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ORIGINAL REPORT

HEALTH-RELATED QUALITY OF LIFE AND CARDIAC REHABILITATION: DOES BODY MASS INDEX MATTER?*

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Objective: **To investigate the relation between body mass index class and changes in health-related quality of life in patients participating in cardiac rehabilitation.**
Design: **Prospective cohort study.**
Patients: A total of 503 patients with acute coronary syndrome.
Methods: **Data from the OPTICARE trial were used, in which health-related quality of life was measured with the MacNew Heart Disease HRQOL Instrument at the start, directly after, and 9 months after completion of cardiac rehabilitation. Patients were classed as normal weight, overweight, or obese.**
Results: **During cardiac rehabilitation, global health-related quality of life improved in patients in all classes of body mass index. Patients classed as overweight had a significantly greater improvement in social participation than those classed as normal weight (5.51–6.02 compared with 5.73–5.93, respectively; difference in change 0.30, $p = 0.025$). After completion of cardiac rehabilitation, health-related quality of life continued to improve similarly in patients in all classes of body mass index.**
Conclusion: **Health-related quality of life improved during cardiac rehabilitation in patients of all classes of body mass index. Patients classed as overweight showed the greatest improvement. The beneficial effects were maintained during extended follow-up after completion of cardiac rehabilitation.**

Key words: cardiac rehabilitation; acute coronary syndrome; quality of life; body mass index; obesity.

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LAY ABSTRACT

Patients with cardiovascular disease are referred to cardiac rehabilitation to help them adopt a healthier lifestyle and achieve a stable psychological status. However, cardiac rehabilitation programmes are probably not suitable for patients of all body mass indexes. Patients who are classed as obese may experience more difficulty in changing their current lifestyle to a healthier one. During cardiac rehabilitation their quality of life might not improve as much as in patients of normal weight. This study investigated the differences between body mass index classes with regard to improvement in quality of life. The results showed that, during cardiac rehabilitation, obese patients undergo the same improvements as patients of normal weight. Patients who are overweight showed a greater improvement in quality of life. It does not seem to be necessary to adjust cardiac rehabilitation programmes for patients who are obese; at least not with respect to improving quality of life.

Since the 1980s cardiac rehabilitation (CR) has been offered to patients with cardiovascular disease (CVD) for secondary prevention. A CR programme generally encompasses exercise sessions and health education. Besides improving physical fitness, adopting a healthier lifestyle, and achieving a stable psychological status, improving health-related quality of life (HRQOL) is one of the main goals of CR (1). Poor HRQOL is associated with higher mortality in patients with CVD (2–4). HRQOL refers to the impact that health conditions and their symptoms have on an individual's quality of life (5) and commonly comprises 3 domains: physical function, emotions, and social participation (6, 7).

A recent meta-analysis indicated that HRQOL improves upon receiving CR (8). However, it is not known whether the effects of CR on HRQOL are equally favourable for patients with and without obesity. Since the core of CR consists of weight-bearing exercise sessions, which may be challenging for patients with obesity, it could be hypothesized that obese patients with CVD would not gain the same health benefits as patients of normal weight, which might translate into a smaller improvement in HRQOL (9). For aerobic capacity, there is increasing evidence that effects achieved during CR are substantially smaller in patients with obesity compared with patients without obesity, and that these effects are non-lasting (10). In addition, obesity is related to a higher frequency of psychological problems and probably to unpleasant feelings when training in a group with non-obese peers (11). Thus, we expect smaller gains in HRQOL in patients with obesity during CR compared with patients of normal weight.

Only a few studies have evaluated the effects of CR on HRQOL specifically in obese patients with CVD.

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A study by Pochmonová et al. showed improvements in HRQOL in patients with ischaemic heart disease during a 12-week exercise programme, regardless of body mass index (BMI) (12). However, the sample size in this study was small ($n=88$) and HRQOL was not evaluated on the longer term. Another study ($n=388$) showed a lower HRQOL (on the physical domain) both before and after CR in patients with extreme obesity (BMI >35.0 kg/m^2) compared with patients with overweight (BMI 25.0–29.99 kg/m^2) and those with obesity (BMI 30.0–35.0 kg/m^2) (13). Lavie & Milani showed improvements in HRQOL in patients with obesity, although with another BMI threshold for obesity (BMI ≥27.3 kg/m^2 in men and ≥27.8 kg/m^2 in women) and measured with a generic questionnaire (14). A recent study showed a lower HRQOL at the start of CR and smaller gains during CR in patients with obesity, although this was not investigated in the longer term (15).

