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Modifiable risk factors and motivation for lifestyle change of CVD patients starting cardiac rehabilitation: The BENEFIT study

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ABSTRACT

Background: To improve lifestyle guidance within cardiac rehabilitation (CR), a comprehensive understanding of the motivation and lifestyle-supporting needs of patients with cardiovascular disease (CVD) is required.
Objectives: This study's purpose is to evaluate patients' lifestyle and their motivation, self-efficacy and social support for change when starting CR.
Methods: 1782 CVD patients (69 % male, mean age 62 years) from 7 Dutch outpatient CR centers participated between 2020 and 2022. Modifiable risk factors were assessed with a survey and interviews by healthcare professionals during CR intake.
Results: Most patients exhibited an elevated risk in 3–4 domains. Elevated risks were most prominent in domains of (1) waist circumference and BMI (2) physical exercise (3) healthy foods intake and (4) sleep duration. Most patients chose to focus on increasing physical exercise, but about 20 % also wanted to focus on a healthy diet and/or decrease stress levels. Generally, motivation, self-efficacy and social support to reach new lifestyle goals were high. However, patients with an unfavorable risk profile had lower motivation and self-efficacy to work on lifestyle changes, while patients with lower social support had a higher chance to quit the program prematurely.
Conclusions: Our results underscore the need to begin CR with a comprehensive lifestyle assessment and highlight the importance of offering lifestyle interventions tailored to patients' specific modifiable risk factors and lifestyle-supporting needs, targeting multiple lifestyle domains. Expanding the current scope of CR programs to address diverse patient needs and strengthening support may enhance motivation and adherence and lead to significant long-term benefits for cardiovascular health.
Clinical trial registration number: Netherlands Trial Register; registration number NL8443

Abbreviations: CR, cardiac rehabilitation; CVD, cardiovascular disease; PHA, personal health application; BMI, body mass index; PCI, percutaneous coronary intervention.

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Introduction

When a patient is diagnosed with cardiovascular disease (CVD), cardiologists usually encourage lifestyle improvements, and when suitable, advise them to follow a cardiac rehabilitation (CR) program. The CR program is a multidisciplinary, outpatient program which aims to promote physical, psycho-social, and work-related recovery in CVD patients and reduce future cardiovascular risk.[1-3] CR programs internationally consist of several core components (e.g., education on risk factors, exercise program, focus on improving lifestyle) to achieve these different treatment goals.[1,2]

Benefits of CR are widely recognized,[4,5] and many studies show that changing modifiable risk factors such as physical inactivity, smoking, alcohol use, unhealthy diet, stress and lack of sleep strongly improves prognosis of CVD.[3,6] For example, patients who experienced an acute cardiovascular event and adhered to three healthy lifestyle behaviors (i.e., not smoking, engaging in regular exercise, and adopting a healthy diet) for 30 days after hospital discharge, showed a 3.8-fold reduction in the risk of re-infarction, stroke and death six months later compared to those who did not follow any of these behavior recommendations.[7]

Although health behavior change and lifestyle risk factor management are core components of CR programs worldwide,[2,3] the primary focus of CR programs is on increasing physical activity through exercise training, as this was historically the first objective of CR.[5] Therefore, CR programs are sometimes referred to as exercise-based CR.[8,9] Other essential health behaviors, such as maintaining a healthy diet, improving sleep quality, and addressing smoking[10] receive less attention in comparison.[1] Incorporating a broader range of lifestyle behavior interventions within CR programs may be essential for improving and maintaining cardiovascular health[10] and also cater to participants' diverse needs and preferences.[11]

The goal of the BENEFIT project is to empower patients with CVD to adhere to guidelines for healthy living and improve lifestyle guidance within CR.[12] The purpose of the current study is to assess the motivation and specific lifestyle-supporting needs and preferences of patients. We addressed the following research questions: (1) Which modifiable risk factors do CVD patients possess before they enter CR?, (2) Which lifestyle domains do CVD patients choose to address to improve their behavior?, and (3) How motivated are CVD patients to change their lifestyle and what is their self-efficacy and social support?

Methods

Study design

This study employs a cross-sectional design, in which we conducted a comprehensive assessment of modifiable risk factors in patients beginning CR to evaluate patients' current lifestyle behaviors as well as their motivation, self-efficacy and social support for making crucial lifestyle changes.

Ethical considerations

This study was approved by the Psychology Research Ethics Committee (registration number 2020–04–14-A.W.M.Evers-V2–2271). In addition, this study was preregistered in the Netherlands Trial Register (NTR; registration number NL8443).

Setting and participants

We recruited patients in 7 Dutch outpatient CR centers of 'CardioVitaal' as part of the BENEFIT study between January 2020 and May 2022. The participating centers were in metropolitan, urban and rural areas across the Netherlands. According to Dutch guidelines,[13] CVD patients can be referred to CR after a (recent) cardiac event (e.g. myocardial infarction or resuscitation) and/or an intervention (e.g. percutaneous coronary intervention, coronary artery bypass grafting, heart valve- / aortic surgery, pacemaker-/ ICD implantation or cardiac ablation). Referral was also possible for CVD patients in a more chronic phase (e.g. chronic heart failure, stable angina or atrial fibrillation).

After referral, the administrative team contacted patients by phone to make appointments for the intake interview for the CR program. After an appointment was set, patients received an email with confirmation of the date and time of the appointment, together with a link to the online CR platform with Personal Health Application (PHA). A digital coach guided patients through their PHA and directed them to the survey, which required completion prior to the intake interview. All patients were requested to fill out this survey by themselves at home, as it was part of their standard CR care. A few days in advance of the intake interview, patients were proactively contacted by phone to offer technical support (e.g., help to register on the platform, finding the survey) and/or motivating patients to fill in the survey.

