Petra Simpson Grom [1,2*]
Aleša Rakar [3]
Marko Novaković [4]

MANAGING LIPID LEVELS IN THE LIFE-LONG REHABILITATION OF PATIENTS WITH CORONARY ARTERY DISEASE

OBVLADOVANJE RAVNI KRVNIH MAŠČOB V PROCESU VSEŽIVLJENJSKE REHABILITACIJE KORONARNIH BOLNIKOV

ABSTRACT

Cardiac rehabilitation includes secondary prevention of cardiovascular events. Since the level of LDL cholesterol, which is an important risk factor for cardiovascular events, had been shown to be insufficiently controlled in persons included in the third phase of cardiac rehabilitation in the Coronary Club of Ljubljana, we aimed to explore if an additional educational program would improve the control of blood lipids and self-management ability in these subjects. Members of the Coronary Club of Ljubljana were invited to join a ten-month structured program for the management of cardiovascular risk factors with an emphasis on lipid control. Participation in the program activities was optional. A total of 146 subjects were enrolled. During the study, a slight decrease was seen in the following parameters: total cholesterol, HDL cholesterol, triglycerides and glycated haemoglobin ($p<0.05$). In the whole group of participants, the median LDL cholesterol level decreased from 2.5 mmol/L (interquartile range [IQR], 1.8-3.4) to 2.2 mmol/L (IQR, 1.7-3.5), but the difference was not statistically significant ($p=0.081$), while in the participants who attended individual consultations or workshops, a significant decrease in LDL cholesterol levels was observed. At the beginning of the study, very high-risk patients had higher activation, indicated with higher median baseline Patient Activation Measure (PAM) score, than high-risk patients (60.6 versus 55.6). During the study, the median PAM score increased in high-risk patients (from 55.6 to 60.6), but not in very high-risk patients. Thus, an additional educational program can improve lipid control and patient activation in subjects included in the third phase of cardiac rehabilitation.

Keywords: cardiac rehabilitation, control of blood lipids, patient activation

[1]Coronary Club of Ljubljana, Ljubljana, Slovenia

[2]Faculty of Sport, University of Ljubljana, Ljubljana, Slovenia

[3]Medscripta, Aleša Rakar s.p., Ljubljana, Slovenia

[4]Department of Vascular Diseases, University Medical Centre Ljubljana, Ljubljana, Slovenia

IZVLEČEK

Kardiološka rehabilitacija vključuje sekundarno preventivo srčno-žilnih dogodkov. V Koronarnem klubu Ljubljana smo pri osebah, vključenih v tretjo fazo kardiološke rehabilitacije, ugotovili nezadovoljivo urejeno raven holesterola LDL, ki je pomemben dejavnik tveganja za srčno-žilne dogodke. Zato smo želeli raziskati, ali bi dodatni izobraževalni program pri teh osebah izboljšal nadzor maščob v krvi in zmožnost, da skrbijo za svoje zdravje. Člani Koronarnega kluba Ljubljana so bili povabljeni v desetmesečni strukturirani program obvladovanja srčno-žilnih dejavnikov tveganja s poudarkom na nadzoru krvnih maščob. Udeležba na posameznih programskih aktivnostih je bila prostovoljna. Skupno je bilo vključenih 146 oseb. Do zaključka programa so se nekoliko zmanjšale vrednosti naslednjih parametrov: skupnega holesterola, holesterola HDL, trigliceridov in glikiranega hemoglobina ($p < 0,05$). V celotni skupini sodelujočih se je mediana raven holesterola LDL znižala z 2,5 mmol/L (kvartilni razpon [IQR]: 1,8-3,4) na 2,2 mmol/L (IQR: 1,7-3,5), vendar razlika ni bila statistično značilna ($p = 0,081$), medtem ko se je pri udeležencih, ki so obiskali individualna svetovanja ali delavnice, raven holesterola LDL statistično značilno znižala. Na začetku raziskave so bili bolniki z zelo velikim tveganjem za srčno-žilne dogodke bolje aktivirani, kar je pokazala višja mediana izhodiščna ocena po vprašalniku PAM, kot bolniki z velikim tveganjem (60,6 proti 55,6). Do zaključka raziskave se je mediana ocena Patient Activation Measure (PAM) zvišala pri bolnikih z velikim tveganjem (s 55,6 na 60,6), ne pa pri bolnikih z zelo velikim tveganjem. Z dodatnim izobraževalnim programom je v tretji fazi kardiološke rehabilitacije torej mogoče izboljšati nadzor krvnih maščob in močneje aktivirati bolnike pri skrbi za svoje zdravje.