Large-scale studies on the role of BMI in the evolution of HRQOL over time are needed to investigate whether CR should be optimized for specific BMI classes, and particularly for patients with obesity. Data from the EUROASPIRE III study, showing a high prevalence of overweight (46%) and obesity (35%) in coronary patients in Europe, highlight this need (16). The aim of the present study was to investigate the relation between 3 BMI classes and changes in HRQOL during and after CR in patients with CVD. It is hypothesized that patients with obesity show smaller improvements in HRQOL than do patients of normal weight.

METHODS

Patient population

Patients were selected from the database of the OPTICARE trial, conducted at Capri Cardiac Rehabilitation, Rotterdam-The Hague, the Netherlands, from 2010 until 2014 (registered on ClinicalTrials.gov, number NCT01395095). This study was described in detail elsewhere (17). In short, the OPTICARE trial was a randomized controlled trial with a primary aim of evaluating the effectiveness of 2 extended CR programmes vs standard CR. Patients aged ≥18 years who experienced an acute coronary syndrome (ACS), defined as "persistent (>20 min) chest pain suggestive of myocardial ischaemia, which is unresponsive to nitroglycerine, and which is accompanied by ST-T changes (electrocardiographic evidence) and/or cardiac troponin elevations (biochemical evidence), regardless of in-hospital treatment" were included in the OPTICARE trial. All patients were fluent in Dutch. Exclusion criteria were severe comorbidities, left ventricle ejection fraction <40%, and psychological or cognitive impairments that may disturb participation in CR. For the current study only data from patients who completed standard CR were used.

The OPTICARE trial was approved by the medical ethics committee of Erasmus MC, University Medical Centre Rotterdam, The Netherlands (MEC-2010-391) and all participating patients provided written informed consent.

Cardiac rehabilitation

Standard CR was provided according to the Dutch guidelines (18, 19), and consisted of an 90-min exercise programme 2 times a week for 12 weeks under the supervision of a physiotherapist. Lifestyle and cardiovascular risk factor education was provided on cardiovascular disease risk factors, medical information, dietary advice and advice on coping with emotions. If needed, complementary programmes, such as a smoking cessation programme, nutritional counselling, and stress management were offered. All components of standard CR were group-based. The exercise programme was obligatory, whereas other components of CR were offered on indication. Before starting the CR programme, each patient underwent an interview to determine his/her individual programme and needs. Completion of the programme was defined as completion of at least 75% of the exercise programme.

Patient selection

A total of 605 patients from the OPTICARE trial were randomized to standard CR in the first 12 weeks and were included in the present study. To investigate the relation between BMI and HRQOL during CR, 102 patients were excluded since they did not complete standard CR. Therefore, a total of 503 patients were eligible for the current study (Fig. 1). To investigate the relation between BMI and HRQOL after completing CR, an additional 255 patients who received an experimental aftercare programme were excluded, resulting in a subpopulation of 248 patients available for this part of the analysis.

Data collection

The following baseline data (start of CR) were used: age, sex, height, weight, educational level, marital status, risk factors and cardiac medication. By using height and weight, BMI was

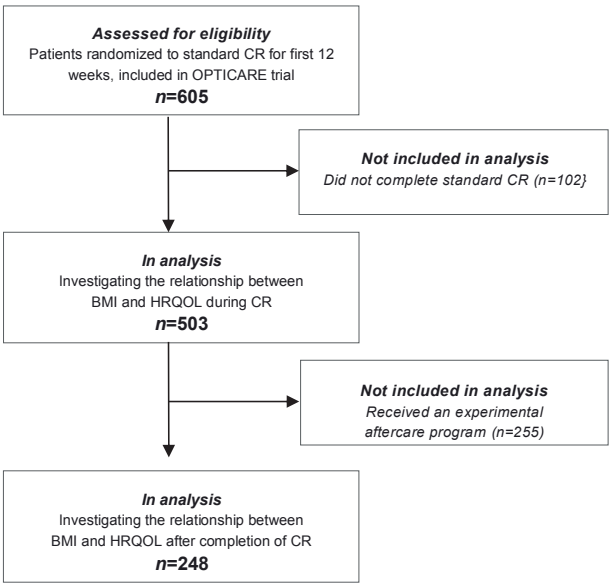

Fig. 1. Flow chart of patient selection. HRQOL: health-related quality of life; BMI: body mass index; CR: cardiac rehabilitation.

