'KEEP YOUR HEART MOVING'

Modification in smoking habits, physical activity and bodyweight after myocardial infarction

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'Houd je hart in beweging'

Het aanpassen van rookgewoonten, lichamelijke activiteit en lichaamsgewicht na een hartinfarct

Proefschrift

Ter verkrijging van de graad van doctor
aan de Erasmus Universiteit Rotterdam
op gezag van de Rector Magnificus

Prof. dr. ir. J.H. van Bemmel

en volgens besluit van het College voor Promoties.

De openbare verdediging zal plaatsvinden op
woensdag 26 november 2003 om 11.45 uur
door
Irma Petra Anna Maria Huijbrechts
geboren te 's-Heerenberg

Promotiecommissie

Promotor:	Prof.dr. J. Passchier
Overige leden:	Prof.dr. H.B. van de Wiel
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	Prof.dr. A.P.W.M. Appels
Co-promotoren:	Dr. J.W. Deckers
	Dr. R.A.M. Erdman

Lay-out: Hilly Broer
Omslag: Caesar Breimer

ISBN 90-806027-6-0

Financial support by the Netherlands Heart Foundation for the publication of this thesis is gratefully acknowledged.
The study described in this thesis was supported by a grant of the Netherlands Heart Foundation (NHS nr. 91-117).

Contents

CHAPTER 1

Introduction

Introduction

Despite advanced medical techniques and increased knowledge on the psychosocial and behavioral factors related to coronary heart disease (CHD), this disease remains the leading cause of death in the western world since World War II.
In the 1930s, patients surviving a myocardial infarction (MI) had at least six weeks bed rest followed by restricted physical activity for up to one year. At that time, a return to normal life was considered almost impossible. Therefore, in the 1950s, the armchair therapy proposed by Levine and Lown must have seemed revolutionary in that it required the patient to sit in a chair for one to two hours a day starting the day after the MI (1). Presumably, this treatment was the start of the psycho-behavioral approach to CHD, following the advances in surgical procedures and pharmacological treatments.

Although Levine and Lown did not encourage exercises as part of their new approach, physical activity was long known to be beneficial for both health and psychological well-being. In spite of this common knowledge, the positive relationship between physical activity and CHD in both primary and secondary prevention was only investigated more recently (2, 3). It was not until the 1980s that the important role of regular exercise in the prevention of cardiac disease was confirmed. Namely, it was shown that a sedentary lifestyle was associated with a higher risk of CHD, whereas physical activity results in physiological and psychological benefits for the cardiac patient (2, 4, 5).
The association between another major risk factor, i.e. smoking, and CHD was already investigated in the 1960s. The prospective studies among one million American men and women (6), among 300,000 American men with a life-insurance policy (7, 8), and among 34,000 British physicians (9) all indicated that cigarette smokers were between 1.5 and 2 times more likely to die of CHD than non-smokers. It is therefore not surprising that since that time many studies have focused on the positive effects of smoking cessation on the morbidity and mortality of patients with CHD (10-15).

Obesity has also been a major risk factor for CHD through its indirect effect on hypertension, diabetes and cholesterol level (16, 17). Apart from this, obesity can be considered a unique risk factor for CHD in that many studies have shown a positive association between obesity and the incidence of CHD (18-20) and recurrent coronary events (21). Obesity is mainly related to eating behavior and physical activity.
Thus, in the last decades, apart from the long-established biological and physical risk factors (such as age, gender, blood pressure, cholesterol level and a positive family history of CHD), lifestyle characteristics were also recognized as risk factors related to CHD.

In more recent CHD research, psychological and social characteristics were also considered as risk factors. For example, some personality characteristics (such as anxiety and depression) as well as vital exhaustion, some types of stress, and various behavioral patterns were recognized as being related to CHD. Most studies searching for a coronary-prone personality have focused on the Type A Behavior Pattern, characterized by competitiveness, time urgency and hostility (22). This construct arose from Friedman and Rosenman's observations of the behavior of their cardiac patients during the 1950s (23, 24). After empirical testing in the 1960s, this construct became widely accepted in the 1970s. In the 1980s, however, the validity of the Type A construct has been questioned, as some studies failed to find a strong association between global Type A behavior and CHD (25). Nowadays, Type A behavior is considered to be multidimensional (26). There is no relationship between global Type A behavior and CHD, although some of the dimensions (especially the hostility component) may be positively related to the occurrence of CHD (27, 28). Meanwhile Type B is considered to be prone to secondary cardiac events (26).
Recently, psychological distress has been reported to be associated with increased morbidity and mortality in cardiac patients. The tendency to experience negative affectivity and the propensity to inhibit self-expression in social interaction designates a personality type (Type D) of coronary patients with an increased risk of fatal and

nonfatal cardiac events (29, 30). Type D personality is even considered a predictor of non-response to treatment and poor prognosis after a cardiac event (31).
In summarizing all possible risk factors, it is worth mentioning that the combination of risk factors has a cumulative effect on the prevalence of CHD (32).

Over the years there has been increasing focus on the psychosocial and behavioral components as risk factors for CHD, especially those that are modifiable by the patient. With the growing awareness of the importance of positively influencing the risk factors, cardiac rehabilitation programs started to emerge. In the 1970s rehabilitation centers worked together with hospitals to offer both inpatients and outpatients cardiac rehabilitation programs. Initially, these programs focused on physical activity, but soon developed a multidimensional approach comprising e.g. physical activity, smoking cessation, stress management, Type A behavior modification, and dietary modification. In general, the multidisciplinary approach was reported to have a positive outcome (33, 34). For example, one of the pioneering multi-approach programs, The Lifestyle Heart Trial (35), combined patient education, Type A behavior pattern modification, stress management, relaxation and breathing exercises, physical exercises and dietary changes. This cardiac rehabilitation intervention group was compared with a usual care group. After a one-year follow-up period, the average obstruction of the coronary arteries decreased in the intervention group and increased in the usual care group. Noteworthy is, however, that half of the patients refused to participate in the intervention program because they had to make more effort for that program than they were prepared to do.
These findings suggest that a multidimensional approach gives the patient a modest positive effect (on smoking habits, physical activity and eating habits) (36) or a small objective benefit (lower frequency of angina, usage of medication and physical disability) (37), although it is often highly appreciated by the participants. The effects on psychological aspects (e.g. increase in well-being and reduction in feelings of anxiety) are the underlying reasons for many patients to participate in 'post' cardiac rehabilitation programs after the initial rehabilitation program. This means that they

maintain the regimen of the rehabilitation program together with fellow-sufferers under the supervision of professionals, instead of joining a regular health or sport club.

Why is it that all MI patients in hospitals have good intentions about adapting their lifestyle to prevent another myocardial infarction, yet only few succeed? For example, in the EUROASPIRE survey on secondary prevention in 21 hospitals in Europe, over 90% of the smokers were advised to quit smoking but only 50% stopped their smoking habit (15).
Nowadays, after about 4-7 days a patient is discharged from the hospital, generally with no pain and almost no persisting cardiac symptoms. A few weeks later the patient has returned to his or her old lifestyle, nothing has really changed. In the hospital the cardiologist emphasized the need to quit smoking, increase physical activity or lose some weight. Although these cardiac risk factors were already well known by the patient, the lifestyle habits seem to be stronger than the motivation and will to change. A narrow escape does not seem to be enough to change deeply rooted habits.
Up to now cardiac risk factors have mainly been studied in isolation with little attention paid to the relationship between them. Therefore, the main aim of the studies described in this thesis was to study the interrelationship between modifiable cardiac risk factors (smoking habits, physical activity and Quetelet index) and biographical and personality characteristics in post-myocardial infarction patients.

For this purpose data were collected from post-MI patients using a study design of repeated measurement. We collected data within the limitations of daily clinical practice, with the least extra demands being made on the patients. Three hospitals participated in this study: 1) the University Hospital Rotterdam-Dijkzigt, 2) the Havenziekenhuis, a non-academic hospital in Rotterdam, and 3) the Holy-ziekenhuis, located in Vlaardingen, a small city close to Rotterdam. Considering the population in a cosmopolitan city like Rotterdam compared to a smaller city like Vlaardingen, and

the fact that more complicated patients often are treated in University hospitals, presumably a representative sample of Dutch cardiac patients has been investigated.

Chapter 1 introduces the topic of study and presents an outline of this thesis. The following three chapters explore the influence of personality characteristics on the three main risk factors for CHD.

Chapter 2 investigates the relationship between changes in smoking habits and personality characteristics. Can persistent smokers be differentiated from patients who will stop smoking after their first MI? Differences in biographical and personality characteristics were examined and determined.

Chapter 3 is based on the method described in chapter 2, but focuses on the relationship between physical activity, and biographical and personality characteristics. The aim was to establish to what extent these characteristics have predictive qualities with respect to determining an increase of physical activities after MI. Differences between the various categories of physical activity were determined in relation to personality and biographical characteristics.

Chapter 4 presents an analysis of changes in bodyweight (transformed into the Quetelet index) after MI. The research question is: To what extent do personality characteristics, (apart from biographical aspects) have predictive qualities with respect to a decrease in the Quetelet index five months after a first MI.

Chapter 5 takes a closer look at the underlying structural relationship between the risk factors. Here it is assumed that the different risk factors influence each other and have to be analyzed in combination to investigate the importance of the variables together. Using the Lisrel structural equation modeling technique, a model is constructed including smoking habits, physical activity and Quetelet index jointly.

Chapter 6 presents a study, which was performed to further elucidate earlier findings. The question here is how, and to what extent, do the more physically active patients succeed in changing other important risk factors such as smoking habits and bodyweight. The study group comprised post-MI patients who participated in a

cardiac rehabilitation program and were therefore encouraged to increase their physical activity level.
Finally, *chapter 7* discusses the results and methodological issues, and presents suggestions for future research and clinical practice.

The studies in this thesis have attempted to find the most appropriate and effective way for each cardiac patient to understand and assess their own risk factors and, if necessary, to find the right sequence to change or modify them. This can be beneficial during participation in a cardiac rehabilitation program and in secondary prevention.

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CHAPTER 2

Modification in smoking habits five months after myocardial infarction: relationship with personality characteristics

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(Journal of Psychosomatic Research 1996; 40 (4): 369-378)

Abstract

The relationship between personality characteristics and spontaneous modification in smoking habits was assessed in 164 patients after their first myocardial infarction (MI). Smoking habits before the MI were investigated in retrospect and five months later. Smoking appeared to have decreased significantly. Persistent smokers could be differentiated from non-smokers and ex-smokers by a significantly high level of state-anxiety and depression. Young persistent smokers had a high level of depression; elderly persistent smokers were highly anxious and had a low level of somatization. The relationship between smoking behavior modification and personality characteristics is discussed in association with intervention programs.

Introduction

Cigarette smoking is a risk factor for the development and progression of coronary heart disease (CHD) in the general population (1, 2). Moreover, it is known that smoking cessation in CHD patients leads to an average decrease in mortality (of over 40%) and morbidity (3-8). It is therefore not surprising that many studies have focused on the positive effects that smoking cessation has on morbidity and mortality in patients with CHD. Percentages of patients who stopped smoking after their first MI range from 28 up to 70% (3-7, 9, 10).

One is inclined to wonder why patients persist in smoking after they have had such a specific warning as a MI. A plausible explanation is that deeply rooted habits are not easy to change. From this point of view, the question arises as to whether personality is important in CHD patients who smoke.

Several personality characteristics have been found to be representative of persistent smokers in general (11-14). In a recently published study (11), which described the 20-year follow-up of college men and women, personality measures were used as predictors for smoking initiation and cessation. The results showed that ex-smokers and current smokers were more impulsive, rebellious (recalcitrant), hostile, socially extroverted, sensation-seeking and willing to express their personal faults than non-

smokers. Further, ex-smokers were less hostile and less sensation-seeking than current smokers. People who initiated smoking were more rebellious, impulsive, sensation-seeking, hostile, less likely to present a positive self-image and socially extroverted than non-smokers.

Most of the research conducted in search of a coronary-prone personality has focused on the Type A behavior pattern (15, 16), a construct that arose from Friedman and Rosenman's (17) observations of the behavior of cardiac patients in their private practice during the 1950s. After empirical testing in the 1960s, this construct became widely accepted in the 1970s, but more recently the validity of the Type A construct has been questioned (18). Type A behavior is no longer seen as unidimensional. Some of the dimensions may be relevant to CHD, for example neuroticism (19-22) somatization, low self-esteem, rigidity (23-25); anxiety, depression (20, 22, 26); anger, aggression, hostility (27, 28) and vital exhaustion (reflecting feelings of excess fatigue, general malaise and lack of energy) (29).
Considering the positive relationships between the above-mentioned personality characteristics and CHD; personality characteristics and smoking habits; and smoking habits and CHD, it seems relevant to investigate these characteristics as predictors of smoking habits after MI.

