Clinical Medicine Insights: Cardiology

ORIGINAL RESEARCH

Exercise in a Healthy Heart Program: A Cohort Study

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Objective: To assess the effects of exercise on resting heart rate (RHR), weight, lipid profile, and blood pressure. We hypothesized that the participants who increased their physical activity would show improvement in their cardiovascular risk factors compared to those who did not.
Design: Retrospective chart review over the mean duration of 4.9 years of follow-up.
Setting: Healthy Heart Program Prevention Clinic at St. Paul's Hospital, Vancouver, British Columbia, Canada.
Participants: We reviewed 300 charts of patients randomly selected from those who attended the Prevention Clinic between 1984 and 2009. 248 (82.7%) patients were referred for primary prevention and 52 (17.3%) for secondary prevention.
Primary and secondary outcome measures: Weight, RHR, lipid profile, and blood pressure were recorded at the initial and last visit.
Results: During a mean of 4.9 years of follow-up, 55% of participants improved their exercise. The mean decrease in the RHR for these patients (group 1) was 5.9 beats per minute (bpm) versus the mean increase of 0.3 bpm for the "no change" group (group 2) ($P < 0.01$). The mean net weight increase in group 1 was 0.06 kg/year versus 0.25 kg/year in group 2. Because of medications, all patients had a significant improvement in their lipid profiles. Furthermore, there was a statistically significant greater reduction in Framingham Risk Score (FRS) in group 1 versus group 2 (11.8% versus 15.1%, $P < 0.01$).
Conclusion: Participation in the program significantly reduces modifiable risk factors for cardiovascular disease. Improved exercise regimen results in lower RHR and greater reduction in FRS. However, even in a Prevention Program, despite strong advocacy of the importance of exercise, a significant percentage of participants does not improve their exercise habits.

Keywords: exercise, resting heart rate, lipid profile, body weight, cardiovascular disease, Framingham risk score

Clinical Medicine Insights: Cardiology 2013:7 145–151

doi: 10.4137/CMC.S12654

This article is available from http://www.la-press.com.

Introduction

The Healthy Heart Program (HHP) at St. Paul's Hospital in Vancouver, Canada consists of three components clinics—the Cardiac Rehabilitation Clinic, the Metabolic Syndrome Clinic, and the Prevention Clinic. Cardiac rehabilitation helps patients who have undergone percutaneous coronary intervention (PCI) and cardiac surgery through cardiovascular (CV) risk reduction education and counseling, as well as an exercise program. Similarly, the Metabolic Syndrome Clinic provides exercise programs to help patients lower their risk from both heart disease and diabetes. The Prevention Clinic focuses on managing modifiable CV risk factors, namely smoking, obesity, physical inactivity, hyperlipidemia, diabetes, and high blood pressure[1] thus reducing CV risk by lifestyle modifications and, when needed, medications in individuals referred for both primary and secondary prevention of cardiovascular disease (CVD). All patients are assessed by a clinic team consisting of a nurse, a dietician, and a physician.

A number of studies have confirmed an association between physical inactivity and coronary heart disease (CHD).[2] Regular physical activity (eg, 5 times a week for at least 30 minutes) improves lipid profile, reduces blood pressure, and reduces the likelihood of developing diabetes.[3–5] Furthermore, regular physical activity reduces resting heart rate (RHR). Numerous studies have shown a strong positive relationship between RHR and CV mortality.[6–15] An elevated heart rate may promote atherosclerosis, cardiac ischemia, cardiac hypertrophy, and eventually, heart failure.[8–10] Nauman et al found that, especially in females, high RHR was associated with higher risk of death from ischemic heart disease. The risk of dying from CVD rose 18% for every 10 beats per minute (bpm) increase in resting heart rate.[15] Current recommendations are for at least 150 minutes of moderate- to vigorous-intensity aerobic physical activity per week, in bouts of 10 minutes or more.[16]

In this study, we assessed the effects of improved physical activity on the changes in the RHR, weight gain, lipid profiles, blood pressure, and Framingham Risk Score (FRS) of patients participating in our program.