calculated and used to classify patients according to the World Health Organization (WHO) guidelines, as: normal weight (BMI 18.5–24.99 kg/m^2), overweight (BMI 25.0–29.99 kg/m^2), and obese (BMI ≥30.0 kg/m^2) (20).

HRQOL was measured at the start of CR (T0), directly after completion of CR (T1) and 9 months after completion of CR (T2). The Dutch version of the MacNew Heart Disease HRQOL Instrument (MacNew) was used to measure HRQOL. This self-administered disease-specific questionnaire for patients with ischaemic heart disease meets the criteria for psychometric properties of reliability, validity and responsiveness and consists of 27 items. It measures HRQOL on 3 domains (physical function, emotions, and social participation) as well as global HRQOL (6, 7). The score on each domain ranges from 1 (poor HRQOL) to 7 (high HRQOL). Questions refer to the last 2 weeks.

Statistical analyses

Baseline data were depicted separately for the 3 BMI classes. Normality of continuous variables (BMI and age) was checked visually and tested with a Kolmogorov-Smirnov test. BMI was not normally distributed and displayed as median and interquartile range. Age was normally distributed and displayed as mean (standard deviation; SD). Differences in mean age between BMI classes were tested by means of analysis of variance (ANOVA). Fisher's least significant difference was used as a post hoc test if ANOVA showed a significant difference between the 3 classes of BMI at baseline. Categorical variables were displayed as numbers and percentages and differences between BMI classes were tested by means of linear-by-linear χ^2 tests for categorical variables (or by Fisher's exact test if groups contained less than 5 measurements).

Two linear mixed-effect models were created to analyse the relation between BMI and HRQOL: one to investigate the relation between BMI and HRQOL at the start and during CR (change between T0 and T1), and one to investigate the same relation, but after completion of CR (change between T1 and T2). HRQOL was modelled as the dependent variable and BMI, age, sex (21) (fixed effects) and time since the start of CR (random intercept) as explanatory variables. BMI, as determined at baseline for each patient, was modelled by 2 dummy variables in both models, with BMI 18.5–24.99 kg/m^2 being the reference category. An interaction term between BMI and time was included in both models to study if HRQOL changes during and after CR differed between BMI classes. Educational level, marital status, work status, cardiovascular risk factors and cardiac medication appeared not to be associated with both BMI or HRQOL, and were therefore not included in the multivariable model. R Statistical software (Version 1.1.463, RStudio Team (2016). RStudio: Integrated Development for R. RStudio, Inc., Boston, MA, USA, URL http://www.rstudio.com/) was used to analyse the data. A p-value <0.05 was considered statistically significant. However, to adjust for the inflation of the type I error probability, significance was stated at <0.0167 for assessing baseline differences between BMI classes, and at <0.025 for the comparison of the 2 higher BMI classes with the reference group in the linear mixed-effect models.

RESULTS

Baseline characteristics

Both the proportion of patients in each of the 3 classes of BMI and baseline values for HRQOL were comparable between patients included and excluded in the analysis (results not shown).

Mean time (95% confidence interval; 95% CI) between hospital discharge and admission to CR was 44.4 (41.5, 47.2) days. Patients classed as overweight were the largest group (49.1%), followed by patients with obesity (27.4%) and patients of normal weight (23.5%). At the start of CR, patients with obesity were significantly younger than patients of a normal weight (55.8 vs 59.5 years, respectively, $p=0.005$, Table I). Furthermore, a higher BMI was associated with a higher frequency of risk factors: 62.3% of the patients with obesity had heart disease in their family history ($p=0.004$), 20.3% had a diagnosis of diabetes ($p=0.001$), 44.2% dyslipidaemia ($p=0.007$) and 47.1% hypertension ($p=0.005$) (Table I).

Relation between BMI class and HRQOL during and after cardiac rehabilitation

At the start of CR, no significant differences in HRQOL were shown between BMI classes (Table II).