The relationship of smoking and personality characteristics in post-MI patients has not yet been investigated. Therefore, the aim of the present study was to explore the relationship between personality characteristics and smoking behavior modification after a first MI.

Method

Participants

From January 1993 to October 1994, 378 patients who had been admitted to the Cardiology Departments of three different hospitals in Rotterdam for their first MI, were eligible to take part in this study. A total of 260 (68.8%) patients participated in the

investigation (N=89 from the University Hospital Rotterdam Dijkzigt, N=92 from the Havenziekenhuis and N=79 from the Holy-ziekenhuis; no significant differences were found between the three groups). In the group of non-participants, 19 (16.1%) died soon after the MI; 32 (27.1%) refused to participate and in 30 patients (25.4%) participation was emotionally or physically too demanding. A further 37 patients (31.4%) were excluded due to practical problems such as transfer to another hospital. The study group comprised 185 men and 75 women, with an adequate command of the Dutch language, who were not suffering from any other serious physical or psychiatric disorder. The non-participants were similar to the participants regarding gender, but were significantly older than the participants. Patients were recruited while still in hospital.

Measures

Smoking behavior was assessed using a structured interview on current and former smoking habits. Recent studies (30-33) comparing self-reports with biochemical measures have shown that the results for respondents not participating in a smoking cessation intervention program generally appear to be valid.

Personality characteristics were assessed using psychological questionnaires. Neuroticism and Somatization of Neurotic Complaints were assessed by two scales from the 'Amsterdamse Biografische Vragenlijst' (ABV, (34)). The questionnaire has good reliability and acceptable validity (35). Rigidity and Self-esteem were derived from the validated 'Nederlandse Persoonlijkheids Vragenlijst' (NPV, (36)); the reliability is considered to be adequate (35). Anxiety and Depression were assessed with the Hospital Anxiety and Depression scale (HAD, (37)). To register anxiety, state and trait, the 'Zelf Beoordelings Vragenlijst' (ZBV, (38)) was completed by the patients and the 'Zelf Analyze Vragenlijst' (ZAV, (39)) was used to register hostility, state and trait. The reliability and validity of the ZBV and ZAV are good (35). Vital Exhaustion was measured with the 'Maastrichtse Vragenlijst' (MV, (40)), consisting of 23 items. Five mood states were measured with the Profile Of Moods State (POMS, (41)), consisting of 32 items, involving Fatigue, Vigor, Tension, Depression and Anger.

Well-being, Feelings of Disability, Displeasure and Social Inhibition were assessed by the Heart Patients Psychological Questionnaire (HPPQ, (42)) with 52 items; its reliability and validity are acceptable (35).

Procedure

All the patients who were hospitalized for their first MI were given a written invitation to participate in the study by the first author. The aim of the study was explained to them and after informed consent obtained, a structured interview was conducted at the hospital and patients were subsequently asked to complete the psychological questionnaires.

Apart from the regular check-up visits at the cardiology department, the patients were invited back to the hospital to participate in the second measurement approximately five months later. The same structured interview was conducted, in which current smoking behavior was assessed. The POMS, HAD and HPPQ were also completed for the second time. An interval of five months was chosen for the second measurement as a reasonable number of patients had the possibility to participate in a physically oriented cardiac rehabilitation program after discharge from the hospital, lasting about three months. After five months the possible influences of such a program are assumed to be stabilized.

Analysis

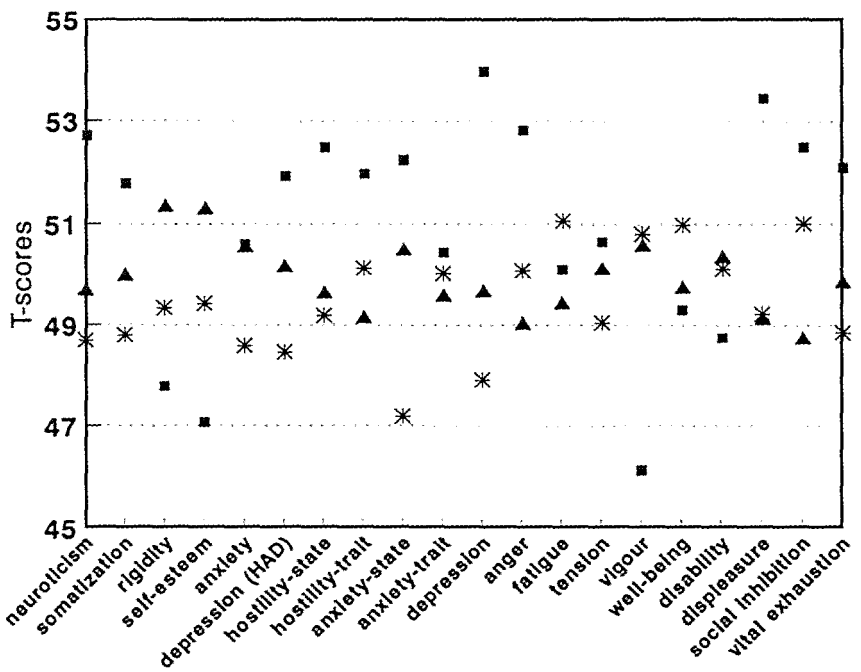
First, subscales for which the percentage of missing data was over fifteen were withdrawn from the analysis; missing values of up to fifteen percent were estimated using the 'predicted mean matching' method (43).

The patient group was divided into three categories: non-smokers who had never smoked (S--), ex-smokers who had stopped smoking after their first MI (S+-) and smokers who were still smoking five months after the MI (S++). These categories of smoking habits formed the independent variables.

The significance of each continuous variable was tested separately using the univariate one-way analysis of variance. Chi-square testing was done for nominal biographical

S++ showed that Cohen's D values for self-esteem and vigor were larger than 0.40, while for displeasure Cohen's D was < -0.40. S+- compared to S++ showed one personality characteristic with a Cohen's D of > 0.40, namely vigor, while state-anxiety, depression (assessed by the POMS) and displeasure had values of lower than -0.40. There were no differences of > 0.40 or < -0.40 between S+- and S--. The results are presented in table 2.

Figure 1. T-scores for personality characteristics with respect to smoking habits



▲ = S--: non-smokers; * = S+-: ex-smokers; ■ = S++: smokers

Table 2: Means, confidence interval and Cohen's D, for the three differentiated categories: S--: non-smokers; S+-: ex-smokers and S++: smokers

		S--		S+-		S++		Cohen's D	Cohen's D	Cohen's D
		μ	95% C.I.	μ	95% C.I.	μ	95% C.I.	S-- – S+-	S-- – S++	S+- – S++
ABV:	• neuroticism	42.61	37.33 to 47.89	40.20	34.06 to 46.34	49.79	40.69 to 58.89	0.10	-0.29	-0.39
	• somatization	19.22	17.80 to 20.64	18.44	16.82 to 20.06	20.38	17.68 to 23.08	0.12	-0.17	-0.28
NPV:	• rigidity	34.93	33.11 to 36.75	33.13	30.65 to 35.61	31.76	28.46 to 35.06	0.21	0.36	0.16
	• self-esteem	29.78	28.50 to 31.06	28.64	27.08 to 30.20	27.24	24.74 to 29.74	0.20	0.40	0.22
HAD:	• anxiety	3.86	3.24 to 4.48	3.31	2.35 to 4.27	4.41	2.99 to 5.83	0.18	0.00	-0.19
	• depression	5.37	4.57 to 6.17	4.64	3.74 to 5.54	5.38	3.86 to 6.90	0.20	-0.17	-0.34
ZBV:	• anxiety-state	38.86	36.62 to 41.10	35.29	32.29 to 38.29	40.72	36.36 to 45.08	0.34	-0.17	-0.49
	• anxiety-trait	35.17	33.11 to 37.23	35.58	32.70 to 38.46	36.00	32.26 to 39.74	0.00	-0.08	-0.04
ZAV:	• hostility-state	11.22	10.60 to 11.84	11.07	10.53 to 11.61	12.17	10.05 to 14.29	0.00	-0.23	-0.27
	• hostility-trait	15.52	14.48 to 16.56	15.98	14.78 to 17.18	16.86	14.92 to 18.80	-0.10	-0.27	-0.17
MV:	• vital exhaustion	7.29	5.97 to 8.61	6.67	5.07 to 8.27	8.66	6.10 to 11.22	0.10	-0.21	-0.31
POMS :	• fatigue	5.32	4.06 to 6.58	6.31	4.43 to 8.19	5.72	3.34 to 8.10	0.00	-0.07	0.10
	• vigor	11.67[a]	10.75 to 12.59	11.76[a,b]	10.64 to 12.88	9.69[b]	7.75 to 11.63	-0.02	0.43	0.44
	• tension	5.47	4.41 to 6.53	4.93	3.65 to 6.21	5.72	3.64 to 7.80	0.11	-0.05	-0.15
	• depression	3.82[a]	2.62 to 5.02	2.76[a]	1.68 to 3.84	6.41[b]	3.11 to 9.71	0.21	-0.37	-0.53
	• anger	4.18	3.16 to 5.20	4.71	3.27 to 6.15	6.14	3.64 to 8.64	0.00	-0.36	-0.36
HPPQ:	• well-being	25.90	24.28 to 27.52	26.82	24.76 to 28.88	25.55	22.65 to 28.45	-0.12	0.05	0.16
	• disability	24.84	23.52 to 26.16	24.69	22.83 to 26.55	23.83	21.25 to 26.41	0.02	0.16	0.13
	• displeasure	15.48	14.60 to 16.36	15.51	14.39 to 16.63	17.34	15.32 to 19.36	-0.01	-0.40	-0.40
	• social inhibition	11.14	10.50 to 11.78	11.84	10.90 to 12.78	12.31	11.13 to 13.49	0.23	-0.38	-0.15

Means on each line with different superscripts were significantly different, while those with the same superscript were not significantly different.

Discussion

Although cigarette smoking is generally accepted as a risk factor for cardiovascular disease, about 40% of the smokers in the present study did not change their smoking habits after their first myocardial infarction (MI). This finding is in line with the literature (3-8). The underlying purpose of this study was to gain an insight into the psychology of persistent smoking after a MI and to explore the relationship of smoking habits after a first MI and personality characteristics. The results showed that the persistent smokers could be distinguished from the non-smokers and the ex-smokers by a high level of state-anxiety (ZBV) and a high depression level (POMS). There was some evidence that the personality characteristics determinant for smoking were modified by age. Hostility did not play a role in this study, although it has been mentioned in the literature as a particular personality characteristic of persistent smokers (11-14).

From prior studies (45, 46) it is known that post-MI patients who entered a smoking cessation intervention program (62% and 69% smoking cessation) had higher rates of smoking cessation than the patients who received usual care (51% and 55% smoking cessation, respectively). In line with our findings, an appropriate method to approach smoking cessation would appear to be an intervention program particularly aimed at smokers with the above-described personality characteristics. Such an intervention program should pay attention to related thoughts and behavior and encourage patients to improve or change in a positive way.

Further, it may be worthwhile to focus on the structure of the motives of cardiac patients to stop or not to stop smoking and, as a consequence, on the development of motivation techniques. Smoking is a consequence of conditioning; it is a way of relaxing in times of stress or nervousness, but it could also be an acquired behavior. For most people, smoking cessation causes a great deal of tension if no alternative is offered to avoid, suppress or cope with feelings of stress. Because cardiac patients in particular are expected to translate (unconsciously) their problems into somatic terms, it could be useful to focus the intervention on their bodily awareness, with for example breathing therapy (47) as an alternative for smoking.

Such an intervention program could operate independently, but it could also be integrated into existing rehabilitation programs. Apart from hospital-based 'quit-smoking interventions' (48), the rehabilitation of CHD patients is nowadays characterized by a multidisciplinary approach with medical, social and psychological aspects (49). In line with this tradition, extra attention should be paid to smokers with the above-mentioned personality characteristics during rehabilitation.

We were able to differentiate the persistent smokers from the other two categories of smokers, but unfortunately not (yet) perfectly. This may be related to the instruments used. As the reliability and validity were satisfactory, this cannot fully explain our findings. Another explanation could be the existence of other, up to now, unknown variables with differential qualities, which require further investigation.