Patients were eligible to participate in the study when (1) they had a basic understanding of the Dutch language as the language of both the PHA and survey was in Dutch, and (2) they were technologically literate in a sense that they possessed (and were able to use) an email address to which invitations were sent to register for the PHA. In total, 2066 patients who enrolled in CR, regardless of referral indication, were eligible for inclusion (see flowchart Fig. 1). When entering the PHA, participants provided informed consent to share their data for research purposes. Of the 2066 enrolled patients, 1782 (86 %) registered themselves online, provided informed consent to participate in the study and filled in parts of the survey.

Measures

The current study utilizes data that were routinely assessed for all patients receiving CR, either by healthcare professionals or through the PHA. Survey data was collected just before or after the intake interview.

Treatment – diagnosis

Reasons for referral were taken from patients' medical files. Reasons for referral to CR were summarized into 12 main categories. When patients' files recorded more than one diagnosis and treatment(s), the most impactful treatment was counted as main reason for referral (see Table 1 for an overview of diagnoses and treatments).

Modifiable risk factors

CVD risk factors such as blood pressure, waist circumference and BMI were routinely assessed by a healthcare professional during the intake and taken from medical records. Blood pressure was measured thrice on the right upper arm in a sitting position using an automatic digital sphygmomanometers and the mean of the last two measures was used for all analyses and measured in millimeters of mercury (mmHg).[14,15] Waist circumference was measured in centimeters (cm) as an indicator of central obesity and was assessed by placing a tape horizontally at the midpoint along the mid-axillary line, situated between the lower edge of the rib cage and the tip of the hip bone, while the patient was in a standing position. Height and weight were measured wearing light clothes but no shoes, to calculate body mass index (BMI; kg m^{-12}).[16,17]

Based on the Personal Health Check developed by the Netherlands Institute for Prevention and E-health Development,[18,19] healthy lifestyle activities were assessed with an online self-report survey.[20] In the Netherlands, the Personal Health Check has been used by over 1250 organizations, municipalities, insurers, and occupational health services to assess modifiable risk factors and provide individuals with insight into their own health.[19] The rating scale for each item varied depending on the type of question (i.e., yes/no; Likert scale; number of days, etc.). Some questions were combined to create specific subscales (e.g. 'minutes of exercising' and 'days per week exercising' were combined to calculate minutes/week exercising). Please see Appendix 1 for the complete lifestyle survey.

The self-report survey assessed health behaviors in six domains: (1) Physical activity: assessed through self-reported minutes per week of moderate to intense exercise to quantify the amount of physical activity performed by participants. Additionally, the frequency of weekly muscle-strengthening activities was assessed. These questions were based on Dutch gold standards for physical activity.[21] (2) Smoking behaviors: assessed was whether the participant smoked, and if yes, the number of tobacco products consumed per day to classify risk groups.[22] (3) Alcohol use: included items based on the Five-Shot Questionnaire,[23] a validated questionnaire to detect drinking problems. (4) Diet: we assessed four different eating patterns. Vegetable intake was measured in spoons per day, with one spoon approximately equivalent to 50 gs. Fruit intake was measured in pieces per day, with one piece approximately equivalent to 100 gs. Sugary drinks and savory and sweet unhealthy snacks were all measured by the number of days per week they were consumed. These four dietary components were selected to represent a more comprehensive eating pattern and to be able to classify patients' diet in line with Dutch gold standards.[24] (5) Stress: items were derived from the Personal Health Check questionnaire,[18,19] which asked patients to distinguish between stress experienced at home and stress experienced at work, with both items rated from 1=never to 4=always. (6) Sleep: assessed was sleep duration measured in hours/night[25] and sleep quality rated on a 10 point scale ranging from 1=very bad to 10=very good.

We used existing gold standard cut-off scores for different modifiable risk factors to classify patients' health into low/moderate/high risk of adverse outcomes. Gold standards were based on national and international guidelines for a healthy population (please see Table 2 for these cut-off values). In addition, patients were asked to indicate which lifestyle domains they wanted to focus on. Possible response options were: 'I want to …. (1) exercise more (2) decrease or stop smoking (3) decrease or stop drinking alcohol (4) eat healthier (5) relax more (6) sleep better'.

Motivation for lifestyle change

Patients were asked to indicate whether they were motivated and able to change their lifestyle regarding one of the six lifestyle domains. If yes, they were asked to define a personal goal concerning this lifestyle domain, for example, the number of steps to take each day if they choose the domain 'exercise'. The motivation survey contained 3 items assessing (1) the patient's level of motivation (i.e. 'how motivated are you to reach this goal?'), (2) the patient's level of self-efficacy (i.e., 'how much confidence do you have that you can achieve this goal, if you try'?') and (3) the patient's level of social support to reach this goal (i.e., 'to what extent do you feel supported by people close to you to achieve this goal?') on a 11-point Likert scale.

Demographic characteristics

Age, gender, family composition (i.e., partner living together; partner not living together; no partner), work (i.e., number of hours/week), household income, and highest education level were assessed with the survey on the PHA. Patients were specifically asked whether they wanted to report on questions concerning education and income, resulting in more missing data on these items. Educational level was categorized into lower (i.e., no education, primary education, prevocational secondary education), medium (i.e., upper secondary education, vocational education), and higher education (bachelor and master programs at universities of applied sciences or research universities or doctoral programs at research universities) according to the Dutch