During CR, mean HRQOL increased in the total study population from 5.11 to 5.63 on physical function, from 5.13 to 5.41 on emotions, from 5.59 to 5.97 on social participation, and from 5.24 to 5.63 on global HRQOL. Patients classed as overweight had a significantly greater improvement in HRQOL compared with patients of normal weight in social participation (5.51–6.02 compared with 5.73–5.93, $p=0.025$) (Table II). No differences were found for patients with obesity compared with patients of normal weight.

After completion of CR, HRQOL increased in the total study population from 5.61 to 5.89 on physical function, from 5.36 to 5.58 on emotions, from 5.90 to 6.26 on social participation and from 5.60 to 5.83 on global HRQOL. Neither patients with overweight or those with obesity differed in their improvement in HRQOL compared with patients of normal weight (Table III).

DISCUSSION

To the best of our knowledge, this is the first large study investigating the longitudinal relationship between BMI and HRQOL in a post-ACS CR population, comprising the periods both during and after CR. After starting at comparable HRQOL levels, HRQOL improved during and after completion of CR in all classes of BMI. Of note was the larger improvement on one domain of HRQOL (social participation) in patients classed as overweight compared with patients of normal weight. This was not observed for patients with obesity. There were no differences in improvements

Table I. Baseline characteristics for patients of normal weight (body mass index (BMI) 18.5–24.99 kg/m^2), overweight (BMI 25.0–29.99 kg/m^2) or obesity (BMI ≥ 30 kg/m^2) ($n = 503$)

Characteristics	Normal weight ($n = 118$)	Overweight ($n = 247$)	Obese ($n = 138$)	p-value
BMI, kg/m^2, median (IQR)	23.6 (22.2, 24.5)	27.6 (26.2, 28.7)	32.1 (31.1, 34.1)	
Sex, males, *n* (%)	89 (75.4)	207 (83.8)	114 (82.6)	0.161
Age, years, mean (SD)	59.5 (9.4)	57.6 (9.2)	55.8 (9.0)	0.005[1]**
Educational level, *n* (%)				0.097
Low	4 (4.0)	10 (5.1)	4 (3.5)	
Intermediate	58 (57.4)	124 (63.3)	84 (74.3)	
High	39 (38.6)	62 (31.6)	25 (22.1)	
Missing	17	51	25	
Marital status, *n* (%)				0.713
Partnered	84 (82.4)	169 (86.2)	91 (80.5)	
Unpartnered	18 (17.6)	27 (13.8)	22 (19.5)	
Missing	16	51	25	
Work status, *n* (%)				0.830
Employed	56 (58.3)	108 (59.3)	59 (56.7)	
Unemployed	40 (41.7)	74 (40.7)	45 (43.3)	
Missing	22	65	34	
Risk factors, *n* (%)				
Family history	52 (44.1)	130 (52.6)	86 (62.3)	0.004**
Diabetes	7 (5.9)	28 (11.3)	28 (20.3)	0.001**
Dyslipidaemia	32 (27.1)	99 (40.1)	61 (44.2)	0.007**
Hypertension	35 (29.7)	101 (40.9)	65 (47.1)	0.005**
Smoking (pre-ACS)	46 (39.0)	87 (35.2)	60 (43.5)	0.441
Cardiac medication, *n* (%)				
Acetylsalicylic acids	114 (97.4)	241 (97.6)	136 (98.6)	0.853
Thienopyridines	100 (85.5)	197 (79.8)	120 (87.0)	0.677
Statins	115 (98.3)	243 (98.4)	129 (93.5)	0.027*
Beta blockers	92 (78.6)	205 (83.0)	117 (84.8)	0.217
ACE inhibitors	83 (70.9)	116 (67.2)	103 (74.6)	0.494

*$p < 0.05$, **$p < 0.01$.
[1]*Post hoc* tests showed a significant difference between normal weight and obese participants ($p = 0.001$) and no significant difference between normal weight and overweight participants ($p = 0.061$) or between overweight and obese participants ($p = 0.065$).
ACS: acute coronary syndrome; ACE: angiotensin-converting-enzyme: IQR: interquartile range; SD: standard deviation.

in HRQOL between BMI classes between the end of CR and 9 months after the end of CR.

