention group is used for the statistical analyses in this thesis. In the intervention group, two-thirds of the participants were male. The majority of the group were over the age of 50 and lived with a partner. Further demographic descriptives are displayed in **Table 1**. Before the start of the CR program, the majority of the participants did not smoke, one quarter exercised less than just thirty minutes per week, and almost one-third of them experienced stress at home all the time. Additional information about participants' lifestyle behaviours before the CR program started is presented in **Table 2**. During the CR program more than three-quarters of the participants followed ten or more FIT sessions, roughly 60% followed PEP sessions, and the majority of participants attended between zero and five lifestyle coaching sessions **(Table 3)**.

Table 1: Participant characteristics

Variables	N	%
Gender		
Male	414	70.5
Female	173	29.5
Age		
<50 years old	75	12.8
50-60 years old	147	25.0
60-70 years old	184	31.4
70+ years old	181	30.8
CR location		
Radboud	267	45.5
Polyfysiek	163	27.8
Dokkum	59	10.0
Oud- Beijerland	26	4.4

Ijmuiden	21	3.6
Almere	9	1.5
Amsterdam CB	42	7.2
Education level		
Low	117	26.1
Middle	121	26.9
High	211	47.0
Work		
Employed	305	52.0
Unemployed	282	48.0
Income (€)		
0-1500	79	17.6
1501-2000	59	13.1
2001-2500	66	14.7
2501-3000	84	18.7
3001-3500	35	7.8
>3500	67	14.9
Rather not say	59	13.1
Partner		
No partner	118	20.1
Partner but living apart	33	5.6
Partner and living together	436	74.3
Heart event		
Heart transplantation	1	0.2
Coronary Artery Bypass Grafting (CABG)	82	14.1
Heart valve surgery	59	10.2

Percutaneous Coronary Intervention (PCI)	264	45.4
ICD/Pacemaker implantation	29	5.0
Ablation procedure	19	3.3
TAVI	5	0.9
Thoracic aortic surgery	9	1.5
MAZE procedure	4	0.7
Stable angina pectoris (conservative treatment)	10	1.7
Other (o.a. conservative treated ACS and arrhythmia)	88	15.1
Heart failure (without other indication)	11	1.9
Heart failure		
No heart failure	530	90.3
Heart failure	57	9.7

Table 2:Lifestyle behavior before the start of the CR program

Variables	N	%
Minutes of physical activity per week		
Less than 29.59 minutes	181	32.2
30 until 59.59 minutes	26	4.6
60 until 119.59 minutes	59	10.5
120 until 179.59 minutes	59	10.5
180 until 239.59 minutes	62	11.0
240 until 299.59 minutes	35	6.2
300 until 359.59 minutes	29	5.2
360 until 419.59 minutes	18	3.2
420 minutes or more	93	16.5
Smoking		
No	531	90.5
Yes	56	9.5
Smoking products per week		
Less than one smoking product	16	2.9
1 until 4.99 smoking products	11	2.0
5 until 9.99 smoking products	11	2.0
10 until 14.99 smoking products	6	1.1
15 or more smoking products	12	2.1
Non smoking	531	90.3
Alcoholic drinks per week		
Less than 1 glass	252	43.0
1 until 4.99 glasses	131	22.4
5 until 9.99 glasses	107	18.4
10 until 14.99 glasses	58	10.0

15 until 19.99 glasses	13	2.3
20 until 23.99 glasses	15	2.6
24 glasses or more	11	2.0
Vegetables per day		
Less than less one piece of vegetables	31	5.3
1 until 1.99 pieces of vegetables	109	18.7
2 until 2.99 pieces of vegetables	184	31.6
3 until 3.99 pieces of vegetables	117	20.1
4 until 4.99 pieces of vegetables	85	14.6
5 until 5.99 pieces of vegetables	30	5.2
6 until 6.99 pieces of vegetables	15	2.6
7 or more pieces of vegetables	11	1.9
Fruits per day		
Less than one piece of fruit	229	39.2
1 until 1.99 pieces of fruit	139	23.8
2 until 2.99 pieces of fruit	146	25.0
3 until 3.99 pieces of fruit	56	9.6
4 until 4.99 pieces of fruit	7	1.2
5 until 5.99 pieces of fruit	5	0.9
6 until 6.99 pieces of fruit	2	0.3
7 or more pieces of fruit	0	0
Stress at home		
Never	134	22.8
Once in a while	261	44.5
Several times	171	29.1
Always	21	23.6