Methods

Retrospective chart review

After approval by the St. Paul's Ethics committee, charts from 528 patients that attended the clinic between 1984 and 2009 were randomly selected from the HHP Prevention Clinic database. This review provided the data from the patients' initial and last visits. RHR was recorded at each visit after at least 5 minutes of rest in a sitting position. Heart rate was measured by palpation of the radial pulse over a period of 30 seconds. Charts with missing heart rate data or from subjects who were on medications or had conditions that affect the heart rate were excluded, leaving 300 charts (202 males and 98 females). The database also included anthropometric, demographic, and clinical characteristics data, including the diagnosis, lipid lowering medications, other medication history, laboratory values, and interventions initiated at the clinic. Framingham risk score (FRS) was calculated at the initial and last visits using patients' mean age during the period of follow-up.[17–19] Data regarding the patients' exercise status were also collected at each visit. Physical activity was assessed semi-quantitatively using the FITT (frequency, intensity, time, and type) principle. The exercise (at least 30 minutes of moderate intensity physical activity a day) was ranked on a scale from 0–2 (0 = none, 1 = 1 – 4x/week, and 2 = >4x/week). The patients who increased their physical activity by one point on the scale (up from the initial visit) were categorized as the improved group (group 1), while those who remained at the same level or decreased their activity were included in group 2. To promote the patients' healthy lifestyles and compliance with the exercise regimen, they were encouraged to follow the 0-5-30 principle, namely no smoking, five servings of vegetables/fruits a day, and exercise at least 30 minutes a day.

Plasma lipid levels were measured by standardized enzymatic methods in accredited laboratories in British Columbia. Patients of our clinic require a referral from their family physician or a specialist. Initial patient visit includes an interview with a nurse, dietitian, and physician. During the entire period of follow-up (usually at 6 month intervals), individual education and support and guidance are offered to help patients improve their lifestyle.

Statistical analysis

Continuous variable characteristics were expressed as a mean and standard deviation, while dichotomic traits were expressed as a frequency. Means were compared using a 2-tail Student's *t*-test and Analysis

of Variance (ANOVA) test. The Student's *t*-test was performed on data that was confirmed to have Gaussian distribution. All statistical analyses were carried out using SPSS 12.0 software package (SPSS Inc., Chicago, IL, USA). All the tests of statistical significance were two-sided, with a 95% confidence interval; a *P*-value < 0.05 was considered to be statistically significant.

Results

As shown in Table 1, the mean age of the patients was 60 ± 15.1 years. There were 202 men (67.3%, mean age of 58 ± 13.3 years) and 98 women (32.7%, mean age of 63 ± 18 years). 248 patients (82.7%) were referred for primary prevention and 52 (17.3%) for secondary prevention based on their history of CVD. There were no significant differences in the history of smoking, hypertension, family history of premature CVD, and use of medications between the two groups (Table 1). However, the incidence of diabetes was higher in HHP participants whose exercise pattern did not change (group 2) compared to those who increased their physical activity (group 1). Interestingly, more patients (61.5%) in group 2 exercised 1–4 times weekly compared to 46.1% in group 1 at baseline, but they remained at this or an even lower level (Table 1) during the follow-up period (4.9 years).

Table 1. Characterization of the population of patients referred to Healthy Heart Program Prevention Clinic on admission.

	Group 1	Group 2
Gender		
M	116	136
F	49	29
Age (yrs) means ± SD		
60 ± 15.1	59.3 ± 16.2	63.1 ± 14.9
Primary prevention	136	112
Secondary prevention	29	23
History of smoking	32.1%	31.9%
Hypertension	15.2%	12.6%
Diabetes	6.1%	20.7%
Family history of premature CVD	18.8%	21.5%
Frequency of physical activity		
<1 times/week	43.0%	27.4%
1–4 times/week	46.1%	61.5%
>4 times/week	10.9%	11.1%
Medications	–	–
Statins	31.5%	34.1%
Fenofibrates	13.3%	11.8%
Follow-up time (yrs) means ± SD		
4.9 ± 3.9	5.1 ± 4.0	4.8 ± 3.8

Notes: Group 1: Improved exercise group; Group 2: Non-improved exercise group.
Abbreviations: M, male; F, female; kg, kilogram; RHR, resting heart rate; CVD, cardiovascular disease.

Table 2 summarizes the differences in the studied parameters between the two groups at the initial and at the last clinic visit. Of a total of 300 participants, 56% of men and 50% of women improved their physical activity. Overall 55% of participants improved their physical activity. In group 1, there were significant differences in the RHR and lipid profiles (a mean low-density lipoprotein [LDL]-C decrease of 0.8 mmol/L, a mean high-density lipoprotein [HDL] increase of 0.14 mmol/L, and a mean triglyceride decrease of 1.0 mmol/L) and blood pressure (a mean systolic and diastolic pressure decrease of 4 mmHg, respectively) between the first and last visit. There was a trend for better weight control in group 1 compared to group 2 (a mean weight increase of 0.064 kg/year versus 0.25 kg/year). However, there was a statistically significant difference in RHR at the last visit between the two groups (a mean decrease of 5.9 bpm in group 1 versus a mean increase of 0.3 bpm in group 2) (Table 2).