Another restriction of this study is that unfortunately it was impossible to measure how much advice patients were given by their cardiologist or general practitioner to quit smoking after discharge from the hospital. Such advice has at least a small effect but is out of reach of observation. Nevertheless, this possible effect will be equally divided among the three categories.

Further it is well established that smokers are 'economical with the truth' as regards their smoking habits; the deception rate ranges from 16% to 40%, while participating in a smoking cessation program (50, 51). Biochemical measures however, to avoid this problem are not reliable either (31-33). Comparing self-reports with biochemical measurements among respondents not involved in a smoking cessation program gives high correspondence between the different methods. Knowing this, in spite of the shortcomings of the method, a structured interview has been chosen in this study.

In the light of the results of the present study, to supply tailor-made intervention programs to support CHD patients in their endeavor to stop smoking, more attention should be paid to personality characteristics. The effect of such a program on smoking habits after myocardial infarction needs to be studied.

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CHAPTER 3

Modification of physical activity five months after myocardial infarction: relevance of biographic and personality characteristics

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(International Journal of Behavioral Medicine 1997; 4 (1): 76-91)

Abstract

The relationship between modification of physical activity, a risk factor for coronary heart disease, and personality characteristics was assessed in 166 survivors of a first myocardial infarction (MI). Physical activity was assessed before MI in retrospect, and again five months after MI. Patients were divided into three categories according to their current daily-life physical activities: less active than before MI (n=24), equally active as before MI (n=82), or more active than before MI (n=60). A significant differentiation was found between patients who became less physically active than before MI, and the other two categories. This less active category was characterized by feelings of disability, a low level of vigor and feelings of anxiety. In addition, this patient group was, on average, older and more often female. The results were adjusted for participation in a cardiac rehabilitation program. Finally, in the discussion is recommended to involve psychological intervention in the exercise program for the less active category of patients to diminish feelings of anxiety and disability, and to improve vigor.

Introduction

Whether habitual physical activity is associated with the onset and course of cardiovascular diseases has been well investigated (1-5). From these studies it can be concluded that a high frequency of physical activity, performed at equally spaced intervals over a long time span, protects against the development of coronary heart disease (CHD) (6).

The same positive relationship between exercise and CHD was shown in studies on physical activity combined with exercise training in secondary prevention (4, 7-16). The results from several intervention studies indicate that exercise training as part of a rehabilitation program for post-MI patients increases functional capacity (ranging from 23% to 33%), and decreases mortality (ranging from 20% to 37%) (9-11, 13, 17, 18). These data indicate that, participation in a physically oriented cardiac rehabilitation program may be beneficial for cardiac patients, especially after the first cardiac event.

Most of the research conducted to define a coronary-prone personality has focused on Type A behavior pattern (19, 20). Nowadays, Type A behavior is considered to be multidimensional. Some of these dimensions may be positively related to the occurrence of CHD, e.g. neuroticism (21-23); low self-esteem, rigidity (inflexibility) (24-26); anger, aggression and hostility (reflecting irritability, anger, and cynicism) (27, 28). Further, somatization (feelings of physical dysfunction) (24-26); anxiety, depression (21, 22, 29) and vital exhaustion (reflecting feelings of excess fatigue, general malaise and lack of energy) (30) while not being part of the generally accepted Type A construct are found to be associated with CHD.

No study on post-MI patients has investigated the relationship between modification of physical activity on the one hand and biographic and personality characteristics on the other.

Therefore, the research questions addressed in this study were: 1) what percentage of post-MI patients remains active or will become physically active shortly after MI in order to minimize the risk of a second cardiac event? and 2) to what extent do biographic and personality characteristics have predictive qualities with respect to determining the start of physical activities post-MI?

Method

Participants

From January 1993 to October 1994, 378 patients admitted to the Cardiology Departments of three hospitals in Rotterdam with first MI were eligible to take part in this study. A total of 260 (68.8%) patients participated (n=89 from the University Hospital Rotterdam-Dijkzigt, n=92 from the Havenziekenhuis, and n=79 from the Holy-ziekenhuis). No significant differences were found between the three groups for biographic and medical characteristics. In the group of non-participants, 19 (16.1%) died soon after MI; 32 (27.1%) declined to participate, and in 30 patients (25.4%) participation was emotionally or physically too demanding. A further 37 patients (31.4%) were excluded due to practical problems, such as transfer to another hospital. The

study group comprised 185 men and 75 women, with adequate command of the Dutch language, who were not suffering from any other serious physical or psychiatric disorders. Non-participants were similar to participants regarding gender, but were significantly older than the participants. Patients were recruited while still in hospital.

Measures

Physical activity was assessed by means of a structured interview about physical activity, and a measure of the Leisure and Social Activities scale (LSA, (31)). The items in the structured interview are answered with 'yes' or 'no'. The LSA asks for degree of activity before MI, ranging from 'never' to 'often'; or, five months post-MI, the degree of change in physical activity, ranging from 'never' to 'more'.

Personality characteristics were assessed using psychological questionnaires. Neuroticism and Somatization of Neurotic Complaints were assessed by two scales from the 'Amsterdamse Biografische Vragenlijst' (ABV, (32)). The questionnaire has good reliability and acceptable validity (33). Rigidity and Self-esteem were derived from the validated 'Nederlandse Persoonlijkheids Vragenlijst' (NPV, (34)); the reliability is considered adequate (33). Anxiety and Depression were assessed with the Hospital Anxiety and Depression scale (HAD, (35)). To register state and trait anxiety, the 'Zelf Beoordelings Vragenlijst' (ZBV, (36)) was completed and the 'Zelf Analyse Vragenlijst' (ZAV, (37)) was used to register state and trait hostility. The reliability and validity of the ZBV and ZAV are good (33). Vital Exhaustion was measured with the 'Maastrichtse Vragenlijst' (MV, (38)), consisting of 23 items. Five mood states were measured with the Profile Of Moods State (POMS, (39)), consisting of 32 items, involving Fatigue, Vigor, Tension, Depression, and Anger. Well-being, Feelings of Disability, Displeasure, and Social Inhibition were assessed by means of the Heart Patients Psychological Questionnaire (HPPQ, (40)) with 52 items; its reliability and validity are acceptable (33).

Information about a) clinical interventions related to the MI; b) length of hospitalization; and c) participation in a cardiac rehabilitation program, and biographic information, was obtained using both a structured interview and the medical record of the patient.

Procedure

All patients hospitalized with first MI, were given a written invitation to participate in the study by the first author (I.H.). The aim of the study was explained and, after informed consent was obtained, a structured interview was conducted in the hospital a few days after MI. Patients were subsequently asked to complete the psychological questionnaires.

Apart from the regular control visits at the departments of Cardiology, patients were invited back to the hospital to participate in the second measurement approximately five months after MI. The same structured interview was again conducted and the POMS, HAD, and HPPQ were completed for the second time. A lapse of five months until the second measurement was chosen because patients could elect to participate in a physically oriented cardiac rehabilitation program following discharge from the hospital. After five months, the possible influences are assumed to have stabilized. Participation was registered.

Analysis

Data from patients who had completed less than 50% of the subscales were not included. Subscales with 15% or more missing data were withdrawn from analysis; missing values of up to 15% were estimated using the 'predicted mean matching' method (41).

Physical activity was considered to be the main criterion in this study. To categorize physical activity, the answers to questions on walking, cycling and sports practice and the results on the LSA, all assessed both a few days after MI, and five months later, were split up into four categories, comprising 'never physically active', 'less active than before MI', 'equally active as before MI' and 'more active'. First, patients were assigned to the 'more active' category if they had increased the level of at least one of the physical activities (n=60). Next, patients with no change in physical activities, i.e. they stayed as active as before MI, were assigned to the 'equally active' category (n=82). Subsequently, patients with decreased physical activities were assigned to the 'less active' category (n=21). Due to the small number of patients in the category 'never active' (n=3), this category was combined with the 'less active' category (total n=24).

Thus, finally there were three distinct categories of patients. In order to compare the levels of the different variables, and as a consequence to interpret unambiguously, the values have to be transformed to an equal level and equal variability. In this study is decided to transform the values into T-scores (mean = 50; standard deviation = 10). Subsequently, the three categories have been visualized.

Significance of the continuous variables for the three categories was tested by univariate one-way analysis of variance. Chi-square testing was done for biographic variables. Due to multiple comparisons, pair wise testing was done by means of Student's Newman-Keuls procedure for continuous data. For nominal data, Bonferroni's procedure was applied. The magnitude of the difference on each psychological variable for the physical activity categories is indicated by Cohen's D (42).

Personality characteristics, including the biographic variables gender and age, were analyzed jointly to test whether these could differentiate between the three categories of physical activity. In order to be entered into the multivariate model, these variables had to meet the criteria of Cohen's D of $D < -0.40$ or > 0.40.

A multivariate confounder score (43) was calculated, comprising three medical variables: a) clinical interventions related to the MI; b) number of days of hospitalization; and c) participation in a cardiac rehabilitation program.

With multiple linear discriminant analysis according to the Wilk's Lambda method, the number of statistically significant ($p< 0.05$) discriminant functions was determined. To gain insight into the differential qualities of the variables in the discriminant model, a priori probability was set to be equal for all three categories. The group means were presented as z-scores (i.e. mean: 0.0; variance: 1.0). As a measure of relative importance the standardized regression coefficient for each variable was presented: a positive regression coefficient signifies that the variable discriminates between the categories positively. If the sign of the regression coefficient is negative, the variable discriminates between the categories negatively. In order to gain insight into the stability of the solution the results have to be crossvalidated. The crossvalidation procedure was as follows: 1). Each category (less active, equally active and more active) was randomly divided into five subsamples (a,b,c,d and e) with equal probability to be assigned to

either subsample. 2). On four of the five subsamples (training sample) the analysis was performed. On the fifth subsample the results were tested on stability of the solution (validation sample). The training sample comprised five changing subsamples. As a consequence subsamples separately were tested on stability of the solution (validation sample). 3). Finally, the scores for the five subsamples representing the validation sample were averaged.

Results

Patient characteristics

Baseline measurements were obtained from 260 patients, while 204 (78.5%) participated in the second measurement carried out approximately five months after the MI. Among dropouts, 21.4% (n=12) had died before the second measurement, 62.5% (n=35) declined to participate further, and 16.1% (n=9) dropped out for other reasons, e.g. the onset of other physical or psychiatric disorders between the two measurement points. At baseline, there was no difference between participants and dropouts for gender, age, and physical activity. After correction for incomplete data, 166 patients were entered into the final analysis. Table 1 summarizes biographic and medical characteristics of the study population according to the three categories of physical activity five months after MI. No significant differences were found between the three categories with respect to gender, living with a partner, length of hospitalization or cardiac events. A statistically significant difference was found with respect to age: patients in the 'less active' category were older than those in the 'equally active' category, and the latter were older than the patients in the 'more active' category. Similarly, occupational status differed significantly: in the 'less active' and the 'equally active' category proportionally less patients were employed compared to the 'more active' category. Participation in a cardiac rehabilitation program was also significantly larger in the 'more active' category than in the other two categories.

Table 1: Biographic and medical characteristics of the three categories of patients (in %) (n=166)

	Less active n=24 (15%)	Equally active n=82 (49%)	More active N=60 (36%)
Biographic characteristics			
Male	50.0	76.8	88.3
Age (in years, mean (sd))	70.04 (6.89)[a]	63.09 (10.59)[b]	55.50 (11.64)[c]
Living with a partner	82.0	77.3	60.7
Occupational status:			
▪ employed	8.3[a]	22.0[a]	51.7[b]
▪ not employed:	91.7[a]	78.0[a]	48.3[b]
- unemployed	0.0	2.4	8.3
- retired	37.5	41.5	25.0
- housewife	37.5	15.9	6.7
- unfit for work	16.7	13.4	8.3
- not working for unknown reasons	0.0	4.8	0.0
Medical characteristics			
Rehabilitation program	25.0[a]	37.8[a]	63.3[b]
Hospitalization (mean number of days)	11.6	14.9	14.5
Cardiac events (PTCA, CABG, recurrent MI)	16.7	14.6	16.6

Percentages and means with different superscripts are significantly different, while those with the same or no superscript are not significantly different.
PTCA: Percutaneous Transluminal Coronary Angioplasty
CABG: Coronary Artery Bypass Graft

Personality characteristics

Univariate analysis

When comparing 'less active' patients to both other categories, 'less active' patients showed significantly more somatization, feelings of depression (HAD), vital exhaustion, fatigue and disability, and a significantly lower level of self-esteem, vigor and well-being. Furthermore, 'less active' patients were significantly more depressed (POMS) and tense than 'equally active' patients.