HRQOL values at the start of CR in the current study were comparable to those in a study investigating HRQOL in a large sample of Dutch patients with CVD (unknown BMI), entering CR (22). We expected that HRQOL would be lower in patients with obesity compared with normal weight patients at the start of CR, since this was found for persons with obesity in the general population (23–25). An explanation for the absence of this difference might be that patients in our study have experienced a life event, which is likely to affect HRQOL in all BMI classes, and thereby might have dominated the relation between BMI and HRQOL. Gunstad et al. found a lower HRQOL in CR patients with extreme obesity (BMI > 35.0 kg/m^2) compared with patients with overweight and patients with obesity at the start of CR (13). This may suggest that mainly patients with extreme obesity might be in need of additional care. In OPTICARE, only a very small group of 24 patients had a BMI≥35 kg/m^2, and, hence, the current study had insufficient power to analyse the class of patients with extreme obesity to evaluate this suggestion.

We expected to observe a smaller improvement in HRQOL during CR in higher classes of BMI compared with lower classes of BMI when following an exercise-based CR programme. However, patients classed as overweight improved more in HRQOL during CR compared with normal weight patients, and exceeded the clinically important change of 0.5 points (26) It cannot be ruled out that this larger improvement might be a result of a slightly (but not significantly) lower level at the start of CR in patients with overweight (i.e. regression towards the mean). In addition, it should be kept in mind that the improvement is a mean of the change and that the lower boundary of the confidence interval is below the clinically important change of 0.5. Therefore,

Table II. Mean health-related quality of life values per body mass index (BMI) class at the start of cardiac rehabilitation (CR) and directly after completion of CR, and mean change in HRQOL during CR ($n = 503$)

BMI classes	At the start of CR (T0) Mean (95% CI)	p-value	Directly after completion of CR (T1) Mean (95% CI)	Change during CR (Δ T0–T1) Mean (95% CI)	p-value
Physical function					
< 25 kg/m^2	5.24 (5.01, 5.46)		5.60 (5.38, 5.83)	0.37 (0.14, 0.59)	
25–30 kg/m^2	5.08 (4.92, 5.24)	0.258	5.71 (5.54, 5.87)	0.63 (0.47, 0.79)	0.036
≥ 30 kg/m^2	5.04 (4.83, 5.25)	0.216	5.47 (5.26, 5.69)	0.43 (0.22, 0.65)	0.643
Emotions					
< 25 kg/m^2	5.23 (5.01, 5.45)		5.46 (5.24, 5.68)	0.23 (0.01, 0.45)	
25–30 kg/m^2	5.08 (4.93, 5.24)	0.289	5.37 (5.21, 5.53)	0.28 (0.12, 0.44)	0.657
≥ 30 kg/m^2	5.13 (4.92, 5.33)	0.499	5.38 (5.17, 5.59)	0.26 (0.05, 0.46)	0.845
Social participation					
< 25 kg/m^2	5.73 (5.51, 5.95)		5.93 (5.71, 6.16)	0.20 (–0.02, 0.43)	
25–30 kg/m^2	5.51 (5.36, 5.67)	0.113	6.02 (5.85, 6.18)	0.50 (0.34, 0.67)	0.025*
≥ 30 kg/m^2	5.62 (5.41, 5.83)	0.463	5.91 (5.70, 6.13)	0.30 (0.08, 0.51)	0.542
Global					
< 25 kg/m^2	5.35 (5.15, 5.54)		5.64 (5.44, 5.83)	0.29 (0.09, 0.49)	
25–30 kg/m^2	5.19 (5.05, 5.33)	0.206	5.67 (5.52, 5.81)	0.48 (0.33, 0.62)	0.069
≥ 30 kg/m^2	5.21 (5.03, 5.40)	0.329	5.54 (5.35, 5.73)	0.33 (0.14, 0.52)	0.718

*$p < 0.025$. 95% CI: 95% confidence interval. Results are based on multivariable linear mixed-effect modelling. BMI < 25 is the reference group for all analyses.