Stress at work		
Never	317	54.0
Once in a while	126	21.5
Several times	128	21.8
Always	16	2.7
Average hours of sleep per night		
Less than 5 hours	7	1.2
5 until 5.59 hours	43	7.4
6 until 6.59 hours	104	17.9
7 until 7.59 hours	152	26.2
8 until 8.59 hours	192	33.1
9 until 9.59 hours	46	8.4
10 or more hours	36	6.2

Table 3:CR sessions followed by participants

Variables	N	%
Number of FIT sessions followed		
0	4	0.7
1	3	0.5
2	2	0.3
3	3	0.5
4	4	0.7
5	15	2.6
6	18	3.1
7	25	4.3
8	30	5.1
9	36	6.1
10 or more	447	76.1
Number of PEP sessions followed		
0	246	41.9
1	130	22.1
2	211	35.9
Number of lifestyle coaching sessions followed		
0	78	13.3
1	141	24.0
2	111	18.9
3	74	12.6
4	47	8.0
5	33	5.6
6	42	7.2
7	42	7.2

8	14	2.4
9	3	0.5
10	2	0.3

The additional effect of lifestyle coaching to the regular CR program on improving lifestyle factors

To investigate whether lifestyle coaching had an additional effect beyond FIT and PEP on the lifestyle elements, first regression analyses were conducted of the combined effect of FIT and PEP alone. Subsequently, the study examined whether lifestyle coaching explained significant additional variance to the models. The multiple regression analyses showed that the added value of lifestyle coaching to FIT and PEP, immediately after completion of the CR program, did not have a significant influence on the improvements of the lifestyle elements physical activity (F change = 2.239, (1, 304), p = .136), smoking (F change = 0.128, (1,28), p = .723), eating vegetables (F change = 0.007, (1,326), p = .935), eating fruits (F change = 0.003, (1,328), p = .956), stress at home (F change = 1.874, (1,333), p = .172), stress at work (F change = 0.342, (1,333), p = .559), and hours sleep per night (F change = 0.524, (1,327), p = .470). At the one-year follow-up, these results remained non-significant. However, lifestyle coaching did have a significant additional influence on consuming alcohol, explaining an additional 0.5% of the variance directly after the CR program ended (F change = 3.879, (1, 333), β = -.070, p = .049). At the third measurement, one year after the start of the CR program, the test showed a small significant additional effect of lifestyle coaching on consuming alcohol. The extra explained variance at this point was 1.8% (F change = 10.050, (1,219), β = -.136, p = .002). Each additional lifestyle coaching session was associated with a decrease of 0.196 alcoholic drinks per week directly after the CR program ended (b = -0.196, p = .049) and a decreased alcohol consumption of 0.320 alcoholic drinks per week one year after the start of the CR program (b = -0.320, p = .002) **(Table 4)**.

The additional effect of lifestyle coaching on physical activity compared to the other lifestyle factors in the short and long term

The second assumption stated that lifestyle coaching will have more effect on physical activity than on the other seven lifestyle factors. Though, results showed no significant additional effect of lifestyle coaching on physical activity (β = -.084, p = .136). At the one year follow up no significant effect of lifestyle coaching on physical activity was found either (β = .001, p = .985) **(Table 4)**.

Additional effects of FIT and PEP on the lifestyle factors

Nonetheless, significant effects of the other CR elements on the lifestyle factors were found. Directly after the end of the CR program significant effects were found of PEP on stress at work (β = .102, p = .009) and FIT on hours of sleep (β = .107, p =.012). At the one-year follow-up, there were significant effects of FIT on consuming alcohol (β = 0.103, p = .017) and FIT on stress at work (β = .120, p = .022) **(Table 4)**. All the aforementioned effects were small.