Cohen's D was used to assess the magnitude of the statistically significant differences between categories (see table 2). When comparing the 'less active' category with each of the other two categories Cohen's D value was greater than or equal to 0.40 for somatization, depression (POMS and HAD), state and trait anxiety, vital exhaustion, fatigue and disability, whereas self-esteem, vigor, and well-being were less than -0.40. Furthermore, compared with 'equally active' patients the 'less active' category had values greater than 0.40 for neuroticism and tension. Comparison between the 'equally active' and the 'more active' categories revealed only small Cohen's D values.

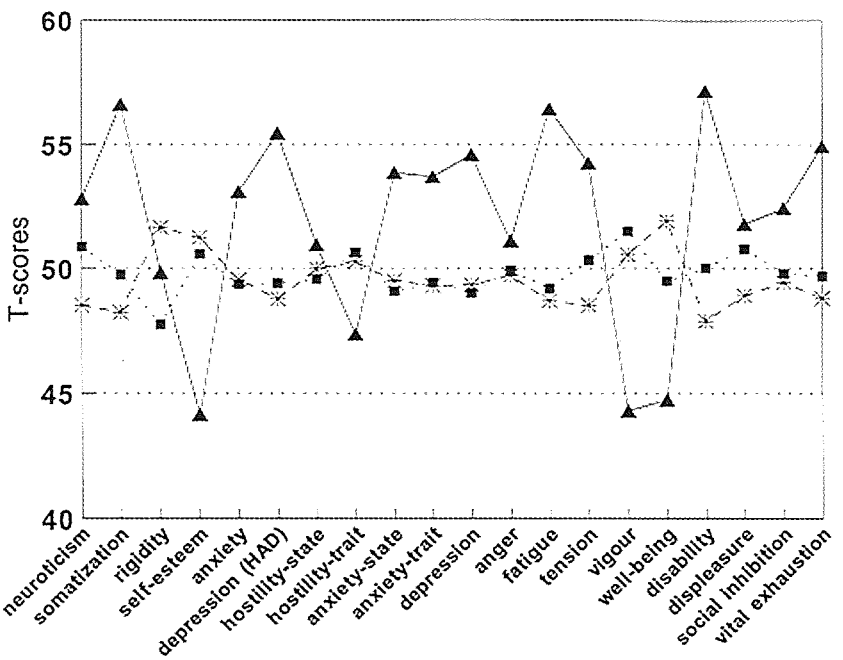
Table 2: Means, confidence interval (C.I.) and Cohen's D, for the three categories of patients

		Less active		Equally active		More active		Cohen's D	Cohen's D	Cohen's D
		Mean	95% C.I.	Mean	95% C.I.	Mean	95% C.I.	Less - equally	Less - More	Equally - more
ABV:	• neuroticism	50.04	41.22 to 58.86	39.80	34.92 to 44.69	45.40	38.58 to 52.22	0.50	0.19	-0.23
	• somatization	23.50[a]	20.56 to 26.44	18.08[b]	16.76 to 19.41	19.07[b]	17.46 to 20.67	0.87	0.69	-0.16
NPV:	• rigidity	33.58	30.49 to 36.67	35.21	33.43 to 36.98	31.73	29.11 to 34.35	-0.21	0.20	0.39
	• self-esteem	25.50[a]	22.40 to 28.60	29.74[b]	28.47 to 31.02	29.35[b]	28.00 to 30.70	-0.69	-0.65	0.07
HAD:	• anxiety	6.29	4.58 to 8.00	5.00	4.23 to 5.77	4.93	3.99 to 5.87	0.36	0.35	0.02
	• depression	5.54[a]	4.02 to 7.06	3.41[b]	2.77 to 4.06	3.62[b]	2.81 to 4.43	0.69	0.59	-0.07
ZBV:	• anxiety-state	42.50	37.73 to 47.27	37.79	35.55 to 40.03	37.33	34.48 to 40.19	0.45	0.46	0.04
	• anxiety-trait	39.21	35.48 to 42.94	34.90	32.79 to 37.01	35.03	32.40 to 37.66	0.46	0.43	-0.01
ZAV:	• hostility-state	11.67	10.20 to 13.14	11.34	10.55 to 12.13	11.20	10.44 to 11.96	0.09	0.15	0.04
	• hostility-trait	14.67	12.82 to 16.51	16.06	15.06 to 17.06	16.23	14.90 to 17.57	-0.31	-0.04	-0.01
MV:	• vital exhaustion	10.38[a]	7.95 to 12.80	6.62[b]	5.39 to 7.85	7.17[b]	5.46 to 8.88	0.67	0.50	-0.09
POMS :	• fatigue	9.58[a]	6.43 to 12.74	4.87[b]	3.36 to 6.08	5.17[b]	3.68 to 6.66	0.79	0.70	-0.05
	• vigor	8.88[a]	6.79 to 10.96	11.65[b]	10.79 to 12.50	12.07[b]	10.86 to 13.27	-0.67	-0.67	-0.10
	• tension	7.50[a]	5.65 to 9.35	4.67[b]	3.62 to 5.73	5.57[a,b]	4.25 to 6.89	0.60	0.39	-0.18
	• depression	6.79[a]	3.46 to 10.12	3.62[b]	2.38 to 4.86	3.42[a,b]	1.99 to 4.85	0.51	0.54	0.04
	• anger	5.25	2.65 to 7.85	4.52	3.52 to 5.53	4.63	3.18 to 6.09	0.15	0.11	-0.02
HPPQ:	• well-being	22.13[a]	19.08 to 25.17	27.52[b]	25.98 to 29.07	25.70[b]	23.69 to 27.71	-0.76	-0.47	0.25
	• disability	29.13[a]	26.90 to 31.35	23.38[b]	22.08 to 24.48	24.62[b]	22.82 to 26.41	1.08	0.69	-0.22
	• displeasure	16.63	14.95 to 18.30	15.38	14.47 to 16.28	16.18	14.96 to 17.41	0.31	0.10	-0.18
	• social inhibition	12.29	11.10 to 13.48	11.35	10.69 to 12.01	11.47	10.59 to 12.34	0.32	0.25	-0.04

Means on each line with different superscripts are significantly different, while those with the same superscript are not significantly different

For the sake of unambiguous interpretation, the mean values for all the patients were transformed into T-scores (mean = 50; standard deviation = 10). Figure 1 presents the T-scores for the different personality characteristics related to the three categories of physical activity.

Figure 1. T-scores for personality characteristics related to physical activity



▲ = less active; * = equally active; ■ = more active

Multivariate analysis

The 13 psychological variables that met the criteria of Cohen's D greater than 0.40 or < -0.40 were entered into a multiple discriminant analysis together with gender and age. The first two discriminant functions were statistically significant ($p<0.05$) with a correlation between the three categories of physical activity and the variables entered in the discriminant model of 0.59 and 0.30, respectively. Five variables contributed

significantly to both discriminant functions that differentiate the three categories. In the second discriminant function, the most important variable was feelings of disability. In addition, four variables contributed significantly to the first discriminant function, namely age, vigor (negatively associated), gender, and state-anxiety.

Table 3: The relative importance[1] of the variables discriminating the three categories

	Functions	
	I	II
Disability (HPPQ)	-0.39	0.96
Age	0.71	-0.17
Gender	0.39	0.09
State-Anxiety (ZBV)	0.29	-0.02
Vigor (POMS)	-0.52	-0.18

[1] Standardized regression coefficient was considered as a measure of relative importance
For abbreviations, see text

The variables entered in the final discriminant model correlated best with the relevant linear discriminant functions. In this analysis the importance of the predictor variables were adjusted for the multivariate confounder score, comprising three important medical variables; a) clinical interventions related to the MI; b) length of hospitalization; and c) participation in a cardiac rehabilitation program. 'Less active' patients proved to have the highest group mean on the first discriminant function (0.92) as well as on the second (0.72), while the 'more active' category had the lowest group mean on the first function (-0.57). Verbalized, patients who became less physically active after the first MI were characterized by strong feelings of disability, a low level of vigor, and anxiety; in addition they are on average older and more often female. In contrast, patients who became more physically active after the first MI were characterized by feelings of vigor, not feeling disabled; moreover, they were on average relatively young and more often male.

Finally, the 'more active' category comprised relatively more men who were free from feelings of anxiety.

The statistical solution, assessed by crossvalidation, appeared to be highly stable.

Table 4: Group means of the discriminant function before and after crossvalidation

Group	Function 1		Function 2	
		Crossvalidation		Crossvalidation
	Before	After	Before	After
Less active	0.92	0.83	0.72	0.55
Equally active	0.15	0.13	-0.24	-0.21
More active	-0.57	-0.54	0.04	0.03

Discussion

The main objective of this study was to investigate: 1) what percentage of post-MI patients remain active or will become physically active shortly after MI in order to minimize the risk of a second cardiac event? and 2) to what extent do biographic and personality characteristics have predictive qualities with respect to determining the start of physical activities post-MI? For many people a sedentary lifestyle is considered a major risk factor for cardiovascular diseases (1-5). Although patients were not actually asked about their opinion, it is assumed that this generally accepted notion might be the reason why about 36% of the patients in the present study became physically more active of their own accord after the first MI. About 49% remained on the same level, while 15% became less active or stayed as inactive as before MI.

In the present study a significant differentiation could be made between the least physically active - and smallest - category of patients, and the other two categories. This least active category is characterized by feelings of disability, a low level of vigor, and feelings of anxiety. In addition, they were, on average, older and more often female. Biographic characteristics may have played a major role in this differentiation: the high mean age and, as a consequence, the negative work status of this sedentary 'less active' category may explain why these patients have less opportunity to improve their physical activity level. The relatively small percentage of patients in this category participating in a cardiac rehabilitation program, underscores this trend. It may be assumed that these patients made a relatively passive adaptation to normal life after MI. The proportionally high prevalence of mostly elderly female patients in this sedentary category concurs with other reports (44-46). Women are more likely than men to have domestic responsibilities, and may have less time available for physical activities (46). Particularly older women may have difficulty in overcoming patterns of socialization that underestimate the importance of leisure and physical activity for females (46, 47). Being female and relatively older, and perceiving more anxiety and less vigor is in accordance with the general finding that women experience more emotional symptoms than men (48). Additionally, the relationship between being older and experiencing less vigor appears to be self-evident. The presence of strong feelings of disability after MI in this

particular group can probably be explained by the combination of biographic and personality characteristics and may, as such, be expected.

In line with these findings, the patients that showed more physical activity after first MI were younger, more often male, and, as a consequence, characterized by a higher prevalence of current employment. Moreover, more patients from this group participated in a rehabilitation program than from the sedentary category.

Although it was possible to differentiate the least active category from the other two categories, the present study has some limitations. For example, some relevant variables may have been omitted, e.g. the motivation of patients to increase their physical activity, and/or the possibility of taking advantage of nearby sports facilities. Another consideration is the choice of measurements. As the reliability and validity of all instruments were satisfactory, this should increase confidence in the data. However, with regard to validity, the variable 'self-esteem' was measured by a few items focusing specifically on work. Due to the small percentage of patients who were currently employed, some of these questions were not relevant to them. In this case a structured interview may be of more value than the questionnaire approach. Furthermore, it is noteworthy that the scores of the personality characteristics are very similar for the 'more active' and the 'equally active' categories. This may be due to a 'ceiling effect' in which the 'equally active' category was already physically active and could not demonstrate much more improvement.

Finally, it was attempted to differentiate between the patients who did (n=77) and those who did not (n=85) participate in a rehabilitation program. After logistic regression it was found that age, gender and three personality characteristics (namely rigidity, vigor and social inhibition) showed discernible differences between these two groups. Participants were relatively younger, more often male, and showed relatively less rigidity, less vigor and less social inhibition. The role of social inhibition in discerning between patients who did and those who did not participate in a cardiac rehabilitation program is in line with recent findings (49). These authors found that cardiac patients who scored high on both trait anxiety and social inhibition, and followed a cardiac rehabilitation program after a cardiac event, accounted for > 80% of cardiac mortality after five years follow-up. Thus,

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Chapter 4

Modification in Quetelet index five months after myocardial infarction: relevance of biographic and personality characteristics

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(Preventive Medicine 1999; 28: 86-91)

Abstract

Obesity can be considered as a risk factor for (re-)occurrence of coronary heart disease.