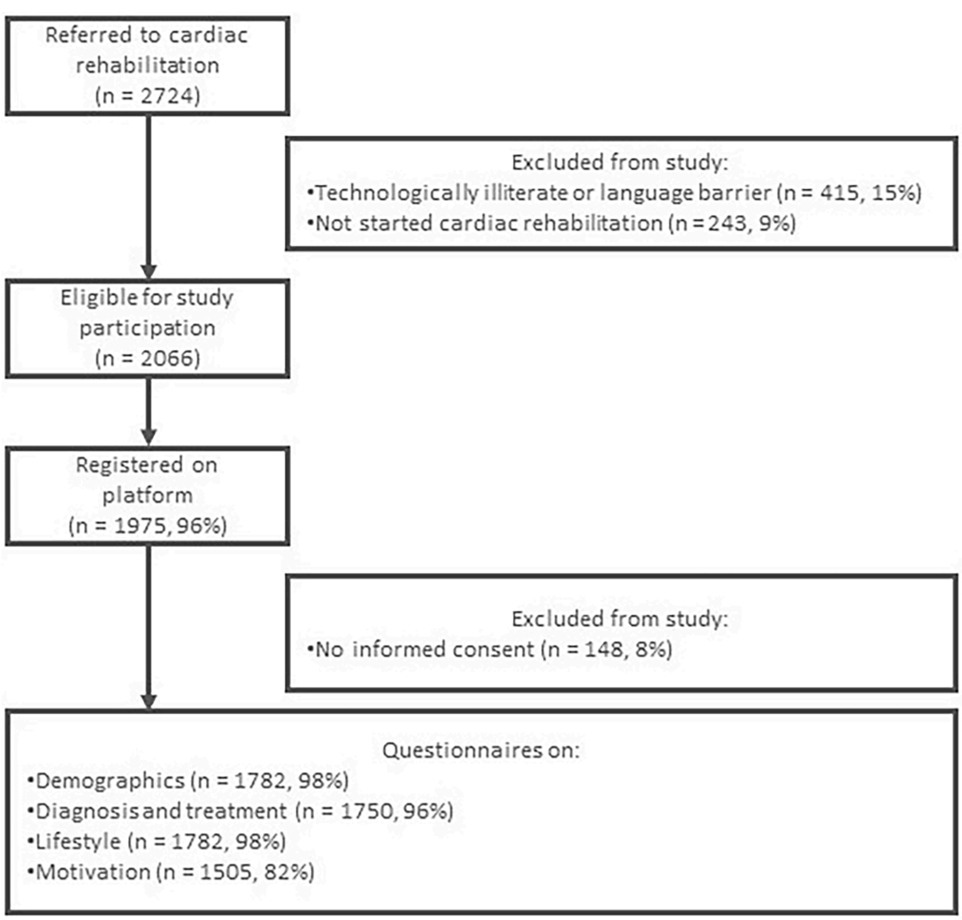

Fig. 1. Flowchart of particpants in the study.

Table 1
Clinical and demographic characteristics of CVD patients starting CR.

Variable	*N*	%
Treatment - diagnosis	**1750**	
Percutanous Coronary Intervention (PCI)	785	44.9
Other (i.e. conservative treated ACS and arrythmia)	295	16.9
Coronary Artery Bypass Grafting (CABG)	244	13.9
Heart valve surgery	161	9.2
ICD/Pacemaker implantation	73	4.2
Ablation procedure	53	3.0
Stable angina pectoris (conservative treatment)	54	3.1
Heart failure (without other indication)	33	1.9
Thoracic aortic surgery	21	1.2
TAVI	18	1.0
MAZE procedure	10	0.6
Heart transplantation	3	0.2
Age	**1782**	
Age <50	240	13.5
Age 50–59	444	24.9
Age 60–69	605	34.0
Age >70	493	27.7
Family status	**1773**	
partner – living together	1276	72.0
partner – not living together	116	6.5
No partner	381	21.5
Education	**1392**	
Low	391	28.1
Middle	422	30.3
High	579	41.6
Working	**1774**	
No	887	50.0
Yes, yet currently 0 h	110	6.2
Yes, currently 1–30 h	310	17.4
Yes, currently 31–40 h	322	18.2
Yes, currently >40 h	145	8.2
Income per month	**1331**	
0–1500 euro	293	22.0
1501–2000 euro	191	14.4
2001–2500 euro	210	15.8
2501–3000 euro	175	13.1
3001–3500 euro	98	7.4
>3500 euro	172	12.9
Rather not say	192	14.4

Table 2
Lifestyle risk classifications.

Variable		High risk	Moderate risk	Low risk
Health	BMI = kg/m^2[16,17]	≥35 6.3 %	≥25<35 59.1 %	<25 34.6 %
	Waist circumference (cm)[3]	*M* ≥ 102 / *F* ≥ 88 57.4 %	*M* ≥ 94<102 / *F* ≥ 80<88 24.5 %	*M* < 94 / *F* < 80 18.1 %
	Systolic blood pressure (mmHg)[3,15]	≥160 7.0 %	≥140<160 18.9 %	<140 74.1 %
	Diastolic blood pressure (mmHg)[3,15]	≥100 4.9 %	≥90<100 11.8 %	<90 83.3 %
Exercise	Moderate-intensity (minutes/ week)[3,20]	<150 53.7 %	n/a	≥150 46.3 %
	Muscle strengthening (times/week)[20]	<2 62.0 %	n/a	≥2 38.0 %
Smoking	Tobacco products (products / day)[21]	≥10 OR ≥1 < 10 & within 1 hour after waking 6.9 %	>0 < 10 & not within 1 hour after waking 4.4 %	0 88.8 %
Alcohol	Five-shot score (range 0–7)[22]	≥2.5 8.7 %	n/a	<2.5 91.3 %
Diet	Vegetables (spoons/day; 1 spoon ≈ 50 gram)[3,23]	<4 76.2 %	n/a	≥4 23.8 %
	Fruit (pieces/day; 1 piece ≈ 100 gram)[3,23]	<2 62.7 %	n/a	≥2 37.3 %
Stress	Stress at home	much 3.3 %	moderately 30.8 %	little 65.9 %
	Stress at work	much 2.7 %	moderately 20.1 %	little 77.2 %
Sleep	Sleep (hours/day) (hours/day)[24]	*A* < 7 or >9 OA <7 or>8 39.1 %	n/a	A 7–9 OA 7–8 60.9 %

Note. References refer to cut-off values based on according gold standards;. *M* = male, *F* = female, *H*=high, *L*=low; *A* = adults (<64 years), OA = older adults (≥65 years).

educational system.[26]

Analyses

Descriptive statistics

First, a general inspection of the data was carried out to explore and summarize the data using IBM SPSS Statistics version 26. We used cut-off values to categorize patients into high/moderate/low risk groups based on each modifiable risk factor (Table 2). In addition, descriptive statistics such as the mean, standard deviation and median were calculated for all measures for both the sample as a whole and for sub-groups based on important demographics and reported in Table 3.