Ključne besede: kardiološka rehabilitacija, nadzor krvnih maščob, aktivacija bolnikov

Corresponding author:* Petra Simpson Grom

Coronary Club of Ljubljana, Štepanjsko nabrežje 38, 1000 Ljubljana, Slovenia
E-mail: petra.simpson.grom@gmail.com
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INTRODUCTION

Comprehensive cardiac rehabilitation includes assessment of risk factors, patient empowerment, psychosocial support and secondary prevention – which involves regular physical exercise, appropriate diet, the avoidance of smoking, and pharmacological treatment. It has been proven that with organized cardiac rehabilitation for coronary patients the number of hospitalizations and the risk of death from cardiovascular disease (CVD) can be reduced and the quality of life improved (Anderson et al., 2016).

The Coronary Club of Ljubljana (KKL) is a centre for the third phase of cardiac rehabilitation and it has been rehabilitating heart patients since 1981. An important part of cardiac rehabilitation is regular physical exercise, which in KKL includes specialised methods, such as a triangular model of dynamic aerobic exercise, synchronized cardiorespiratory rehabilitation (the G-I-O program) (Fras et al., 2019), and exercise in the sitting position for cardiovascular patients with locomotor disability.

Another important task of the KKL is prevention of cardiovascular events through lifestyle changes and risk factor control. In a recent systematic assessment of the management of cardiovascular risk factors in members of KKL we found a good control of blood pressure and blood sugar. Further, the number of smokers among the members was very small. On the contrary, body weight and cholesterol levels were not controlled sufficiently since only 16% of patients achieved a low-density lipoprotein (LDL) cholesterol level below 1.8 mmol/L, which was the target value for secondary prevention at the time of the analysis. Among the patients who had had myocardial infarction, 24% achieved this target (Rakar & Simpson Grom, 2020).

It is known that LDL cholesterol plays a key role in atherosclerosis, thus controlling this risk factor is very important in the prevention of CVD, as emphasised in the current guidelines of the European Society of Cardiology. According to these guidelines, a serum level of LDL cholesterol below 1.4 mmol/L is recommended for patients with coronary artery disease. The key measures to achieve this goal are a healthy diet and the use of appropriate medications (Visseren et al., 2021).

It has been shown that patients with CVD have higher serum levels of lipoprotein(a) than persons without CVD and several prospective studies confirmed that an elevated level of lipoprotein(a) is a risk factor for atherosclerotic CVD (Danesh et al., 2000, Kronenberg et al., 2022). While the relationship between lipoprotein(a) concentration and cardiovascular outcomes is linear, a threshold of 300 mg/L, which indicates a clinically significant increase in

CVD risk, has been suggested for persons without previous cardiovascular events (Kronenberg et al., 2022). An elevated level of lipoprotein(a) has been shown to be associated with an increased risk of cardiovascular events also in individuals with established atherosclerotic cardiovascular disease (Berman et al., 2024).

Patient activation, which describes the knowledge, skills, and confidence a person has in managing their health and healthcare, is an important aspect of self-management for adults with chronic health conditions. The Patient Activation Measure (PAM) has become the most used tool to measure this parameter (Hibbard et al., 2005, Roberts et al., 2016).

This study aims to evaluate the effects of an additional educational rehabilitation program on the control of blood lipids and on self-management ability in persons with increased cardiovascular risk or stable cardiovascular disease who were included in a comprehensive rehabilitation program in the KKL.

METHODS

Participants

All members of the KKL with stable coronary disease (at least 6 months since myocardial infarction or at least 3 months since percutaneous or surgical revascularization of coronary arteries) and members without established atherosclerotic cardiovascular disease but with increased cardiovascular risk (because of the presence of risk factors such as arterial hypertension or hypercholesterolemia) were invited to join a structured program for the management of cardiovascular risk factors with an emphasis on lipid control. The exclusion criteria were: severe or uncontrolled heart failure, uncontrolled heart rhythm disorders, severe or uncontrolled heart valve disease, recent inflammation of cardiac muscle (less than 6 months ago) or pericardium (less than 3 months ago).

The study was approved by the National Medical Ethics Committee (no. 0120-43/2022/4) and was conducted in accordance with the Declaration of Helsinki. The participants were informed about the study procedures and provided written informed consent prior to inclusion into the study.