The relationship between modification in Quetelet index, and personality characteristics was assessed in 166 survivors of a first myocardial infarction (MI). Quetelet index (weight/(height)^2) was calculated a few days after first MI, and again five months later. A multiple regression analysis was executed, with the Quetelet index after five months as dependent variable, and adjustment for gender, age and Quetelet index at baseline.

It was found that strong feelings of vital exhaustion and lack of tension significantly contributed to the prediction of increased Quetelet index five months after a first MI.

It is recommended to make use of individually-tailored interventions based on these personality characteristics to accomplish bodyweight reduction in MI patients.

Introduction

Obesity is a major risk factor for coronary heart disease (CHD) through its indirect effect on hypertension, diabetes, and cholesterol level (1-3). Apart from this, obesity can also be considered as a unique CHD risk factor according to the Nurses Health Study (4, 5). The results of that study show a positive association between Quetelet index (QI = weight/(height)^2) and the incidence of nonfatal myocardial infarction, death due to coronary heart disease and confirmed angina pectoris. Obese women with a QI higher than 29 had a relative risk of CHD that was three times the risk of women with a QI lower than 21. The NHANES I Epidemiologic Follow-up Study found similar results (6); women with a QI of 29 or more showed an increased risk of 1.5 for CHD compared with women with a QI of less than 21. The Framingham Study (7), observing coronary heart disease occurrence over a period of 26 years, found a strong positive association between weight and the incidence of CHD, particularly among women.

A positive relationship between QI and cerebrovascular mortality was found in a study among non-smoking and non-drinking Seventh-day Adventist men (8). Comparing the

lowest (QI < 22.3) quintile with the highest (QI > 27.5), the relative risk was 0.60 for cerebrovascular mortality.

In a CHD intervention study executed in Germany (9) a group of patients with stable angina pectoris was compared with a control group receiving usual cardiological after care. The intervention was based on regular exercise and a low-fat diet. In the intervention group bodyweight decreased significantly with 5% versus 0% in the control group; coronary artery disease also progressed at a slower pace compared with the control group. The results of a comparable study (10) show that in a group of diagnosed CHD patients, the group, which was most successful in reducing simultaneously a number of risk factors, exhibited both a weight loss of 9.2 kg of the baseline weight and a reduction in current overall CHD risk of 41%.

Apart from the association between the progress in arteriosclerosis and weight, from literature is known that several personality characteristics are associated with weight loss. Data derived from interviews with post-coronary patients revealed that behavioral, personality, and social support characteristics were positively associated with maintenance of favorable changes in weight, while symptoms of depression were correlated negatively with maintenance of weight loss (11). In the University of North Carolina Alumni Heart Study (UNCAHS) (12), longitudinal data showed that persons with high hostility scores at baseline were significantly more likely at follow-up to exhibit a large body mass index. A ten-week weight reduction program (13) showed as one of the principal findings that women with low self-esteem at baseline lost significantly less weight than women with medium or high scores on self-esteem. Looking at restrained eaters among young college females, a significant negative relationship with self-esteem, anxiety and depression was found (14-16).

Considering the interest of the relationship between QI, CHD and several personality characteristics such as self-esteem, depression and anxiety, while so far the scarce existing studies on post-coronary patients has not applied valid questionnaires for the measurement of these psychological characteristics, the current research question is:

To what extent do (validly measured) personality characteristics, apart from biographic aspects, have predictive qualities with respect to the decrease or increase of IQ five months after an imminent life event as a first MI?

Method

Participants

From January 1993 to October 1994, 378 patients admitted to the Cardiology Departments of three hospitals in Rotterdam with first MI, were eligible to take part in this study. A total of 260 (68.8%) patients participated (N=89 from the University Hospital Rotterdam Dijkzigt, N=92 from the Havenziekenhuis and N=79 from the Holy-ziekenhuis) No significant differences were found between the three groups for biographic and medical characteristics. In the group of non-participants, 19 (16.1%) died soon after the MI; 32 (27.1%) refused to participate and in 30 patients (25.4%) participation was emotionally or physically too demanding. A further 37 patients (31.4%) were excluded due to practical problems such as transfer to another hospital. The study group comprised 185 men and 75 women, with adequate command of the Dutch language, who were not suffering from any another serious physical or psychiatric disorders. Non-participants were similar to participants regarding gender, but were significantly older than the participants. Patients were recruited while still in hospital.

Measures

Biographic and medical information was obtained using both a structured interview and the medical record of the patient.

Quetelet index was calculated: weight in kilograms divided by the square of the height in meters. According to WHO classification an adult with a QI of 25 or more is overweight. For example, to decrease the QI with one point a person with height 165 cm has to lose three kilograms, while a person with height 185 cm has to lose four kilograms.

Personality characteristics were assessed using psychological questionnaires. Neuroticism (min 0; max 123) and Somatization of Neurotic Complaints (min 0; max 49)

were assessed by two scales from the 'Amsterdamse Biografische Vragenlijst' (ABV, (17)). The subscales consist of 30 and 17 items, respectively, which can be rated on a 3-point scale (yes, ? or no). Reliability and validity for the Dutch population have been proven to be sufficient (18). Rigidity (min 0; max 50) and Self-esteem (min 0; max 38) were derived from the validated 'Nederlandse Persoonlijkheids Vragenlijst' (NPV, (19)). The subscales consist of 25 and 19 items, respectively, which can be rated on a 3-point scale (right, ? or wrong). The reliability is considered adequate (18). Anxiety and Depression were assessed with the Hospital Anxiety and Depression scale (HAD, (20)). The questionnaire consists of 14 questions, half concerning anxiety and half concerning depression. The possible answers indicate the intensity of the given mood; the sum of the individual scores gives overall scores for anxiety (min 0; max 21) and for depression (min 0; max 21). Validity and reliability have been proven for British studies (21). To register state and trait anxiety, the 'Zelf Beoordelings Vragenlijst' (ZBV, (22)) was completed. Each subscale entails 20 items (min 20; max 80). Items are scored on a 4-point Likert scale (state: 1-4: not at all to very much; trait: 1-4: almost never to almost always). Reliability of this questionnaire has proven to be good (18). The 'Zelf Analyse Vragenlijst' (ZAV, (23)) was used to register state and trait hostility. Each subscale consists of 10 items (min 10; max 40). The items can be rated on a 4-point scale (state: 1-4: not at all to very much; trait: 1-4: almost never to almost always). The reliability and the validity of the ZBV and ZAV are good (18). Vital Exhaustion was measured with the 23 items of the 'Maastrichtse Vragenlijst' (min 0; max 46) (MV, (24)). This questionnaire can be rated on a 3-point scale (yes, ? or no). Five mood states were measured with the Profile Of Moods State (POMS, (25)), involving Fatigue, Vigor, Tension, Depression and Anger. The subscales consist, respectively, 6, 5, 6, 8 and 7 items, which are rated on a 5-point scale varying from 0, not at all to 5 extremely. Reliability in the Netherlands has proven to be good. Well-being (min 12; max 36), Feelings of Disability (min 12; max 36), Displeasure (min 10; max 30) and Social Inhibition (min 6; max 18) were assessed by means of the Heart Patients Psychological Questionnaire (HPPQ, (26)); its reliability and validity are acceptable (18).

Procedure

All patients hospitalized with first MI were given a written invitation to participate in the study by the first author (I.H.). The aim of the study was explained and after informed consent was obtained, patients were asked to complete the psychological questionnaires. Bodyweight was determined during admission into hospital.

Apart from the regular control visits at the departments of Cardiology, patients were invited back to the hospital to participate in the second measurement approximately five months after MI. Bodyweight was again determined. A lapse of five months until the second measurement was chosen because patients could elect to participate in a physically-oriented cardiac rehabilitation program following discharge from the hospital. After five months the possible influences are assumed to be stabilized. Participation was registered.

Statistical analysis

First of all, data from patients who had completed less than 50% of the subscales were excluded. Next, subscales with 15% or more missing data were withdrawn from the analysis, and finally, missing values up to 15% were estimated using the 'predicted mean matching' method (27). The QI was calculated by dividing weight by the square of the height.

For the purpose of unambiguous interpretability, the values of the personality characteristics were transformed into T-scores (mean = 50; standard deviation = 10) for all of the patients. A square root or log transformation was used for the personality characteristics if the scores were skewed to the right (i.e. square root transformation for anxiety and depression (HAD), neuroticism, tension, vigor, rigidity, self-esteem and vital exhaustion; log transformation for somatization, anger, fatigue and displeasure).

Multiple regression analysis was used for each personality characteristic separately, with the QI five months after MI as dependent variable, adjusted for gender, age and Quetelet index at baseline. This analysis was repeated with the model fitted, on the

understanding that was adjusted for age and gender only. Significance level for removal was fixed at 0.05.

Finally, multiple regression analysis (backwards procedure) was executed for all personality characteristics jointly, with the QI five months after MI as dependent variable, adjusted for gender, age and QI at baseline. This analysis was also repeated with the model fitted, adjusted for gender and age only.

Results

Patient characteristics

A baseline measurement was obtained from 260 patients; 204 (78.5%) of them participated in the second measurement carried out approximately five months after the MI. All patients were advised about the classical risk factors by their cardiologist. None of the patients participated in any type of structured weight reduction program, neither during hospitalization nor after discharge from the hospital. In the drop-out group, 21.4% (n=12) died before the second measurement, 62.5% (n=35) did not want to participate any further in the study and 16.1% (n=9) dropped out for other reasons, such as the onset of other physical or psychiatric disorders in the period after MI. The drop-outs did not differ in gender, age and QI at baseline from the participants. After correction for inconclusive data, 166 patients entered into the statistical analysis. This study group had a mean age of 61.4 (sd 11.6) years and consisted of 128 men (77.1%). Their mean QI was 26.0 at baseline and 25.9 after five months (see figure 1). QI was decreased with one point or more for 19% of the study group, 18% showed increased QI with one point or more, whereas 63% remained stable. Table 1 summarizes the biographic characteristics of the study group.

Figure 1: Quetelet index at baseline and five months after myocardial infarction (N=166)

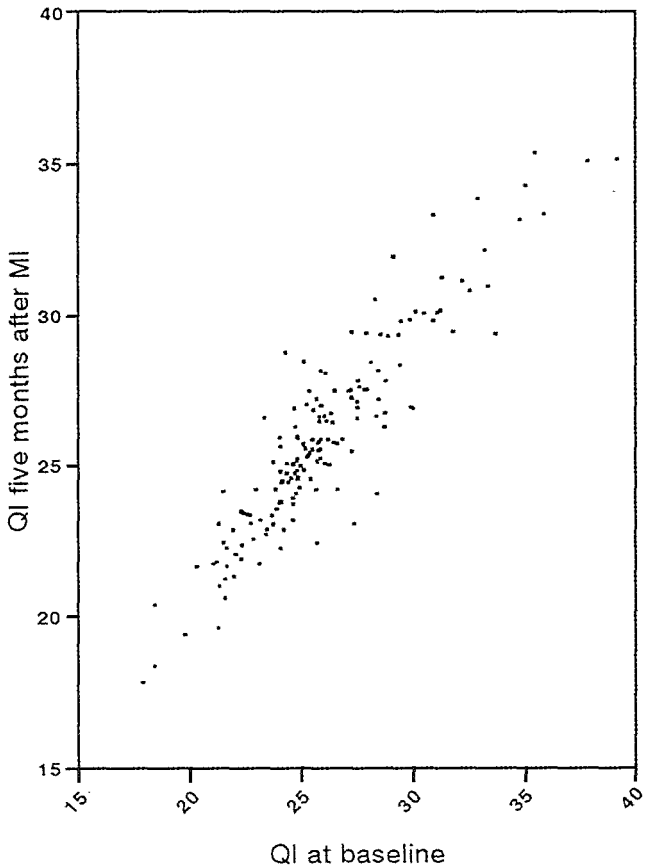

Table 1: Biographic characteristics of the study group (N=166)

Biographic characteristics	
Male	77.1%
Age (years) mean (sd)	61.4 (11.6)
Living with a partner	76.7%
Occupational status:	
▪ employed	30.8%
▪ unemployed	4.2%
▪ retired	34.9%
▪ housewife	15.7%
▪ unfit for work	12.0%
▪ not working for unknown reasons	2.4%
Quetelet index before MI, mean (sd)	26.0 (3.6)
Quetelet index five months after MI, mean (sd)	25.9 (3.3)

Variables separately

By executing a multiple regression analysis, all personality characteristics were analyzed separately with the QI five months after MI as dependent variable, and adjustment for gender, age and QI at baseline. It was found that vital exhaustion significantly contributed to the prediction of the QI five months after MI. None of the other characteristics measured in this study did so. If the adjustment for QI at baseline was left out the results were no longer significant (table 2).