Analyses

Correlations were calculated to examine the relationships between the modifiable risk factors together with motivation and demographics measures including heart failure. Pearson's correlation coefficients were used when both variables were continuous measures or Likert scale measures and point-biserial correlations in the case of one continuous measure and one dichotomous measure. With a large sample size, even (very) small group differences and correlations would already indicate significant differences. Therefore, significant effect sizes were discussed only if they were at least in the small-medium range. We used guidelines set by Cohen to define small ($r = 0.1$ / Cramér's $V = 0.1$ / $\eta2 = 0.01$), medium ($r = 0.3$ / Cramér's $V = 0.3$ $\eta^2 = 0.06$), and large effect sizes ($r = 0.5$ / Cramér's $V = 0.5$ / $\eta2 = 0.14$). Finally, three binary logistic regression analyses were performed, to analyze the effect of motivation, self-efficacy and social support on prematurely quitting the CR program (yes/no).

Results

Of the 1782 CR participants, 1223 (69 %) were male and their mean age was 62 (*SD*=11.5) years (range: 17 to 89 years). The most common reason for referral to CR was percutaneous coronary intervention (PCI, 45 %). Eight percent of patients had heart failure with reduced ejection fraction. However, 6 % received multiple diagnoses and/or treatments next to heart failure and only 2 % did not have any other indication for referral for CR. Most patients (72 %) had a partner and were living together. Half of all patients (50 %) had work and from these patients, about half of them (53 %) still worked approximately full time (31–40 or 40+ hours of work per week). See Table 1 for more clinical and demographic characteristics of CVD patients starting CR.

Modifiable risk factors of CVD patients at the start of CR are reported in Tables 2 and 3. About two-thirds (65 %) were overweight or obese (i.e., BMI ≥25 kg m^{-12}). Most male (78 %) and female (90 %) patients were in the moderate-high risk group concerning waist circumference, and thus had an increased risk for metabolic complications. Finally, 33 % of the patients were in the moderate-high risk group for blood pressure (i.e. systolic ≥140 mm Hg and diastolic ≥90 mm Hg).[14,15]

Most participants (54 %) did not obtain at least 150 min/week of moderate intense exercise, as recommended by guidelines.[3,21] There

Table 3
Lifestyle risk factors and motivation for lifestyle change by heart failure and demographics.