Table 4: Values are *b* = unstandardized regression coefficients and *β* = standardized regression coefficient, T2 = directly after the end of the CR program, T3 = one year after the start of the CR program. *=$p \leq .05$.

	Physical activity	Smoking	Consuming alcohol	Eating vegetables	Eating fruits	Stress at home	Stress at work	Hours of sleep
	b, (β)	***b, (β)***	***b, (β)***	***b, (β)***	***b, (β)***	***b, (β)***	***b, (β)***	***b, (β)***
T2								
FIT	-3.773, (-.039)	-0.326, (-.098)	0.368, (.099)*	0.024, (.026)	-0.050, (-.086)*	0.005, (.012)	0.043, (.087)*	0.083, (.107)*
PEP	8.183, (.043)	-0.087, (-.013)	-0.484, (-.066)	-0.066, (-.036)	0.046, (.041)	0.035, (.040)	0.099, (.102)*	-0.027, (-.018)
Lifestyle coaching	-6.076, (-.084)	-0.157, (-.063)	-0.196, (-.070)*	0.003, (.004)	-0.001, (-.002)	-0.021, (-.064)	-0.008, (-.022)	-0.018, (-.031)
T3								
FIT	-2.820, (-.023)	-0.596, (-.138)	0.324, (.103*)	0.003, (.003)	-0.009, (-.018)	0.005, (.012)	0.053, (.120)*	0.016, (.022)
PEP	-23.560,(-.096)	-0.765, (-.091)	-0.093, (-.015)	0.028, (.017)	-0.54, (-.056)	0.026, (.031)	0.024, (.027)	0.000, (.000)
Lifestyle coaching	0.112, (.001)	-0.464, (-.145)	-0.320, (-.136*)	-0.026, (-.043)	0.015, (.042)	-0.026, (-.080)	-0.032, (-.095)	-0.021, (-.039)

Discussion

Research and results

This study aimed at examining the working mechanism of cardiac rehabilitation separately, to investigate whether lifestyle coaching has an additional effect to the regular CR program on improving lifestyle factors, especially physical activity. Results showed that the addition of lifestyle coaching to the regular CR program, which initially aims at improving physical activity and providing mental support, did not lead to meaningful additional effects on the lifestyle improvements. Only a small decrease in alcohol consumption was found. In addition, the effect of lifestyle coaching on physical activity was not more remarkable than for the other seven lifestyle domains. Both directly after the program and at the one-year follow-up.

The results that the addition of lifestyle coaching to the regular CR program did not have a greater effect on improving physical activity compared to the other seven lifestyle factors, in the short and long term, are in contrast with the expectation. Instead of a positive effect, the results even displayed a negative association; the more lifestyle coaching patients received, the less patients exercised. Since the statistical analyses measured an additional effect, a possible explanation for the contrasting results could be the correction for FIT and PEP. However, when measuring the effect of lifestyle coaching on physical activity right after the program and one year later alone, a higher number of lifestyle coaching sessions still did not lead to an increase in physical activity. Another possible explanation for these findings may lie in the pre-existing effectiveness of the regular CR program in increasing physical activity, due to the emphasis on exercising through the FIT sessions. Breeman et al. (2025) found that cardiac patients participating in the standard CR program already showed improvements in physical activity levels. This may suggest that the addition of lifestyle coaching does not provide substantial additional benefits, possibly because the standard CR program already is sufficiently effective in increasing physical activity among CR participants.

Moreover, lifestyle coaching did not have a considerable effect on reducing smoking, eating vegetables and fruits, having stress at home and at work, and hours of sleep in both the short and long term either. The addition of lifestyle coaching, nevertheless, had a small impact on decreasing alcohol consumption. This finding is