Table 2: Relative importance of baseline personality characteristics separately

		ß[1]	Se	p	ß[2]	Se	p
ABV:	• neuroticism	0.04	0.76	0.59	0.00	0.03	0.81
	• somatization	0.11	0.08	0.10	0.01	0.03	0.68
NPV:	• rigidity	0.02	0.08	0.76	-0.02	0.03	0.64
	• self-esteem	0.01	0.08	0.90	0.00	0.03	0.98
HAD:	• anxiety	0.02	0.08	0.79	-0.03	0.03	0.34
	• depression	-0.01	0.08	0.93	-0.04	0.03	0.17
ZBV:	• anxiety-state	0.01	0.08	0.91	-0.03	0.03	0.35
	• anxiety-trait	-0.01	0.77	0.88	0.01	0.31	0.73
ZAV:	• hostility-state	0.05	0.08	0.49	0.02	0.03	0.54
	• hostility-trait	0.10	0.08	0.20	0.02	0.03	0.53
MV:	• vital exhaustion	0.10	0.08	0.10	0.07	0.03	0.04
POMS :	• fatigue	-0.05	0.08	0.49	0.02	0.03	0.48
	• vigor	0.04	0.08	0.60	0.04	0.03	0.17
	• tension	-0.00	0.08	0.96	-0.02	0.03	0.45
	• depression	0.01	0.08	0.86	0.05	0.03	0.11
	• anger	0.04	0.08	0.58	0.17	0.03	0.60
HPPQ:	• well-being	0.00	0.08	0.96	0.00	0.03	0.99
	• disability	0.07	0.08	0.39	0.03	0.03	0.32
	• displeasure	0.04	0.08	0.63	0.01	0.03	0.84
	• social inhibition	-0.01	0.08	0.93	0.02	0.03	0.54

[1] Adjusted for gender and age
[2] Adjusted for gender, age and QI before MI

Variables jointly

By executing a multiple regression analysis all personality characteristics were analyzed jointly with the QI five months after MI as dependent variable, and adjustment for gender, age and QI at baseline. It was found that vital exhaustion and tension jointly contributed to the prediction of the QI after five months. In conclusion, strong feelings of vital exhaustion and lack of tension contribute to an increased QI five months after MI (table 3). If the adjustment for QI at baseline was left out, the results showed a similar trend, although not statistically significant.

Table 3: Relative importance of baseline characteristics jointly for Quetelet index five months after myocardial infarction

	ß[1]	Se	p	ß[2]	Se	p
Gender	0.23	0.60	0.004	0.01	0.03	0.632
Age	-0.16	0.02	0.036	-0.06	0.03	0.056
QI baseline	----	----	----	0.91	0.03	0.000
MV: vital exhaustion	0.18	0.31	0.074	0.14	0.04	0.000
POMS: tension	-0.12	0.34	0.224	-0.12	0.04	0.004

[1] Adjusted for gender and age
[2] Adjusted for gender, age and QI before MI

Discussion

While generally spoken a QI between 20 and 25 points is usually considered as healthy, 57% of the patients in the present study showed a QI of 25 or more at baseline; this indicates that the sample population is relatively overweight. The main objective of this study was to explore the relationship between biographic and personality characteristics and the prediction of changes of QI five months after MI. The results showed that strong feelings of vital exhaustion (MV) and lack of tension (POMS) significantly contributed to the prediction of an increased QI five months after MI. A possible explanation for the association between a rise in QI after MI and vital exhaustion could be the effect of a vicious cycle: feelings of vital exhaustion and a relaxed, sedentary lifestyle might lead to eating in excess of the physical need, and finding relief in eating. This can lead to weight gain, possible disappointment about own one's 'weak' attitude and persistence of feelings of vital exhaustion. In line with this thinking it is established that restrained eaters tend to consume more food and to overeat when they have violated their diet, forcing them to restrain this eating habit again (14, 28); apparently, it is difficult to break this cycle. These findings are in agreement with those reported by Finnegan (11), Nirr (13), de Zwaan (15) and Schwartz (16) who also found that women with low self-esteem, increased anxiety and feelings of depression found it difficult to decrease their bodyweight.

That relatively less tension contributes significantly to a relatively increased QI five months after MI is more difficult to comprehend. Lack of tension could be explained by feelings of content or convenience: 'everything is under control'. In this situation, patients may deny the cardiac problems and refuse to pay attention to their current lifestyle. In this frame of mind, the need to reduce their bodyweight may be neglected. This attitude is supported by another study in which a personality classification system was used to treat physically healthy obese patients (29). Using both the Rorschach test and interviews by psychiatrists, types of personality were classified into four groups according to the healthiness of personalities. Type Ia was classified as 'indifferent type'. These patients were always passive and indifferent to everything, including their

appearance and bodyshape; they had a tendency to deny undesirable realities. This patient group seemed to be the most common type in obese patients. Type Ib was classified as 'immature type'; this type was found in younger patients and therefore not applicable to the present study. Type II was classified as 'false stable type'. These patients seemed apparently stable but were suffering from psychological distress; they often ate to escape from distress. Type III was classified as 'maladjusted type'; they were unable to adjust to their situation. The lack of tension found in the present study conforms with the 'indifferent' Type Ia, while the relative strong feelings of vital exhaustion is in line with both Type II and Type III. Patients experienced psychological distress due to their cardiac history and had problems in adapting to their new situation because of their inability to give up their unhealthy eating habits.

Finally, the Yoshida study showed that bodyweight rebound one or two years after treatment was reduced with the personality-oriented therapy program compared to the results observed with the previous conventional therapies.

In the present study group 47.5% participated in a cardiac rehabilitation program. Of the 30 patients that showed increased QI, 15 participated in such a program. Unfortunately, participation in a cardiac rehabilitation program does not guarantee any success with respect to loss of bodyweight.

The present findings form a first step to the approach according to Yoshida (29), implying that an intervention for weight reduction individually tailored to the type of personality reinforces positive results.

The present study did not investigate the motives of cardiac patients with regard to their wish to lose bodyweight or, consequently, the development of techniques to control bodyweight. Also the role of the partner, family members and/or the environment was not included in the study. These, and the association of QI with other cardiac risk factors such as smoking habits and physical activity, will be topics for future research.

Summary, the present study is the first which indicates that vital exhaustion is, apart from being an important risk factor for MI itself (as is known from other studies (24, 30), also a risk factor in cardiac patients for overweight, both before and after MI.

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Chapter 5

Empirical modeling of risk factors after myocardial infarction

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Abstract

The structural relationship is explored between three risk factors for myocardial infarction (MI). Smoking habits, physical activity and Quetelet index (QI) were examined in post-MI patients (N=166), before MI and five months later. Constructing a model using the LISREL program we found that former smoking habits, QI, and participating in walking and cycling had a strong positive relationship with the corresponding risk factors five months later.

Smoking habits changed positively in patients who undertook moderate physical activity five months after MI, and the change in QI was also influenced by smoking habits and moderate physical activity. This suggested that individuals who still smoked after five months had a higher chance of having a lower QI in that period. Moreover, those who were physically active in a moderate way five months after MI had a relatively low QI. Moderate physical activity is therefore suggested to be an appropriate intervention for MI patients.

Introduction

Cardiovascular disease is the major cause of morbidity and mortality in industrialized countries and the relationship between cardiovascular disease and risk factors remains a major topic of research.

Epidemiological and intervention studies support the clinical impression that both physical and behavioral factors are predictive for the prevalence and incidence of coronary heart disease (CHD). Smoking (1-3), obesity (4-7) and absence of physical activity (8-13) were found to be highly significantly associated with the prevalence of CHD.

Moreover, it is known that smoking cessation in CHD patients leads to an average decrease in mortality (of over 40%) and morbidity (1, 3, 14-17). Percentages of patients

who stopped smoking after their first myocardial infarction (MI) range from as low as 28% up to 70% (1, 3, 14-19).

Many studies have found a relationship between lack of exercise and CHD (5, 8, 10-13, 20-22); a sedentary lifestyle is considered a major risk factor for CHD (9, 23, 24). Thus, it is concluded that a high frequency of physical activity, over a long time span, protects against the development of CHD (25). The same positive relationship between exercise and CHD was shown in studies on physical activity combined with exercise training in secondary prevention (5, 12, 13, 20-22, 26). Obesity is also a major risk factor for CHD, not only through its indirect effects (e.g. dietary risk factors, higher serum cholesterol levels, and prevalence of diabetes and hypertension)(7, 27), but also due to the positive association between Quetelet index (QI = weight in kilograms /(height in meters)^2) and the incidence of nonfatal MI, death due to CHD, and angina pectoris (4, 6).

Further, psychological characteristics such as depression can play an important role in the dynamics of smoking (28). Brown et al. (29), suggested that the association between depressive symptoms and physical activity may be greater than that between depressive symptoms and smoking, because physical inactivity (or motor retardation) is part of the syndrome of depression, whereas smoking may be used by some patients as a form of self-medication to attenuate distress or symptoms of depression.

It is also known that psychological characteristics can play an important role in risk factor modification. Huijbrechts et al. (30) found that five months after a first MI persistent smokers could be differentiated from non-smokers and ex-smokers by a significantly higher level of state-anxiety and depression. Further, less active patients were characterized by a low level of vigor and feelings of disability and anxiety (31). Finally, strong feelings of vital exhaustion and lack of tension significantly contributed to the prediction of an increased QI (32).

Summarizing the literature, it is noteworthy that, so far, all these major behavioral risk factors have been investigated separately. Therefore, the present study investigates jointly those variables known to influence a change in risk factors.

Using the data of previous studies, the main question addressed here is: To what extent are the risk factors smoking, physical activity and Quetelet index interrelated? Do they have any predictive qualities for change in lifestyle five months after MI?
The aim of the study is to identify a model, which fits the data from a statistical viewpoint and allows the substantive importance of each variable to be translated to the situation of the cardiac patient.

Methods

Participants

From January 1993 to October 1994, 378 patients admitted to the Cardiology Departments of three hospitals in Rotterdam with first MI were eligible to participate in this study. Of these, 260 (68.8%) patients participated (89 from the University Hospital Rotterdam-Dijkzigt, 92 from the Havenziekenhuis, and 79 from the Holy-ziekenhuis). There were no significant differences between the three groups for biographic and medical characteristics. In the group of non-participants, 19 (16.1%) died soon after MI, 32 (27.1%) refused to participate, 30 patients (25.4%) found participation too emotionally or physically demanding, and 37 patients (31.4%) were excluded due to organizational problems (e.g. transfer to another hospital). Non-participants were comparable to participants for gender, but were significantly older than the participants. The study group comprised 185 men and 75 women, with adequate command of the Dutch language, who were not suffering from any other serious physical or psychiatric disorders. All patients were recruited while still in hospital.

Measures

Biographic and medical information was obtained using a structured interview and the medical record of the patient.
A structured interview was used to assess former and current smoking habits and physical activities such as walking and cycling. In the Netherlands cycling is considered a routine physical activity, especially among older persons. Answers to the items in the

interview were dichotomized (no=1/yes=2). A measure of the Leisure and Social Activities scale (LSA) was used to gain information on physical activities before MI and on any change in activities five months later (33). At baseline answers could be: 'never=1', 'sometimes=2', 'regular=3' and 'often=4', and after five months 'never=1', 'less=2', 'equal=3' and 'more=4'.

The QI was calculated: i.e. weight in kilograms divided by the square of the body height in meters.

Anxiety and Depression were assessed using the Hospital Anxiety and Depression scale (HAD), which consists of 14 questions, half reflecting depression and half anxiety (34). The answers indicate the intensity of the mood; the sum of the individual scores is considered to represent anxiety and depression (min. 0; max. 21).

Procedure

This study was part of a larger one aiming to identify biographic and personality characteristics related to risk factor modification after MI (30-32). All patients hospitalized with a first MI were given a written invitation and details of the study. After informed consent was obtained, a structured interview was conducted in the hospital a few days after MI. Patients were subsequently asked to complete the psychological questionnaires.

Apart from the regular control visits to the departments of cardiology, patients were invited to the hospital again to participate in the second measurement approximately five months after MI, using the same procedure. A five-month interval was chosen because patients could elect to participate in a physically-oriented cardiac rehabilitation program following discharge, and after five months the possible influences are assumed to have stabilized.