Interventions

The participants were included in a ten-month (from 2022 to 2023) structured program for the management of cardiovascular risk factors with an emphasis on lipid control, which offered the following services:

- individual consultations with a cardiologist focused on the management of cardiovascular risk factors, especially blood lipids (15 minutes each);
- workshops with a cardiologist on the importance of lipid control and taking medication (1 hour each);
- stress management workshops (1 hour each);
- nutrition workshops with a clinical dietitian (1 hour each).

Participation in these activities was optional.

All participants continued with their regular rehabilitation exercise (twice a week for 45 minutes), which included specialized methods, such as a triangular model of dynamic aerobic exercise, the G-I-O program, or exercise in the sitting position for cardiovascular patients with locomotor disability. A triangular model of dynamic aerobic exercise is based on the integration of G-I-O elements, elements for mobility of the spine and joints, and elements for strengthening the body using free weights of up to 1 kg or one's own weight. G-I-O is an integrated method, which connects breathing, sensorimotor functions and higher brain processes. It is based on the synchronization of body movements with breathing and was described in detail elsewhere (Fras et al., 2019).

Measured parameters

Data on age, gender, medical history, cardiovascular risk factors (arterial hypertension, diabetes, dyslipidaemia, smoking), and regular drug therapy was gathered. Body weight and height as well as a serum level of lipoprotein(a) were measured at baseline.

Serum lipids (total cholesterol, LDL cholesterol, high-density lipoprotein [HDL] cholesterol, and triglycerides) and glycated haemoglobin (the percentage of haemoglobin that is bound to glucose, which provides a reflection of blood glucose control over a longer period of time) were measured after fasting at baseline and after the ten-month program.

Before and after the program the six-minute walk test was performed to measure aerobic exercise capacity. This test measures the distance that a patient can quickly walk on a flat, hard surface in a period of 6 minutes (ATS, 2002).

At baseline and after the program the participants completed a Short Form of PAM (PAM-13; the Slovenian version), which is a 13-item questionnaire for assessment of the patient's self-reported knowledge, skill, and confidence in the self-management of their health or chronic condition. The PAM survey measures patients on a 0–100 scale and segments them into one of four activation levels along an empirically derived continuum, where 1 and 4 denote the lowest and highest level of patient activation, respectively (Hibbard et al., 2005).

Statistical analysis

The data was summarized with descriptive statistics. Differences between 2023 and 2022 (value in 2023 minus value in 2022) were tested using the nonparametric Wilcoxon test for dependent samples in the case of not normally distributed data (e.g. serum lipids, glycated haemoglobin, the PAM score) or the t-test for dependent samples in case of normally distributed data (e.g. the six-minute walk test).

Since the values of lipoprotein(a) were not normally distributed, Spearman's correlation was used to evaluate the association between lipoprotein(a) and the numerical variables. To evaluate the association between lipoprotein(a) and the categorical variables, the non-parametric Wilcoxon test for independent samples (in case of two samples) or the Kruskal-Wallis test (in case of more than two samples) was used.

The association between the PAM score and the studied parameters of cardiovascular risk was evaluated using Spearman's correlation in the case of numerical variables and the nonparametric Wilcoxon test for independent samples in case of categorical variables.

The programs IBM SPSS Statistics for Windows and Microsoft Excel were used for data analysis.

Since a large number of statistical tests can increase the chance of making a type I error, the calculated p-values should be understood in a descriptive sense. Thus, the performed statistical analysis is of an exploratory nature, which means that the results can be interpreted in terms of hypothesis generation and not hypothesis confirmation.

RESULTS

Participant characteristics

A total of 146 patients were enrolled in the study, 98 (67%) of whom were females. The median age of the participants was 74.0 years (interquartile range [IQR], 69.8-79.0). The median body mass index (BMI) was 27.1 kg/m^2 (IQR, 24.9-29.0).

The most frequently reported diagnoses were myocardial infarction (30.8%), arterial hypertension (29.5%), heart failure (25.3%) and hypercholesterolemia (21.2%). More than a third of patients (38.4%, N=56) belonged to the very high cardiovascular risk category. At baseline, 55 patients (37.7%) were receiving lipid-lowering medications.

Participation in the program activities

Of 146 included patients, 84 participated in at least one program activity, while 62 did not participate in any activity. The numbers of patients who participated in workshops and individual consultations are shown in Table 1.

Table 1. Participation in workshops and individual consultations.