Variable		Total *N*	Total *M (SD)/ %*	Heart failure			Sex *M(SD)/%*			Age *P (r)*	Education *M(SD)/%)*				Income *P (r)*
				No	Yes	*P* (η^2/V)	Males	Females	*P* (η^2/V)		Low	Middle	High	*P* (η^2/V)	
Health	BMI = kg/m^2	1782	27.3 (4.7)	27.3 (4.7)	27.6 (4.8)	.405 (0.000)	27.1 (4.5)	27.6 (5.3)	**.046 (0.002)**	**.005 (−0.067)**	28.3 (5.0)	27.7 (5.2)	26.4 (4.1)	**<0.001 (0.030)**	**.024 −0.062**
	Waist circumfr. (cm)	1684	100.7 (13.6)	100.5 (13.5)	103.6 (14.3)	**.012 (0.004)**	102.9 (12.7)	96.2 (14.3)	**<0.001 (0.053)**	**.019 (0.057)**	103.2 (13.5)	102.3 (15.4)	98.6 (13.0)	**<0.001 (0.022)**	.689 −0.011
	Sys. BP (mm Hg)	1738	128.2 (19.2)	128.7 (18.9)	121.8 (22.1)	**<0.001 (0.010)**	128.2 (19.0)	128.1 (19.8)	.885 (0.000)	**<0.001 (0.139)**	128.8 (20.1)	128.0 (19.5)	127.0 (18.4)	.335 (0.002)	.936 −0.002
	Dias. BP (mm Hg)	1738	78.6 (12.1)	78.8 (11.8)	76.4 (14.4)	**.021 (0.003)**	78.9 (11.8)	78.0 (12.6)	.133 (0.001)	**<0.001 (−0.087)**	78.1 (12.4)	79.6 (12.4)	78.7 (12.1)	.255 (0.002)	.448 .021
Exercise	Intensity (min./week)	1698	185 (210)	187 (212)	157 (177)	.117 (0.001)	185 (204)	184 (221)	.934 (0.000)	.151 (−0.035)	144 (194)	197 (221)	213 (208)	**<0.001 (0.018)**	.318 .028
	Muscle (times/week)	1782	1.8 (2.4)	1.8 (2.4)	1.6 (2.4)	.493 (0.000)	1.7 (2.3)	1.9 (2.5)	.079 (0.002)	**.001 (0.077)**	1.8 (2.5)	1.7 (2.3)	1.9 (2.3)	.503 (0.001)	.773 −0.008
	Sitting (hours/day)	1728	7.4 (3.1)	7.4 (3.1)	7.8 (2.9)	.143 (0.001)	7.6 (3.1)	7.0 (3.0)	**<0.001 (0.009)**	.655 (−0.011)	7.2 (2.8)	7.5 (3.1)	7.8 (3.1)	**.014 (0.006)**	.447 .021
Smoking	Smoking (yes)	1782	12.3 %	12.4 %	11.3 %	.790 (0.009)	13.2 %	10.6 %	.140 (0.037)	**<0.001 (−0.146)**	18.2 %	15.4 %	7.6 %	**<0.001 (0.138)**	**.015 −0.067**
	Smoking* (product/day)	219	8.5 (8.5)	8.5 (8.5)	8.7 (8.1)	.952 (0.000)	8.6 (8.5)	8.5 (8.5)	.939 (0.000)	.616 (−0.034)	8.2 (8.1)	8.6 (8.0)	9.0 (10.5)	.895 (0.001)	.759 .024
Alcohol	Alcohol intake	1782	72.3 %	72.9 %	65.2 %	.062 (0.046)	76.0 %	64.2 %	**<0.001 (0.123)**	**.013 (−0.059)**	66.5 %	71.8 %	81.9 %	**<0.001 (0.150)**	**<0.001 −0.113**
	Drinking* (glass/ day)	1287	0.9 (1.2)	0.9 (1.3)	1.0 (1.1)	.489 (0.000)	1.1 (1.4)	0.5 (0.7)	**<0.001 (0.039)**	.143 (0.041)	0.8 (1.3)	1.0 (1.2)	1.0 (1.1)	.065 (0.005)	.913 .003
	Five-shot (range 0–7)	1780	1.0 (1.0)	1.0 (1.0)	0.9 (0.9)	.186 (0.001)	1.2 (1.0)	0.8 (0.8)	**<0.001 (0.034)**	**<0.001 (0.088)**	0.9 (0.9)	1.0 (1.0)	1.3 (0.9)	**<0.001 (0.033)**	**<0.001 .105**
Diet	Vegetables (spoons/day)	1758	2.8 (1.4)	2.9 (1.4)	2.7 (1.3)	.264 (0.001)	2.8 (1.3)	3.0 (1.6)	**.003 (0.005)**	.766 (−0.007)	2.5 (1.3)	2.7 (1.3)	3.2 (1.5)	**<0.001 (0.045)**	.110 .044
	Fruits (pieces/day)	1770	1.4 (1.0)	1.4 (1.0)	1.4 (1.0)	.878 (0.000)	1.3 (1.0)	1.5 (1.0)	**<0.001 (0.009)**	**<0.001 (0.135)**	1.3 (1.0)	1.3 (1.0)	1.5 (1.0)	**<0.001 (0.011)**	.106 .044
	Sugary drinks (glass/ day)	1775	0.9 (1.6)	0.8 (1.6)	1.0 (1.6)	.313 (0.001)	1.0 (1.7)	0.5 (1.0)	**<0.001 (0.024)**	**<0.001 (−0.182)**	1.1 (1.7)	1.1 (1.7)	0.6 (1.4)	**<0.001 (0.019)**	.152 −0.039
	Snacks (portions)	1782	1.1 (1.2)	1.1 (1.2)	1.1 (1.3)	.557 (0.000)	1.1 (1.1)	1.2 (1.3)	.579 (0.000)	**<0.001 (−0.086)**	1.2 (1.4)	1.2 (1.2)	1.2 (1.2)	.859 (0.000)	.708 −0.010
Stress	Stress home (range 1–4)	1782	2.1 (0.8)	2.2 (0.8)	2.1 (0.7)	.336 (0.001)	2.1 (0.8)	2.3 (0.8)	**<0.001 (0.017)**	**<0.001 (−0.224)**	2.1 (0.8)	2.2 (0.8)	2.2 (0.8)	.545 (0.001)	**<0.001 −0.108**
	Stress work (range 1–4)	1782	1.7 (0.9)	1.7 (0.9)	1.6 (0.8)	.301 (0.001)	1.7 (0.9)	1.6 (0.9)	**<0.001 (0.010)**	**<0.001 (−0.451)**	1.5 (0.8)	1.8 (0.9)	1.8 (0.9)	**<0.001 (0.023)**	**<0.001 .175**
Sleep	Sleep (hours/day)	1744	7.3 (1.5)	7.3 (1.5)	7.5 (1.5)	.203 (0.001)	7.4 (1.5)	7.1 (1.5)	**.001 (0.007)**	**<0.001 (0.086)**	7.3 (1.6)	7.2 (1.5)	7.4 (1.3)	**.027 (0.005)**	.087 .047
	Sleep quality (range 1–10)	1782	6.8 (2.0)	6.8 (2.0)	7.0 (2.0)	.178 (0.001)	6.9 (1.9)	6.5 (2.0)	**<0.001 (0.009)**	**.003 (0.069)**	6.7 (1.9)	6.6 (2.0)	7.0 (1.8)	**.006 (0.007)**	**.001 .093**
Motivation	(range 0–10)	1505	8.3 (1.7)	8.3 (1.7)	8.6 (1.3)	**.028 (0.003)**	8.3 (1.7)	8.3 (1.7)	.704 (0.000)	.152 (−0.037)	8.2 (1.7)	8.3 (1.6)	8.5 (1.5)	**.028 (0.006)**	**.016 .071**
Self-efficacy	(range 0–10)	1505	7.6 (2.0)	7.6 (2.0)	7.9 (1.7)	.102 (0.002)	7.7 (2.0)	7.3 (1.9)	**.002 (0.007)**	.686 (−0.010)	7.5 (2.0)	7.6 (2.0)	7.7 (1.8)	.280 (0.002)	**.026 .066**
Social support	(range 0–10)	1505	7.9 (2.4)	7.9 (2.4)	8.1 (1.9)	.336 (0.001)	8.0 (2.4)	7.7 (2.4)	**.010 (0.004)**	.867 (−0.004)	8.0 (2.2)	7.7 (2.6)	8.2 (2.1)	**.004 (0.009)**	**<0.001 .108**

Note: *smokers/drinkers only; BMI = body mass index; Sys. BP = systolic blood pressure; Dias. BP= diastolic blood pressure; BP = blood pressure; *M* = mean; *SD* = standard deviation; η^2 = partial eta squared; V = Cramer's V; *r* = correlation.