We further analyzed the data according to gender and age in group 1. There were some basic differences between the male and female groups. As shown in Table 3, women tend to have lower body weight, faster RHR, higher HDL levels, and lower blood pressure. While exercise had the same significant effect on the RHR in both men and women, men had more favorable responses in lowering their total and LDL cholesterol and raising HDL cholesterol (Table 3). There was a statistically significant difference in diastolic blood pressure at the last visit between the male and female groups. Younger (<60 years old) and older (≥60 years) individuals benefited equally from improved exercise pattern. There were no statistically significant differences between the two age groups (data not shown). We calculated FRS at the first and the last visit for the participants in whom all the appropriate data were available (76%). As shown in Table 4, there was a statistically significant decrease in the risk score from a mean of 15.7%–13.4%. Although both groups showed marked decrease in the risk score, group 1

Table 2. Changes in weight, RHR, lipid data, and blood pressure between the initial and last visit.

	Group 1 (n = 165)			Group 2 (n = 135)		
	First visit	Last visit	Change	First visit	Last visit	Change
Weight (kg/4.9 yrs)	83.2 ± 14.5	83.5 ± 16.7	0.3 ± 23.0 (n = 139)	81.03 ± 16.86	82.23 ± 15.59	1.4 ± 22.8 (n = 91)
RHR (bpm)	72.0 ± 8.7	66.7 ± 7.0§§	–5.9 ± 10.6** (n = 165)	70.9 ± 8.3	70.8 ± 8.6	0.3 ± 12.3 (n = 111)
TC (mmol/L)	6.9 ± 2.5	5.6 ± 1.5	–1.1 ± 2.7** (n = 139)	6.6 ± 1.7	5.6 ± 1.7	–0.9 ± 2.8** (n = 90)
LDL (mmol/L)	4.2 ± 1.7	3.3 ± 1.3	–0.8 ± 2.0** (n = 111)	4.2 ± 1.5	3.4 ± 1.6	–0.7 ± 2.4* (n = 68)
HDL (mmol/L)	1.2 ± 0.5	1.3 ± 0.4	0.1 ± 0.6** (n = 140)	1.2 ± 0.5	1.3 ± 0.4	–0.03 ± 0.7 (n = 83)
TG (mmol/L)	3.6 ± 5.1	2.3 ± 2.4	–1.0 ± 4.4** (n = 139)	3.3 ± 3.9	2.6 ± 2.8	–0.5 ± 5.0 (n = 90)
Blood pressure (mmHg)						
Systolic	126 ± 17	122 ± 17	–4 ± 17** (n = 163)	124 ± 15	124 ± 15	0 ± 15 (n = 133)
Diastolic	79 ± 11	75 ± 10	–4 ± 12** (n = 163)	78 ± 11	75 ± 11	–3 ± 12** (n = 133)

Notes: Data shown represent means ± SD. *$P < 0.05$, **$P < 0.01$, first vs. last visit; §§$P < 0.01$, group 1 vs. group 2. The mean duration for patient follow-up was 4.9 years. Group 1: Improved exercise group; Group 2: Non-improved exercise group.

Table 3. Changes in weight, RHR, lipid data, and blood pressure for men and women in group 1.

	Male (n = 116)			Female (n = 49)		
	First visit	Last visit	Change	First visit	Last visit	Change
Weight (kg/4.9 yrs)	87.5 ± 14.5	88.2 ± 14.9	0.9 ± 6.8 (n = 98)	73.4 ± 14.2§§	73.0 ± 15.7§§	0.2 ± 6.5 (n = 45)
RHR (bpm)	71.7 ± 7.8	66.3 ± 7.2	–5.4 ± 9.4** (n = 116)	74.5 ± 8.1§	67.5 ± 6.6	–7.0 ± 9.2** (n = 49)
TC (mmol/L)	6.5 ± 2.4	5.3 ± 1.3	–1.29 ± 2.5** (n = 99)	7.1 ± 1.9	6.0 ± 1.6§§	–1.1 ± 2.0* (n = 47)
LDL (mmol/L)	4.2 ± 2.4	3.2 ± 1.2	–0.6 ± 1.3** (n = 78)	4.5 ± 1.8	3.6 ± 1.4§§	–0.9 ± 1.8** (n = 48)
HDL (mmol/L)	1.1 ± 0.3	1.2 ± 0.4	0.1 ± 0.3** (n = 97)	1.4 ± 0.5§§	1.5 ± 0.4§§	0.1 ± 0.4* (n = 42)
TG (mmol/L)	3.7 ± 4.1	2.3 ± 2.1	–1.5 ± 4.1** (n = 99)	3.0 ± 3.0	2.4 ± 3.2	–0.5 ± 5.0 (n = 46)
Blood pressure (mmHg)						
Systolic	129 ± 16	124 ± 14	–5 ± 17** (n = 114)	121 ± 18§§	120 ± 20	–1 ± 17 (n = 49)
Diastolic	80 ± 9	76 ± 8	–4 ± 11** (n = 114)	76 ± 12§§	70 ± 11§§	–6 ± 12** (n = 49)