Activity	Number of participants
Individual consultation with a cardiologist	20
Workshop with a cardiologist	59
Stress management workshop	16
Nutrition workshop	43

Changes of the measured parameters

A slight decrease was seen in the following parameters: total cholesterol, HDL cholesterol, triglycerides and glycated haemoglobin ($p<0.05$) (Table 2).

Table 2. Measured parameters before (2022) and after (2023) the ten-month structured program for the whole group of participants (N=146).

Variable	2022	2023	P-value*
Total cholesterol (mmol/L)	4.2 (3.5-5.3)	4.1 (3.4-5.2)	0.026
LDL cholesterol (mmol/L)	2.5 (1.8-3.4)	2.2 (1.7-3.5)	0.081
HDL cholesterol (mmol/L)	1.3 (1.1-1.6)	1.3 (1.1-1.5)	0.002
Triglycerides (mmol/L)	1.1 (0.9-1.4)	1.0 (0.8-1.4)	0.012
Glycated haemoglobin (%)	5.6 (5.3-5.9)	5.5 (5.3-5.9)	0.002
Six-minute walk test (m)	512 (451-584)	512 (455-603)	0.981
PAM score (points)	58.1 (51.0-70.2)	60.6 (51.0-67.8)	0.261

Notes. All variables are expressed as medians and interquartile ranges. *For the difference between 2023 and 2022. PAM, Patient Activation Measure.

LDL cholesterol

In the whole group of participants, the median LDL cholesterol level decreased from 2.5 mmol/L (IQR, 1.8-3.4) in 2022 to 2.2 mmol/L (IQR, 1.7-3.5) in 2023, but the difference was not statistically significant (p=0.081) (Table 2). The number of participants who achieved the target level of LDL cholesterol for secondary prevention of CVD (below 1.4 mmol/L) increased from 13 (8.9%) to 16 (11.0%) (Table 3).

Table 3. Number of participants in different LDL cholesterol categories in 2022 and 2023 (N=146).

LDL cholesterol (mmol/L)	2022 N (%)	2023 N (%)
<1.4	13 (8.9)	16 (11.0)
1.4-2.6	62 (42.5)	67 (45.9)
2.7-3.6	36 (24.7)	30 (20.5)
>3.6	35 (24.0)	33 (22.6)

In the subgroup of participants who were at very high cardiovascular risk (N=56) the median LDL cholesterol level decreased from 1.9 mmol/L (IQR, 1.6-2.6) to 1.8 mmol/L (IQR, 1.5-2.2), which was not statistically significant (p=0.128).

In the participants who attended individual consultations or workshops within the program, a significant decrease in LDL cholesterol levels was observed, while LDL cholesterol levels did not decrease in persons who did not participate in these additional activities (Table 4).

Table 4. Levels of LDL cholesterol in 2022 and 2023 according to the participation in different activities.

Activity	**Number of participants**	**LDL cholesterol (mmol/L)**		**P-value***
		2022	**2023**	
Individual consultation with a cardiologist	20	3.7 (2.1-4.4)	3.1 (1.8-4.0)	0.001
Workshop with a cardiologist	59	2.6 (1.8-4.0)	2.0 (1.6-3.3)	<0.001
Stress management workshop	16	2.7 (1.8-3.5)	2.2 (1.7-3.3)	0.010
Nutrition workshop	43	2.6 (1.8-3.7)	2.0 (1.6-3.0)	<0.001

Notes. Values of LDL cholesterol are expressed as medians and interquartile ranges. *For the difference between 2023 and 2022.

Lipoprotein(a)

The median level of lipoprotein(a), which was measured at baseline in 144 participants, was 23 nmol/L (IQR, 10-103). Forty-eight participants (33.3%) had a lipoprotein(a) level above 64 nmol/L, which was the laboratory reference value associated with a significantly increased cardiovascular risk. There were no statistically significant associations between lipoprotein(a) and other laboratory parameters.

PAM score

A total of 123 participants completed the PAM questionnaire. The median PAM score was 58.1 (IQR, 51.0-70.2) in 2022 and 60.6 (IQR, 51.0-67.8) in 2023, but the difference was not statistically significant (p=0.261) (Table 1). During the study the number of participants in PAM level 1 decreased and the number of participants in PAM levels 2 and 3 increased (Table 5).

Table 5. Number of participants in each PAM level in 2022 and 2023 (N=123).