was also a large group of patients who did not exercise at all at the beginning of CR (22 %). The recommendation to do muscle-strengthening or bone-strengthening activities at least twice a week was not met by 62 % of the patients and almost half of all patients (45 %) never did any muscle exercises. Mean hours of sitting each day were 7.4 (*SD*: 3.1) hours. Tobacco was smoked by 12 % of all patients, smoking a mean of 8.5 (*SD*: 8.5) tobacco products a day. Also, 72 % of all patients drank alcoholic beverages at least occasionally. Patients who drank consumed approximately 1 glass a day (mean 0.9 glasses) of alcoholic beverages, and 9 % of the patients were classified as heavy (high risk) drinkers (i.e. five-shot score $\geq$2.5). Regarding nutrition, patients consumed approximately 3 servings of vegetables (i.e. mean 2.8) and one and a half pieces of fruit (i.e. mean 1.4) a day. This translates to approximately 140 gs of vegetables and 140 gs of fruits per day, less than recommended (i.e., both 200 gr).[3,24] Overall 76 % of all patients did not adhere to guidelines for vegetable intake and 63 % did not adhere to guidelines for fruit intake. The average number of self-reported sugary drinks (mean 0.9 drinks) and unhealthy snacks (mean 1.1 snacks) intake was approximately both 1 per day. In total, 34 % of all patients reported moderate-high stress levels from factors related to home and 23 % reported moderate-high stress levels from factors related to work. Many patients (39 %) qualified as being at high risk for sleep problems, getting too much (11 %) or too little (28 %) sleep.[25] Sleep quality was rated 6.8 on a scale of 1–10. Based on these 6 lifestyle domains, we examined the number of lifestyle domains in which patients showed an elevated risk. Results showed that all patients showed at least elevated risks in 2 domains, with most patients showing risk factors in 3–4 domains (i.e., 2 domains: 22 %; 3 domains: 40 %, 4 domains: 31 %, 5–6 domains: 8 %).

Many patients expressed preferences to concentrate on either 1 domain (59 %) or 2 domains (36 %) of behaviors. Exercising behavior emerged as the overwhelmingly favored domain, with 71 % of participants indicating a preference to improve their physical activity. Following this, but at a significant distance, were relaxation techniques (21 %), healthier eating habits (19 %), and improved sleeping patterns (16 %). Fig. 2 provides a comprehensive breakdown of the frequency of all selected lifestyle domains. Patients' motivation, self-efficacy and social support to work on these lifestyle behaviors and reach their lifestyle goals were classified as relatively high (see Table 3).

There were only one moderate-high correlation between demographic characteristics and modifiable risk factors; stress from work was negatively related to age (r=−0.451, p < .001). Motivation, self-efficacy and support were overall not moderately or highly related to any demographics. Some small-moderate associations (with all p<.001) were found between motivation and modifiable risk factors (see Table 4). For example, more exercising was related to higher motivation (r = 0.117), self-efficacy (r = 0.124) and social support (r = 0.113). More stress at home was related to lower feelings of self-efficacy (r=−0.122) and lower feelings of social support (r=−0.152). Better sleep quality was related to higher motivation (r = 0.165), self-efficacy (r = 0.221) and social support (r = 0.164).

For exploratory purposes, we also examined how motivation, self-efficacy and social support were related to CR participation. Of the 1782 participants, 172 patients (10 %) stopped the CR program prematurely for varying reasons, for example, issues related to health, motivation or work. We found no differences in motivation for lifestyle change (OR = 0.95, p = .217) and self-efficacy in lifestyle change (OR = 0.95, p = .155) between patients who did and did not quit the program. However, prematurely quitting the program was related to social support (OR = 0.92, p = .006), indicating that each point decrease in social support (range 0–10) increases the odds of prematurely quitting by 8 %.

Discussion

This study identified four prominent domains where a substantial portion of CVD patients who started CR exhibited risk factors: (1) waist circumference and BMI, (2) inadequate engagement in moderate-to-intense physical exercise, (3) insufficient intake of healthy foods, and (4) failure to meet recommended sleep durations. Overall, most patients showed elevated risks across three or four lifestyle domains. Notably, motivation, self-efficacy and social support to change unhealthy lifestyle habits were high at the start of CR. Additionally, we found that patients who dropped out of the CR program reported lower levels of social support for lifestyle change compared to those who successfully completed the CR program.

Our findings regarding modifiable risk factors align closely with the findings documented in the EUROASPIRE V registry,[27] yet we also found some differences. For example, our findings revealed similar rates of high waist circumference (i.e. between 57 and 59 %), yet our sample

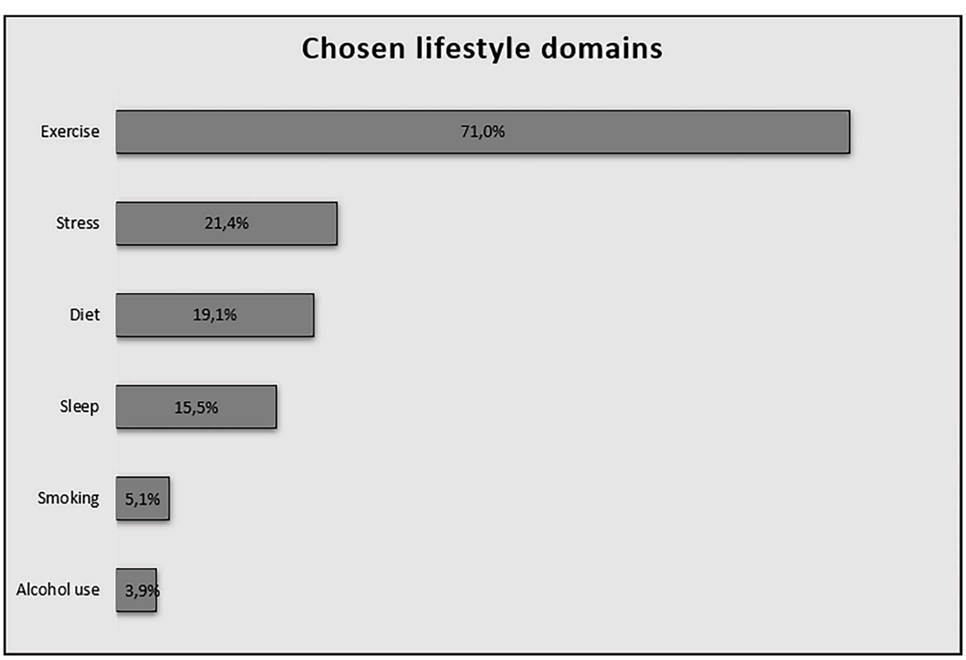

Fig. 2. Chosen lifestyle domains of participants.