Statistical analysis

To explore the interrelationship of being physically active, smoking and overweight, structural equation modeling was applied (35, 36). Because this was an explorative study, analysis was restricted to manifest variables only. To gain insight in the structure

of the variables, a model generating strategy was chosen. The analysis was performed with the LISREL8 program (35). Because of the ordinal nature of some variables, the correlation matrix was estimated with PRELIS as a preprocessor for LISREL (37, 38). Parameters were estimated by the maximum likelihood.

The study aim was to identify a model, which fits the data from a statistical viewpoint and allows each parameter to have a substantive meaning. The statistical modeling was predominantly data driven. The strategy of fitting structural models was as follows: a) estimating autocorrelations (baseline variable with corresponding variable after five months), b) estimating autocorrelations and freeing the correlations of the independent variables (e.g. baseline variables), c) the foregoing strategy including freeing the error correlations of the dependent variables (e.g. variables after five months), and d) changing the model, step by step by omitting variables concerning content. To identify statistically significant and meaningful parameters, the modification index was used, under the condition that the autocorrelations were preserved. The performance of the candidate models was derived from: 1) Chi-square, including degrees of freedom and the p-value, for model fit, 2) standardized root mean squares of residuals (SRMR), 3) root mean squares error of approximation (RMSEA), including the p-value, 4) goodness-of-fit adjusted for degrees of freedom (AGFI), 5) expected crossvalidation index (ECVI) representing the stability of the model after crossvalidation, and 6) parsimony of the model: the simpler the better. In addition, the explained variance of the dependent variables is presented. Throughout the modeling the interrelationship of the independent variables was considered to be free.

If two or more competing models are mathematically equivalent (39, 40), they will all be considered.

Results

Patient characteristics

A baseline measurement, in retrospect from before MI, was obtained from 260 patients; of these 204 (78.5%) participated in the second measurement approximately five

months after the MI. In the dropout group, 21.4% died before the second measurement, 62.5% no longer wished to participate, and 16.1% dropped out for other reasons, e.g. onset of other physical or psychiatric disorders in the period after the MI. The dropouts did not differ from the participants in age, gender, smoking behavior, physical activity and QI. After correction for inconclusive data, 166 patients entered the final analysis. Table 1 summarizes the characteristics of the patients.

Table 1: Characteristics of the study group (N=166)

Characteristics	Before myocardial infarction	After five months
Male (%)	77.1	--
Age (years) mean (sd)	61.4 (11.6)	--
Living with a partner (%)	76.7	--
Smoker (%)	44.6	18.2
Physical activity:		
▪ walking (%)	46.6	65.3
▪ cycling (%)	58.5	57.3
▪ sports (%)	18.5	37.2
Quetelet index, mean (sd)	26.0 (3.6)	25.9 (3.3)
Range	17.8 - 39.1	17.8 - 35.4

Smoking habits decreased from 44.6% smokers at baseline to 18.2% five months after MI. Walking and sports activities increased (table 1) whereas cycling slightly decreased. The QI remained stable over the five months.

Modeling

Cycling was positively related with doing sports (r = 0.31) and negatively related with QI (r = -.22) all assessed at baseline (for economy of space these relationships are omitted from figure I).

Figure 1: Structural model of risk factors for myocardial infarction patients (N=166; X^2 =21.71; Adjusted Goodness-of-it (AGFI) = 0.92)

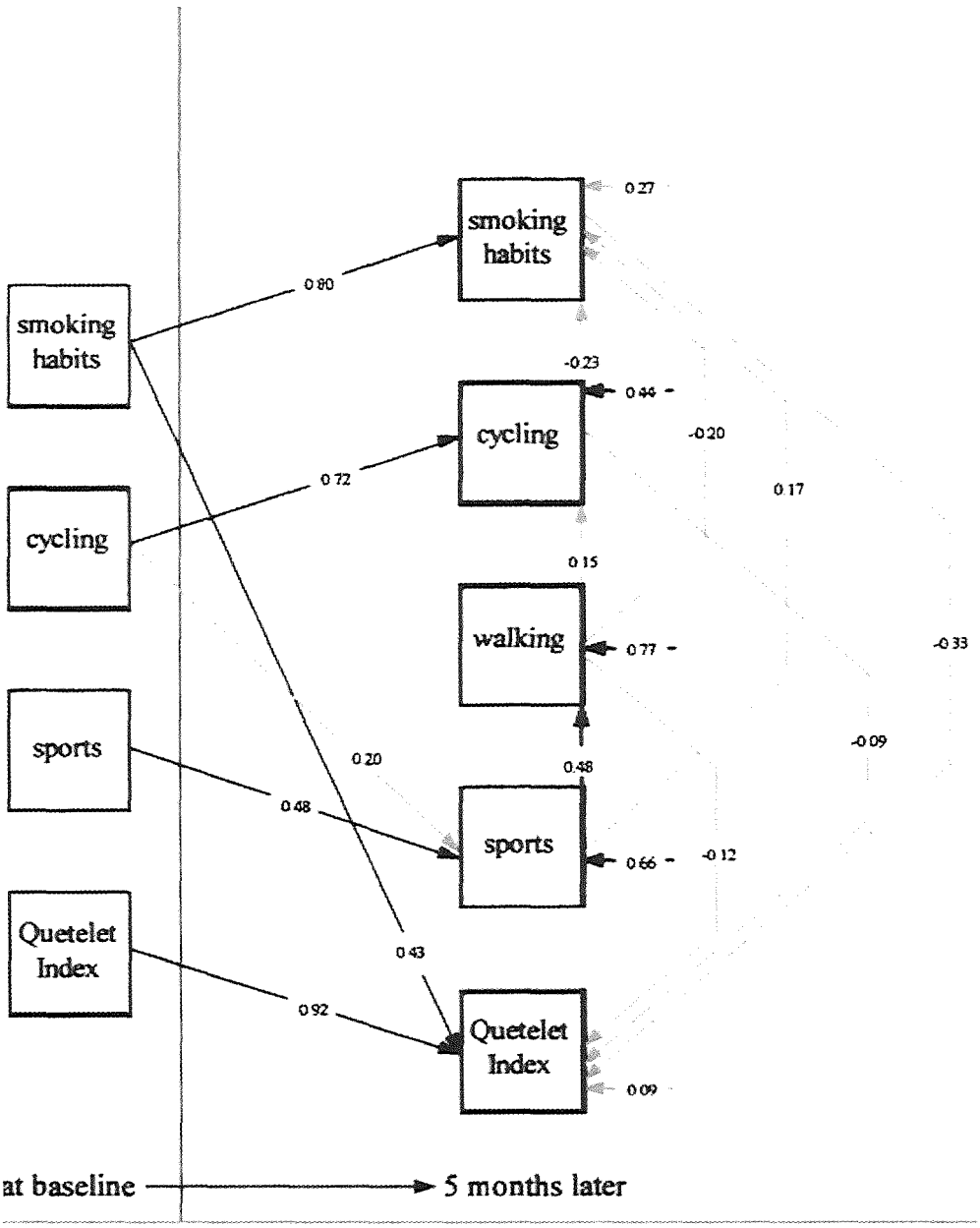

Table 2: Results of model search: goodness-of-fit tests of successive models

Model description	X^2	Df	p-value	RMSEA	AGFI	ECVI
1. Autocorrelations	239.33	30	0.00	0.21	0.68	1.81
2. Error correlations of dependent variables	103.44	20	0.00	0.16	0.72	1.08
3. Pathways	49.03	20	0.001	0.095	0.86	0.74
4. Reversed pathways	83.69	20	0.00	0.14	0.78	0.96
5. Without walking	56.18	16	0.001	0.13	0.81	0.71
6. Depression	21.86	20	0.35	0.024	0.93	0.57
7. Without depression	21.72	16	0.15	0.047	0.92	0.50

For abbreviations see text

Table 3: Correlations between the risk factors at baseline and five months later (N=166).

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1. Smoking, before MI										
2. Smoking, 5 months later	**0.81**[1]									
3. Walking, before MI	0.19	0.09								
4. Walking, 5 months later	0.04	-0.14	0.19							
5. Cycling, before MI	-0.01	-0.18	-0.17	0.10						
6. Cycling, 5 months later	0.00	-0.20	-0.16	0.22	**0.73**					
7. Sports, before MI	0.09	0.03	0.15	0.21	0.31	0.37				
8. Sports, 5 months later	0.11	0.07	0.02	0.48	0.35	0.40	**0.55**			
9. QI, before MI	-0.13	-0.14	-0.08	-0.01	-0.22	-0.11	-0.02	0.03		
10. QI, 5 months later	0.03	-0.08	-0.09	-0.08	-0.20	-0.15	-0.05	-0.04	**0.92**	
11. Depression	-0.02	0.11	-0.09	-0.06	-0.31	-0.21	-0.19	-0.15	0.02	-0.03

[1] The strongest correlations (>0.50) are printed **bold**
MI: Myocardial Infarction; QI: Quetelet index

The final model (figure 1, table 2) suggests that the estimated autocorrelations (baseline variable with corresponding variable after five months; table 3) were important for smoking habits, cycling, sports activities, and QI. No significant relationship was found between walking before MI and after five months. Leaving the variable 'walking after five months' out of the model (table 2, model 5) leads to a better fit of the model; for the same reason, the model finally chosen (table 2, model 7) does not include depression.
According to this model (figure 1), only one variable is predictive not only for itself after five months, but also has predictive qualities for other variables. Smoking before MI is strongly associated with QI after five months, i.e. smokers before MI had a relatively high QI five months later. A significant relationship between smoking after five months and QI was also found, but in the other direction, indicating that individuals who still smoked five months after MI had a higher chance of a lower QI in that period than those who did not smoke.
Furthermore, physical activity after five months was related to smoking habits after five months. More precisely, moderate physical activities such as walking and cycling after five months, have a negative relationship with smoking habits, implying that patients who walk or cycle after five months have a higher chance to quit smoking after five months.
On the other hand, doing sports after five months has a positive relationship with smoking habits, indicating that patients doing sports activities after five months persist in their smoking habits.

Besides direct effects (one variable influencing another variable) there are also indirect effects whereby one variable influences another variable, which influences a third variable (see table 4a and 4b). The importance of the indirect effects proved to be relatively minor, with the exception (again) of smoking: i.e. smoking habits before MI indirectly influence QI five months later by their influence on smoking habits after five months. The direct and indirect effects on smoking are similar in magnitude, but in opposite directions.

Table 4a. Direct and indirect effects of variables before myocardial infarction (MI) on variables five months later (N=166)

Before MI	Smoking habits		Cycling		Walking		Sports		Quetelet index	
After 5 months	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect
Smoking habits	0.80	--	--	-0.14	--	--	--	0.03	--	--
Cycling	--	--	0.71	0.02	--	--	--	0.04	--	--
Walking	--	--	--	0.10	--	--	--	0.23	--	--
Sports	--	--	0.20	--	--	--	0.48	--	--	--
Quetelet index	0.43	-0.27	--	-0.03	--	--	--	-0.04	0.92	--

Table 4b. Direct and indirect effects of variables five months after myocardial infarction (MI) on themselves

Before MI	Smoking habits		Cycling		Walking		Sports		Quetelet index	
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect
Smoking habits	--	--	--	--	--	--	--	--	--	--
Cycling	-0.21	--	--	--	--	--	--	--	--	--
Walking	-0.21	-0.03	0.15	--	--	--	--	--	--	--
Sports	0.18	-0.11	--	0.07	0.48	--	--	--	--	--
Quetelet index	-0.33	--	-0.09	0.07	-0.12	0.07	--	-0.09	--	--

Discussion

The aim of this study was to construct a model that takes into account cardiac risk factors before MI and five months later. The model has to fit the data and should also be applicable to the situation of cardiac patients. It was possible to identify a model that fits the empirical data.

The results of the study show that the predictive value of risk factors before MI for risk factors after five months center on the same factor. This implies that the conclusions previously drawn about the separate predictive values of smoking, physical activity and QI are still valid when the three risk factors are evaluated in combination (30-32).

The model showed, for example, that smoking habits play a crucial role in lifestyle changes five months after MI. Smoking before MI is a predictor for QI five months later both directly and indirectly. Because these effects are almost the same, the net effect of smoking on later QI is negligible (which is also shown by the low correlation in table 3).

Smoking habits also influence physical activity, as reported previously (41-44).