Notes: Data shown represent means ± SD. *$P < 0.05$, **$P < 0.01$, first vs. last visit; §$P < 0.05$, §§$P < 0.01$, male vs. female. The mean duration for patient follow-up was 4.9 years. Group 1: improved exercise group.

Table 4. Framingham 10-year risk scores calculated at the 1st and last Visits.

	1st visit	Last visit	Change
Overall (n = 228)	15.7 ± 9.8	13.4 ± 9.3	2.3 ± 5.5**
Group 1 (122)	14.7 ± 9.7	11.8 ± 8.6§§	2.9 ± 5.9**
Group 2 (106)	16.8 ± 9.9	15.1 ± 9.8	1.63 ± 5.1**
Men (n = 151)	18.1 ± 9.6	15.6 ± 9.4	2.4 ± 5.7**
Women (n = 77)	11.0 ± 8.5	8.9 ± 7.3	2.1 ± 5.2**
>60 yrs (n = 80)	22.3 ± 8.4	19.7 ± 8.5	2.6 ± 5.7**
<60 yrs (n = 148)	12.1 ± 8.6	9.9 ± 7.8	2.2 ± 5.5**
Patient with CAD (n = 39)	15.1 ± 10.3	14.2 ± 9.9	1.0 ± 4.8
Patient without CAD (n = 189)	15.8 ± 9.7	13.2 ± 9.2	2.6 ± 5.7**

Notes: Data shown represent means ± SD. **$P < 0.01$, first visit vs. last visit; §§$P < 0.01$ group 1 vs. group 2. The mean duration for patient follow-up was 4.9 years. Group 1: Improved exercise group; Group 2: Non-improved exercise group.

benefited significantly more (11.8% versus 15.8%, $P < 0.01$). In contrast to men, whose mean 10-year risk score declined from 18.1% to 15.6%, women had slightly lower risk score reduction (from 11.0% to 8.9%). This risk reduction between the first visit and the last visit was statistically significant in both the older (above or equal to 60 years old, from 22.3% to 19.7%) and in the younger patients (below 60 years old, from 12.1% to 9.9%). Furthermore, a significant reduction from 15.8% to 13.2% was observed in the primary prevention group. For the secondary prevention cohort, the risk score reduction was not statistically significant (Table 4).

Discussion

Exercise is a key component of therapeutic lifestyle. It has been proven that overall CV risk can be reduced significantly by exercise alone.[20] A classic study that compared the risk of myocardial infarction between bus drivers and bus conductors found that the physically active conductors had 33% fewer cardiac events.[21] Multiple benefits from exercise (or any increase in physical activity) have been identified, including increased survival rates,[22] weight loss, maintenance of lean body mass, blood pressure reduction, increase in HDL-C, improvement in insulin sensitivity, slowing or prevention in the onset of diabetes, improved endothelial function, and reduced systemic inflammation.[23–26] Larson-Meyer et al showed that blood pressure, total cholesterol, LDL, and insulin resistance only improved significantly in the caloric restriction and exercise group compared to caloric restriction only group.[27] Furthermore, most recent prospective cohort studies have demonstrated that improved physical activity has a beneficial effect on reducing the incidence of CHD and stroke.[28]

Our study focused on the effects of improved physical activity on the participants' change in RHR, weight, lipid profile, and blood pressure. We demonstrated that, compared to the program participants who did not improve their physical activity, those who did significantly decrease their RHR. There were no significant differences in the other risk factors which may be related to drug treatment. However, there was a trend to a lower annual weight gain found in the improved exercise group compared to the general Canadian population (which happened even in the group of the participants who did not improve their physical activity) (Fig. 1).[29] Of interest is the fact that group 2 individuals were, on average, more active at baseline. This suggests a possibility that it was easier for those in group 1 to improve. The findings of difference in systolic blood pressure and diastolic blood pressure between men and women in our study are consistent with other reports.[30] While there was a significant decrease in blood pressure in the men of group 1, only diastolic blood pressure was decreased in women. We speculate that this could be related to their baseline differences (Table 3). The effects of improved physical activity were similar in both young (<60 years of age) and older (≥60 years) patients (data not shown). More importantly, enhanced exercise improved CV risk factors calculated by FRS (Table 4) in group 1 compared to those who did not improve their exercise pattern. Despite repeatedly advocating the importance of regular exercise, only about 50% of participants improved their exercise pattern. Thus, regular exercise needs to be repeatedly stressed and evaluated when recommending lifestyle changes.