PAM level	2022 N (%)	2023 N (%)
1	9 (7.3)	1 (0.8)
2	37 (30.1)	39 (31.7)
3	51 (41.5)	57 (46.3)
4	26 (21.1)	26 (21.1)

The PAM score varied based on cardiovascular risk in 2022. Very high-risk patients (N=45) had higher median PAM score than high-risk patients (N=78) (60.6; IQR, 55.6-80.9 versus 55.6; IQR, 51.0-65.5; p=0.018). There was no difference in median PAM score based on cardiovascular risk in 2023. The median PAM score increased significantly in high-risk patients (from 55.6; IQR, 51.0-65.5 to 60.6; IQR 51.0-65.5; p=0.018).

No statistically significant change in PAM score was observed in subgroups of participants who attended individual consultations or workshops within the program.

DISCUSSION

A significant decrease in LDL cholesterol was observed in our patients after taking part in a ten-month structured program for the management of cardiovascular risk factors. This suggests that individual consultations in combination with workshops providing education on the importance of reaching LDL cholesterol targets and healthy eating may be helpful in lipid management. The number of participants in our study who achieved the target level of LDL cholesterol for secondary prevention of CVD (below 1.4 mmol/L) increased from 13 (8.9%) to 16 (11.0%). In the international cross-sectional survey EUROASPIRE V, which included coronary patients and was conducted also in Slovenia, LDL cholesterol below 1.8 mmol/L (the target level for secondary prevention of CVD at the time of the survey) was achieved by 29% of subjects (Kotseva et al., 2019). In our study, LDL cholesterol below 1.8 mmol/L was achieved by 45 participants (30.8%) before and 49 participants (33.6%) after the structured program.

Forty-eight participants (33.3%) in our study had a lipoprotein(a) level above 64 nmol/L, which was the laboratory reference value indicating a significantly increased cardiovascular risk. Studies have confirmed that elevated lipoprotein(a) levels are associated with an increased risk

of cardiovascular events also in patients with coronary heart disease (Shiyovich et al., 2023, Zhang et al., 2023). However, the comparability between the studies is limited due to different lipoprotein(a) assays, measurement units (mg/dL or nmol/L) and cut-off values used. Lipoprotein(a) concentration is predominantly determined by genetics and can be only minimally influenced by lifestyle interventions. According to European Atherosclerosis Society recommendations, a high lipoprotein(a) concentration should be interpreted in the context of other risk factors and absolute global cardiovascular risk, and addressed through intensified risk factor management (Kronenberg et al., 2022).

Patient activation was associated with health outcomes in published studies. Patients with acute decompensated heart failure with lower activation more often required skilled care and had higher 30-day mortality compared to patients with higher activation (Dunlay et al., 2017). Similarly, hospital survivors of an acute coronary syndrome with the lowest level of patient activation were more likely to experience clinically meaningful declines in generic mental and disease-specific health-related quality of life compared with the most highly activated patients in the 6 months following hospital discharge (Erskine et al., 2018). At the beginning of our study, very high-risk patients had higher activation, indicated with higher median baseline PAM score, than high-risk patients (60.6 versus 55.6). This difference in baseline PAM score could be explained by the fact that the subgroup of very high-risk patients mainly included patients after myocardial infarction, who had already undergone the second phase of cardiac rehabilitation and were therefore better equipped to take care of their health. During the study, the median PAM score increased only in high-risk patients (from 55.6 to 60.6), in whom it reached the same level as it had been measured in very high-risk patients. Compared to our results, higher PAM scores were found in the study from United Kingdom, which included patients participating in routine cardiac rehabilitation, using a customisable telemetry system; participating in this rehabilitation program led to an increase in median PAM score from 65.5 to 70.2 (Frith et al., 2021). In a study from Denmark, which compared two different models of coronary patient education to each other, mean PAM scores of 64.47 and 64.95 were achieved (Pedersen et al., 2022).

Limitations

The present study has some limitations. First, the sample size was relatively small. Second, the majority (67%) of participants were women although in general population age-standardized rates of both morbidity and death from CVD are higher in men than in women (Townsend et

al., 2022). Third, members of KKL, who participated in the study, belonged to a selected population of patients with high awareness of CVDs. These are the reasons why the generalizability of our findings to a general population of patients with CVD is limited.

CONCLUSION

We have shown that an additional educational program can improve lipid control and patient activation in subjects who are included in the third phase of cardiac rehabilitation. However, as the majority of our participants still did not reach their target levels of LDL cholesterol at the end of the program, more studies are needed to explore additional measures for improving lipid control in subjects with an increased cardiovascular risk in a real-life setting. Since our sample of participants represent only a small part of the whole population of cardiovascular patients, the question remains if this approach could be successfully applied to a broader population. This warrants further research.

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Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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