Table 4
Correlations between lifestyle risk factors and motivation, self-efficacy and social support.

Variable		Motivation	Self-efficacy	Social support
		P (r)		
Health	BMI (kg m-12)	**.001 (−0.085)**	**<0.001 (−0.136)**	**.002 (−0.081)**
	Waist circumfr. (cm)	**.002 (−0.082)**	**<0.001 (−0.096)**	**.007 (−0.071)**
	Sys. BP (mm Hg)	.066 (−0.048)	.760 (−0.008)	.076 (−0.046)
	Dias. BP (mm Hg)	.730 (−0.009)	.722 (0.009)	.194 (−0.034)
Exercise	Intensity (min./week)	**<0.001 (0.117)**	**<0.001 (0.124)**	**<0.001 (0.113)**
	Muscle (times/week)	**.001 (0.086)**	**<0.001 (0.112)**	**<0.001 (0.112)**
	Sitting (hours/day)	.365 (−0.024)	.053 (−0.051)	**.010 (−0.067)**
Smoking	Smoking (yes)	**.008 (−0.068)**	.079 (−0.045)	**.009 (−0.067)**
	Smoking (products/day)*	.257 (0.084)	.852 (−0.014)	.166 (−0.103)
Alcohol	Alcohol intake (yes)	.635 (0.012)	.657 (−0.011)	.488 (−0.018)
	Drinking (glass/day)*	**.018 (−0.072)**	.203 (−0.039)	.500 (−0.020)
	Five-shot (range 0–7)	.312 (−0.026)	.941 (−0.002)	.253 (0.029)
Diet	Vegetables (spoons/day)	**<0.001 (0.107)**	.238 (0.031)	**.021 (0.060)**
	Fruits (pieces/day)	**.013 (0.064)**	.176 (0.035)	.160 (0.036)
	Sugary drinks (glass/day)	.081 (−0.045)	.899 (0.003)	**.001 (−0.084)**
	Snacks (portions)	**.003 (−0.078)**	**.001 -(0.082)**	.057 (−0.049)
Stress	Stress home (range 1–4)	.447 (−0.020)	**<0.001 (−0.122)**	**<0.001 (−0.152)**
	Stress work (range 1–4)	.744 (0.008)	.662 (−0.011)	.299 (0.027)
Sleep	Sleep (hours/day)	**.002 (0.082)**	**<0.001 (0.095)**	**<0.001 (0.093)**
	Sleep quality (range 1–10)	**<0.001 (0.165)**	**<0.001 (0.221)**	**<0.001 (0.164)**

Note: *smokers/drinkers only; BMI = body mass index; Sys. = systolic; Dias. = diastolic; BP = blood pressure.

exhibited better regulated blood pressure with 22 % being at moderate risk (≥140/90 mmHg) compared to 42 % in the EUROASPIRE V study, and 10 % at high risk (≥160/100 mmHg) versus 12 % in the EUROASPIRE V study.

Overall, our study showed that there is considerable room for lifestyle-related risk factor improvement in patients with CVD who enter CR. Considering patients' recent cardiac events, it is not surprising that almost a quarter did not engage in any regular exercise. One of the core components of CR programs is physical exercise training. This module is followed by most patients[28] and shown to significantly reduce the risk of cardiovascular mortality.[29] Yet, our study showed that many patients have a multitude of modifiable risk factors that are addressable during CR. For instance, given the prevalence of high BMI and waist circumference among many patients, dietary habits emerge as a crucial domain alongside exercise to focus on during CR. Although consumption of sugary drinks and unhealthy snacks did not seem a significant problem among most Dutch patients, meeting the recommended intake of fruits and especially vegetables proved to be challenging.[3,24] Next to weight management, healthy food intake may play a crucial role in reducing the risk of (recurrent) cardiovascular events by addressing multiple factors that contribute to CVD, including cholesterol levels, blood pressure, inflammation and blood sugar.[30,31] A balanced diet rich in fruits and vegetables can significantly lower the risk of recurring cardiovascular problems.[32,33]

Sleep emerges as the third most important domain to focus on during CR, with approximately 30 % of patients failing to meet recommended sleep durations according to current guidelines.[25] Yet 'sleep' was only selected by a mere 16 % of patients as a domain to focus on. This is consistent with prior research indicating that around 40 % of CVD patients experienced mild to moderate insomnia symptoms at the start of CR.[34] Chronic sleep deprivation may stem from various factors, including high stress levels and disturbances like restless legs syndrome, compromising blood pressure regulation and elevating blood pressure levels.[35] Inadequate sleep also significantly impacts obesity and type 2 diabetes[36] while conditions like sleep apnea are strongly linked to hypertension and cardiovascular issues.[37] Encouragingly, improved sleep during CR correlates with enhancements in certain cardiovascular risk markers, such as cholesterol levels.[34] Taken together, our findings indicate a compelling incentive to expand our focus on modifiable risk factors within the CR program.