Limitations

First, patients who were on beta-blockers at any stage were excluded from the study to avoid the effect of these medications on heart rate. Second, although comparable numbers of patients were on lipid-lowering medications, we do not have specific data on the strength or variety of lipid-lowering medications

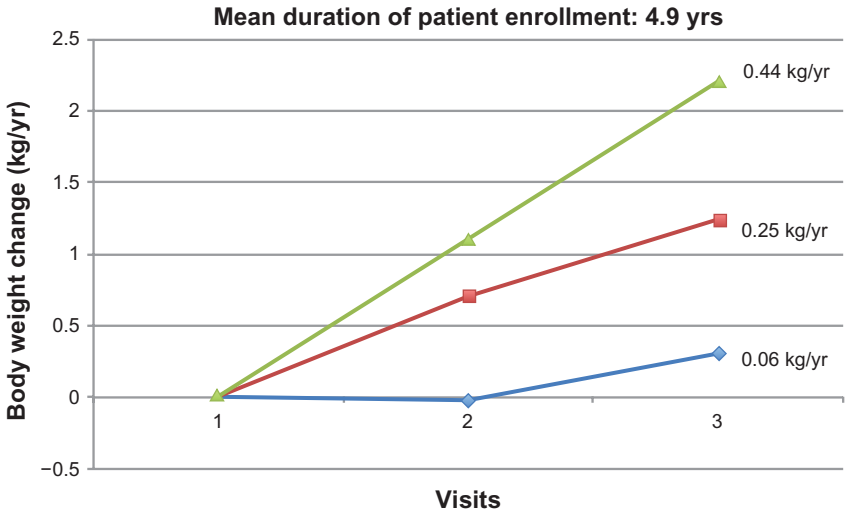

Figure 1. Represents the differences in weight gain rates for the Patients with Increased Exercise Pattern group (blue), the Everyone Else group (red), and the average Canadian adult weight gain (green). Weight change was measured in kg/yr. The visits correspond to the patient's initial visit, second visit and final visit. The mean duration for patient enrollment was 4.9 year.

used in the two groups. Third, the participants did not follow a specific diet. However, the dieticians in the program give standard instructions and advice to all patients. Fourth, the data on exercise are only semi-quantitative and were self-reported. Finally, the reason for non-significant FRS change in the secondary prevention group may be due to the relatively small numbers.

Conclusion

Participation in the HHP significantly reduces modifiable risk factors for CVD and lowers 10-year FRS. Improved exercise regimen provides a cost-effective approach for further reduction in CV risk, such as improvements in resting heart rate, better weight control, and improved lipid profile. New ways of stressing the importance of exercise should be considered. Even in a rehabilitation program, despite strongly advocating the importance of exercise a significant percentage of participants do not improve their exercise habits.

A decrease in resting heart rate appears to be a simple and practical way to monitor improvement in patients' exercise regimen. In this real life study, exercise significantly improved FRS, but close to 50% of participants did not change their exercise habits. The fact that improved exercise is associated with decrease in resting heart rate (and decreased CV mortality) should be emphasized to the patient attending the program.

Author Contributions

Conceived and designed the experiments: AAS, JF. Analyzed the data: JM, ML. Wrote the first draft of the manuscript: JM, AAS. Contributed to the writing of the manuscript: ML, JF. Agree with manuscript results and conclusions: JM, AAS, ML, KG, JF. Jointly developed the structure and arguments for the paper: ML, JF. Made critical revisions and approved final version: ML, JF. All authors reviewed and approved of the final manuscript.

Funding

Author(s) disclose no funding sources.

Competing Interests

Author(s) disclose no potential conflicts of interest.

Disclosures and Ethics

As a requirement of publication the authors have provided signed confirmation of their compliance with ethical and legal obligations including but not limited to compliance with ICMJE authorship and competing interests guidelines, that the article is neither under consideration for publication nor published elsewhere, of their compliance with legal and ethical guidelines concerning human and animal research participants (if applicable), and that permission has been obtained for reproduction of any copyrighted material. This article was subject to blind, independent, expert peer review. The reviewers reported no competing interests.

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