consistent with the article of Smeenk et al. (2024). They found that people who used a lifestyle coaching application, substantially decreased their alcohol consumption within three months of using the app. However, contrary to our findings, the effect in the study of Smeenk et al. (2024) was no longer statistically prominent at the six-month follow-up, although alcohol consumption had decreased compared to baseline levels. This difference might be explained by the absence of actual, personal contact when using an app alone compared to having both an online platform and personal lifestyle coaching as in the CR program of the BENEFIT study. A meta-analytic review found that, overall, face-to-face interventions were more effective and persistent for decreasing alcohol consumption compared to computer-delivered interventions like digital apps in the study of Smeenk and colleagues (Carey et al., 2012). In the study of Hurkmans et al. (2018), aimed at losing weight, participants either received an online app or both an online app and personal counselling. From the group who received both interventions, more participants lost 5% or more bodyweight compared to the app only group. Indicating that the combination of both interventions, as in the BENEFIT study, could be the reason for the long-term positive results in this research. However, this study did not find an effect on dietary improvements when adding lifestyle coaching to the regular CR program. Consequently, the observed additional effect of lifestyle coaching on alcohol consumption may be attributable to chance, as no correction for multiple testing was applied.

Strengths and limitations

As with any research, this research methodology had its strengths and limitations. A strong point of this study was the sample size. The large number of participants makes the results more trustworthy. Furthermore, the sample in this study was highly representative of the broader cardiac rehabilitation population in the Netherlands in terms of age, gender, and socioeconomic status (De Vries et al., 2017). Another strength of this thesis is the longitudinal research design. The different measurement moments made it possible to observe changes in effects over time, hence extending the value of the findings (White & Arzi, 2005). One of the limitations of this study is the absence of correction for multiple testing. Since the Bonferroni correction was too strict, no correction was applied. However, this could lead to false-positive results, an incorrect finding of a significant result. Therefore, the interpretation of the meaningful data, the effect of lifestyle coaching on alcohol consumption, must be carried out carefully.

When replicating the study, it may be worth considering alternative methods to manage multiple testing, for example, applying a False Discovery Rate (FDR) correction, such as the Benjamini–Hochberg method, so statistical power will increase and interpretation of the data will be more accurate (Benjamini & Hochberg, 1995). Moreover, the use of self-report measures can lead to socially desirable responses, reference- and subjective bias, reducing the reliability and validity of the lifestyle data (Kreitchmann et al., 2019). Using other measurement methods in addition to self-reports could enhance the reliability and validity of the data. For example, tracking participants' physical activity using wearable devices such as a smartwatch or giving patients a device that measures their hours of sleep more accurately than their own estimate. Additionally, a further limitation in this study is the use of the Personal Health Check. Although this scale is widely used in the Netherlands, it has not been formally validated, which may consequently affect the validity of the self-reported data. A final limitation of this study is the use of the pairwise deletion method to handle missing data. This approach was utilized since the statistical analyses were conducted in SPSS. However, pairwise deletion is generally considered suboptimal, as it may lead to biased results. When using more advanced statistical software, such as R, Stata, or SAS, more robust methods such as maximum likelihood or multiple imputation are recommended, as they yield less biased results and preserve statistical power (Allison, 2002).

Conclusion

In conclusion, this study found that adding lifestyle coaching to the standard cardiac rehabilitation (CR) program will not further improve participants' developments on the overall lifestyle factors. Only a small effect was observed for reducing alcohol consumption in patients with cardiovascular disease (CVD), however this effect may be attributable to chance since no correction for multiple testing was applied. Contrary to the expectation, adding lifestyle coaching did not lead to a substantial increase in patients' physical activity compared to the other lifestyle factors, neither in the short nor the long term. This may be explained by the pre-existing effectiveness of the standard CR program in promoting physical activity through its fitness sessions, suggesting that adding lifestyle coaching may not be required to achieve optimal improvements in physical activity. Practical implications that follow from these results are that for patients who want to improve their physical activity, smoking, diet, stress, or sleep; following lifestyle coaching in addition to the regular

CR program will not ensure better outcomes. Specifically, CR participants who received more lifestyle coaching sessions, will not necessarily persist in more minutes of physical activity per week. This study contributes to the existing literature by providing further insights on the individual effects of the distinct CR elements on several lifestyle factors, in addition to the more often studied overall impact of the regular CR program. Further research could identify and examine alternative approaches that can help to enhance healthy lifestyle behaviors more effectively among CVD patients participating in CR.

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