Having a heart incident can be a strong wake-up call to start making some difficult lifestyle changes. It is thus encouraging that, overall, CVD patients were very motivated to work on these different lifestyle domains and had relatively high self-efficacy to do so. Interestingly, our study showed that motivation to change one's lifestyle and self-confidence to be able to do so was related to self-reported sleep quality. Lack of sleep may trigger a set of neuroendocrine, metabolic, and behavioral adaptations aimed at conserving energy.[38] Thus patients with poor sleep quality who generally feel tired during the day, may be less motivated to work on a healthy lifestyle. This is another incentive to again, assess stress levels and address healthy sleep habits as an important aspect of cardiovascular risk management during CR. The real challenge may lie in healthy lifestyle behavior maintenance over a longer period of time as changing unhealthy habits is incredibly difficult.[39]

Most high-income countries acknowledge that CR requires a multidisciplinary approach, encompassing both physical and psychosocial well-being.[1-3] However, it is common to overemphasis the physical aspect,[5] especially when CR funding is limited. Despite this, it is crucial to support an interdisciplinary, personalized approach, tailoring lifestyle interventions to each patient's specific modifiable risk factors and according needs and wishes.[2] This personalized care may lead to more meaningful recovery goals,[40] potentially increasing motivation to start and continue CR and maintain healthy behaviors post CR. Future research should explore the cost-effectiveness of such an interdisciplinary, personalized approach. In the Netherlands, a multidisciplinary approach is fully covered for all patients, whereby the team identifies each patient's needs. Dutch funding for CR includes interventions targeting depression or anxiety when necessary.

Strengths of this study are the high response rate achieved among participants and the large total sample size of patients following CR. The high response rate and sample size boosts confidence in the representativeness of our sample and enhances the reliability, validity and generalizability of our findings to other CVD patients starting CR. However, we acknowledge that the research was conducted in a single high income country and careful consideration of differences in cultural context is essential for generalizing patients' modifiable risk factors and lifestyle behavior preferences to other countries and CR programs. For example, gold standards for exercising and healthy food intake may be country specific and prominent clusters of modifiable risk factors may be culture specific (e.g. higher rates of obesity and diabetes in low SES groups), which complicates comparison of outcomes.

Our comprehensive lifestyle assessment allowed us to capture a holistic view of participants' lifestyle and made it possible to determine, for example, the number of modifiable risk factors per patient, their motivation for lifestyle change and their needs regarding a tailored CR program. However, we acknowledge that most lifestyle data are based on self-reported behaviors, which may be subject to recall bias and social desirability bias. Also, self-reports on sleep duration and quality did not offer insights into the underlying reasons for sleep problems, such as sleep apnea. To avoid overwhelming our patients with long questionnaires, we chose not to include a more extensive, validated questionnaire for a detailed assessment of sleep issues, yet this information is important to address these issues. Similarly, to minimize the burden on our patients, we used three single-item measures to assess motivation, self-efficacy, and social support related to achieving the chosen lifestyle goal, which may not fully capture these constructs.

In addition, the metrics used in this study are foremost based on Dutch standards. Recently, the American Heart Association launched the 'Life's Essential 8′ as key measures for cardiovascular health, based on international standards.[10] A particularly advantageous aspect of their approach is the use of a uniform scoring system, ranging from 0 to 100 points, for each metric. This ensures that similar differences in point values across metrics correspond to roughly similar impacts on health. Both our metrics and Life's Essential 8 use continuous scales to measure health behaviors, allowing for the consideration of interindividual differences and the measurement of intraindividual change. This advantage is important as we recommend future studies to monitor changes in health behaviors, motivation and self-efficacy over time. Not only during CR participation but also after, when patients must maintain a healthier lifestyle while receiving much less support. Finally, in future studies, we recommend investigating the impact of anxiety and depression in CVD patients following CR. It is well established that psychosocial factors are associated with cardiovascular disease,[41] Including these variables will provide a more comprehensive understanding of their interplay and impact on overall health and quality of life.

To conclude, there are multiple lifestyle areas of concern, next to physical exercise, that should be more often addressed during CR. In line with other CR guidelines,[2,13,42] these findings underscore the importance of a comprehensive lifestyle assessment of CVD patients before the start of the CR program. Our findings also underscore the pressing need for an interdisciplinary approach offering tailored lifestyle interventions, preferably focusing on more than one lifestyle domain next to physical exercise. This may involve broadening the scope of most current CR programs. Fitting patients' needs may promote CR uptake and actively participating in the CR program, which in turn may have important implications for long-term cardiovascular health and quality of life.

Data availability

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

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CRediT authorship contribution statement

Linda D. Breeman: Writing – review & editing, Writing – original draft, Validation, Supervision, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Andrés Pérez-Alonso:** Writing – review & editing, Methodology, Investigation, Formal analysis. **David Kühling-Romero:** Writing – review & editing, Methodology, Investigation, Formal analysis. **Roderik A. Kraaijenhagen:** Writing – review & editing, Writing – original draft, Software, Resources, Investigation, Funding acquisition, Conceptualization. **Isra Al-Dhahir:** Writing – review & editing, Project administration, Investigation, Data curation. **Renée V.H. IJzerman:** Writing – review & editing, Project administration, Investigation, Data curation. **Roxy van Eersel:** Writing – review & editing, Validation, Project administration, Methodology, Investigation, Formal analysis, Data curation. **Katherine Wolstencroft:** Writing – review & editing, Validation, Methodology, Conceptualization. **Tobias N. Bonten:** Writing – review & editing, Conceptualization. **Douwe E. Atsma:** Writing – review & editing, Conceptualization. **Niels H. Chavannes:** Writing – review & editing, Conceptualization. **Lisette van Gemert-Pijnen:** Writing – review & editing, Conceptualization. **Hareld M.C. Kemps:** Writing – review & editing, Conceptualization. **Wilma Scholte op Reimer:** Writing – review & editing, Conceptualization. **Andrea W.M. Evers:** Writing – review & editing, Writing – original draft, Supervision, Investigation, Funding acquisition, Conceptualization. **Veronica R. Janssen:** Writing – review & editing, Writing – original draft, Supervision, Investigation, Funding acquisition, Conceptualization.

Declaration of competing interest

Roderik Kraaijenhagen is the CEO of the participating cardiac rehabilitation centers. All other authors declare no conflict of interest.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.hrtlng.2024.09.008.

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