Table III. Mean health-related quality of life (HRQOL) values per body mass index (BMI) class directly after completion of cardiac rehabilitation (CR) and 9 months after completion of CR, and mean change in HRQOL after completion of CR ($n = 248$)

BMI classes	Directly after completion of CR (T1) Mean (95% CI)	9 months after completion of CR (T2) Mean (95% CI)	Change after completion of CR (Δ T1–T2) Mean (95% CI)	*p*-value
Physical function				
<25 kg/m²	5.55 (5.24, 5.86)	5.85 (5.52, 6.19)	0.30 (–0.03, 0.64)	
25–30 kg/m²	5.79 (5.58, 6.01)	6.10 (5.87, 6.32)	0.31 (0.08, 0.53)	0.992
≥30 kg/m²	5.32 (5.06, 5.59)	5.53 (5.23, 5.82)	0.20 (–0.09, 0.50)	0.657
Emotions				
<25 kg/m²	5.38 (5.06, 5.69)	5.41 (5.08, 5.75)	0.04 (–0.30, 0.37)	
25–30 kg/m²	5.35 (5.14, 5.57)	5.68 (5.45, 5.91)	0.33 (0.10, 0.55)	0.180
≥30 kg/m²	5.30 (5.03, 5.57)	5.44 (5.14, 5.74)	0.14 (–0.16, 0.44)	0.672
Social participation				
<25 kg/m²	5.79 (5.49, 6.09)	6.14 (5.81, 6.47)	0.35 (0.02, 0.68)	
25–30 kg/m²	6.01 (5.80, 6.22)	6.41 (6.19, 6.63)	0.40 (0.18, 0.62)	0.821
≥30 kg/m²	5.79 (5.53, 6.06)	6.06 (5.77, 6.35)	0.27 (–0.03, 0.56)	0.732
Global				
<25 kg/m²	5.55 (5.28, 5.83)	5.74 (5.45, 6.03)	0.19 (–0.11, 0.48)	
25–30 kg/m²	5.71 (5.52, 5.90)	5.98 (5.78, 6.18)	0.27 (0.07, 0.47)	0.628
≥30 kg/m²	5.44 (5.20, 5.68)	5.61 (5.35, 5.87)	0.17 (–0.09, 0.43)	0.944

CI: confidence interval. Results are based on multivariable linear mixed-effect modelling. BMI<25 is the reference group for all analyses.

we cannot rule out that this finding might be due to chance. We do not have another explanation for these unexpected findings, but future studies on the relationship between BMI and changes in physical activity, physical fitness, and psychological factors should be performed to confirm this relationship and, if true, may add to elucidation of the underlying mechanisms.

The patients with obesity in the current study improved in HRQOL during CR in a comparable manner to that of normal weight patients, but did not exceed the clinically important change of 0.5 points (26). It seems that patients with obesity will, on average, improve close to, or slightly exceeding, the 0.5-point limit during the 9 months after completion of CR compared with baseline levels. It should be noted that it cannot be excluded that the current results are valid only for a subgroup patients with obesity who are highly motivated, since they consented to participate in a trial designed to investigate the effects of extended CR programmes. Considering this, one could question the generalizability of the present results to the entire CVD population with obesity participating in CR. Consequently, it is recommended to further investigate changes in HRQOL in this population, including patients with extreme obesity (BMI ≥35 kg/m²).

Limitations

This study has some limitations. First of all, approximately 20% of the patients did not complete standard CR and were excluded from analysis. However, drop-out of CR was equally distributed among BMI classes and is therefore not expected to have influenced our conclusions. Secondly, it was not possible to conclude whether the improvements found in HRQOL were due to the CR programme, since, due to ethical considerations, a control group not participating in CR was unavailable.

The results of the current study suggest that, from a HRQOL perspective, it does not seem necessary to adjust the standard rehabilitation programme for patients with overweight and those with obesity. However, besides HRQOL, CR is also focused on increasing physical activity, physical fitness and restoring psychological wellbeing. To inform CR centres, these aspects need to be investigated in their relationship with BMI, since they are at least as important as HRQOL with regard to secondary prevention.

Conclusion

Normal weight, overweight and obese patients with CVD started CR at comparable HRQOL levels. Improvements in HRQOL were seen for all classes of BMI. Patients of normal weight and those with obesity improved equally in HRQOL during CR, whereas patients with overweight improved more. Further research is needed with respect to other CR goals, such as improving physical activity, physical fitness and psychological status, and the differences in effects between classes of BMI requires attention, especially as there is a large and increasing population of patients with CVD and obesity.

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