More precisely, persistent smokers increased sports activities but did not increase walking or cycling; in contrast, ex-smokers who quit smoking after five months, increased walking and cycling activities. A possible explanation, although speculative, suggests that smokers may find relief in physical exertion such as sports, whereas ex-smokers can relax with moderate physical activities such as walking and cycling. An explanation may also be found in the personality trait 'sensation seeking' (47, 48); patients with high scores on this trait tend to find internal 'drugs' or external stimuli, supposedly to maintain a mental equilibrium. This trait may be the underlying factor for both smoking and physical activities.

One aim of clinical practice is to achieve all desirable lifestyle changes.

Following the model, it was found that smoking habits played an intervening role between the risk factors, indicating that an intervention should focus on a positive change in smoking habits, even though this is difficult. Because smoking habits were also related to physical activity, the intervention could also focus on changes in moderate physical activity, such as walking or cycling (43, 44). This implies that if the cardiac patient is motivated to be more physically active, this increases the possibility of a positive effect on bodyweight and/or smoking habits (11). The observation that regular exercise was associated with increased self-efficacy to quit smoking and vice versa, prompted King et al. to suggest that successful change in one behavior may motivate other changes (42).

Using a structural modeling approach provides more insight into how the concepts (in this case, the risk factors) influence each other; otherwise, these relationships remain embedded in the overall correlation and regression coefficients.
By elucidating how concepts are interrelated, also over time, enables to formulate a restricted number of competing models and, thus, to design more effective treatment strategies.
Our results indicate that a smoking cessation program for cardiac patients should emphasize the need to avoid weight increase and also stimulate an increase in moderate physical activity.

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Chapter 6

Effect of physical activity after a cardiac event on smoking habits and / or Quetelet index

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(Netherlands Heart Journal 2003; 11 (2): 57-61)

Abstract

To further elucidate earlier findings, the present study investigated whether physical activity could serve as a positive stimulus to modify other changeable cardiac risk factors.

Participants were 140 patients who finished a cardiac rehabilitation program focused on physical activity. Their level of physical activity, smoking habits and Quetelet index before the cardiac event were investigated in retrospect, as well as at present. Current feelings of anxiety and depression were also assessed. Participants were divided into two categories according to their present level of physical activity after finishing the rehabilitation program, compared with that before the cardiac event.

It appeared that the more physically active category contained more smokers. Although many of them quitted smoking, significantly more persisted in their smoking habits compared with the patients who did not increase their physical activity. Significantly less depression was found in the more active patients.

Although it could not be confirmed that physical activity stimulated a positive change in smoking and Quetelet index, the more active patients appeared to be less depressed.

Introduction

Our earlier studies have investigated spontaneous behavioral changes related to cardiovascular risk factors after myocardial infarction (MI) (1-3). These results suggested that after MI, physical activity may play an intermediate role in positively influencing other changeable risk factors, such as smoking habits and being overweight (4, 5). The benefit obtained from different types of physical activity is influenced by variables such as the type of activity, frequency, duration, intensity, and progression. It is reported that moderately intense activities, such as walking, performed on a regular basis protects against cardiovascular diseases (6-10).

In addition to the physical benefits of exercise, physical activity is associated with improvements in various indices of psychological functioning, particularly that of depression. Apart from less depression among healthy active individuals (11), exercise training is reported to reduce the severity of depression in depressed patients (12) and improve depression in post-MI patients (13). In addition, depressive symptoms, physical activity and smoking habits interact, physical activity being inversely associated with depressive symptoms (14), and smoking being positively associated with depressive symptoms (14, 15).

Thus, the importance of physical activity for positive change in other risk factors is evident. Increasing physical activity after a cardiac event is often achieved by participation in a cardiac rehabilitation program. Such programs are now offered to the majority of cardiac patients (16, 17).

The question then arising is how and to what extent do the more physically active patients succeed in beneficially influencing other important risk factors, such as smoking habits and bodyweight. This confirmatory study focuses on cardiac patients who participated in a cardiac rehabilitation program and who increased their physical activity compared with before the cardiac event, measured several months after they had completed the program.

The aim of this study is to elucidate the relationship between changes in physical activity and, assuming that to be a stimulus for further modifications, changes in smoking habits and Quetelet index. Because changes in physical activity can be influenced by anxiety and/or depression, these psychological characteristics were considered in the investigation.

Methods

Patients

According to the Dutch Heart Foundation, 26% of all patients will participate in a cardiac rehabilitation program after an MI and 43% after coronary bypass artery graft

surgery (CABG) (18). In 1997, 1017 patients started a cardiac rehabilitation program after a prior cardiac event. This 'Rotterdam Foundation for Cardiac Rehabilitation' uses the multidisciplinary CAPRI system, named after the institute that developed the system: the CArdioPulmonary Rehabilitation Institute in Seattle, US. The usual program consists of physical activity twice a week over a three-month period. CAPRI focuses not only on physical training but also on psychological and social aspects of cardiac events, such as stress management and programs to quit smoking.

A total of 345 consecutive CAPRI participants, who finished the program between August 1997 and February 1998, participated in this study starting in October 1998. Of these, 78 patients aged $\geq$ 65 years were excluded, leaving 267 eligible to participate. All patients had adequate command of the Dutch language, and were not suffering from any other serious physical or psychiatric disorders.

Measures

Besides basic biographical and medical information, three risk factors were investigated by means of a specially designed checklist (smoking habits, QI and physical activity). The checklists were completed by the patients and therefore the data are subjective. Risk factors were established in retrospect for the period before the cardiac event and at present, sometime after finishing the cardiac rehabilitation program.

Smoking habits before the cardiac event and current smoking habits were investigated and, if a patient smoked, the number of cigarettes smoked per day was registered.

Bodyweight and height were noted for the period before the cardiac event and at present. The Quetelet index was calculated (weight in kilograms divided by the square of the height in meters). A QI score between 20 and 25 indicates a healthy weight.

Physical activity referred to two time points using the Leisure and Social Activities scale (LSA; (19)). The first LSA was used retrospectively to register activities before

the cardiac event and is rated on a four-point scale (never, sometimes, often and regular). The second LSA was completed for present activities compared with activities before the cardiac event and can be rated on a different four-point scale (never, less, equal and more). Because the LSA includes different kinds of leisure activities, the two items asking about physical activity (e.g. walking and doing sports) were selected and used as indicators for physical activity.

All patients were allocated to either a more active group or an equally/less active group depending on their current physical activities compared with before the cardiac event. Patients scoring 'more' on walking at present, and scoring 'equal' or 'more' on doing sports at present were allocated to the 'more physically active' group. Considering the fact that as time passes by, the physical condition of elderly people diminishes, those who maintained sport activities (besides increased walking) were also allocated to the more physically active group. Comparatively speaking, the effort to maintain these activities is increased. All others were categorized to the 'equally/less physically active group' (physical activity category coded as: more=1, less or equal=0).

Current feelings of anxiety and depression were assessed using the Hospital Anxiety and Depression (HAD) scale (20). The HAD questionnaire consists of 14 questions, half reflecting anxiety and half depression. The answers indicate the intensity of the given mood; the sum of the individual scores gives the overall scores (min 0; max 21) for both anxiety and depression. A cut-off score of 7 is considered to be mild and 8 or higher as severe. Validity and reliability have been proven earlier (21).

Procedure

The checklists were sent to 267 eligible participants by post; after two weeks the mailed response was 57.6% (N=154). Because patients could participate anonymously, a reminder was sent to all patients, which finally yielded a response of 65.9% (N=176). Three questionnaires were returned due to an incorrect address and six patients declined to participate.

Statistical analysis

Patient characteristics and risk factors were noted, and anxiety and depression scores estimated.

For the two categories of physical activity, differences in gender and age were compared by chi-square tests and t-test, respectively.

Smoking habits, Quetelet index, and anxiety and depression scores were compared between the two groups by calculating the mean, the standard deviation and the 95% confidence interval (CI). Finally, logistic regression was used for smoking habits and Quetelet index respectively, including anxiety and depression scores, and adjusting for gender and age. Data are presented as actual values or percentages; all significance testing was fixed at 0.05 (two-tailed).

Results

Participants

For reasons of homogeneity, 140 patients were selected with diagnosed arteriosclerosis. The remaining 36 patients participated in the rehabilitation program due to other causes such as valve problems.

There was no difference between the responding group (N=140) and the non-responding group for gender and age. The study group finally comprised 114 males (81%) and 26 females (19%); mean age was 54 (sd 7.5, range 24-64) years (table 1); 75.7% were married.

Table 1: Characteristics of the study group after a cardiac event

N	140
Male (%)	80.7
Age, mean (sd) (years)	54.0 (7.53)
Diagnosis (%)	
MI	57.9
CABG	29.3
Angina Pectoris	7.1
PTCA	5.7
Smoking habits (%)	
Persistent smoker	10.8
Ex-smoker	43.9
Never smoker	45.3
Walking (%)	
Never	3.7
Less	10.4
Equal	51.9
More	34.1
Sports (%)	
Never	20.4
Less	16.1
Equal	28.5
More	35.0
QI before cardiac event, mean (sd)	25.92 (3.40)
QI after cardiac event, mean (sd)	26.18 (3.15)
QI change, mean (sd)	-0.25 (2.08)
Depression, mean (sd)	2.56 (2.57)
Anxiety, mean (sd)	5.22 (3.86)

Of all patients, 75.9% had a first cardiac event before participating in the rehabilitation program. Of the group, 57.9% had experienced an MI, while 29.3% underwent CABG; other reasons for participating in the rehabilitation program were percutaneous transluminal coronary angioplasty (PCTA) or angina pectoris. The interval between the cardiac event and participation in this study ranged from 8 months to 14 months.

Of the smokers in the study group, 80.3% quitted smoking after the cardiac event, whereas 19.7% persisted with this habit. Almost half of the study group did not smoke

before or after the cardiac event. About one third of the participants increased their physical activities. Compared with the situation prior to the cardiac event, half of the group was currently able to walk as far as before and a third could walk even further. Participation in sports remained the same as before in 29% of the patients, while 35% had increased their sports activities after the cardiac event. Mean bodyweight of the study group remained unchanged since the cardiac event and after completing the rehabilitation program. Anxiety and depression scores were within normal ranges.

Physical activity

Dividing the patients into two 'physical activity' categories resulted in a total of 32 (22.9%) patients who had become more physically active than before the cardiac event (table 2). No significant differences were found for gender or age between the two groups.

Table 2: Data on the two categories of physical activity after a cardiac event

	More active		Equally or less active	
		95% C.I.		95% C.I.
N (%)	32 (22.9)		108 (77.1)	
Male (%)	75.0		82.4	
Age, mean (sd) (years)	52.44 (7.62)	49.69 to 55.18	54.47 (7.47)	53.05 to 55.89
Smoking habits, n (%)				
Persistent smoker	7 (21.9)		8 (7.5)	
Ex-smoker	16 (50.0)		45 (42.1)	
Never smoker	9 (28.1)		54 (50.5)	
QI before cardiac event, mean (sd)	25.92 (3.16)	24.79 to 27.07	25.92 (3.48)	25.26 to 26.58
QI after cardiac event, mean (sd)	26.31 (3.56)	25.03 to 27.59	26.14 (3.03)	25.56 to 26.72
Depression, mean (sd)	1.50 (1.65)	0.91 to 2.09	2.87 (2.72)	2.35 to 3.39
Anxiety, mean (sd)	4.57 (2.98)	3.45 to 5.68	5.41 (4.07)	4.63 to 6.18

Significantly more depression was found in the less active patients than in the more active patients. Anxiety did not differentiate between the two categories of physical activity.

Risk factors

Significant differences were found for smoking habits between the two groups (table 2). There were relatively more persistent smokers in the more physically active group. Relatively more patients who had never smoked were found in the equally/less physically active category. No differences were found for the QI between the two groups.

To further analyze the risk factors, logistic regression was applied to smoking habits and QI, including anxiety and depression scores, and adjusting for age and gender. For smoking habits two indicator variables were constructed for persistent smokers and ex-smokers. These two were jointly entered in the model (table 3).

Table 3: Relationship between physical activity and smoking habits after a cardiac event.

Variable	β	Se	exp (B)	p-value
Gender	0.78	0.54	2.17	0.15
Age	-0.02	0.03	0.98	0.44
Anxiety	-0.01	0.09	1.01	0.90
Depression	-0.31	0.15	0.74	0.05
Persistent smokers	1.81	0.71	6.15	0.01
Ex-smokers	0.91	0.51	2.49	0.07

Again, smoking habits differentiated the two categories of physical activity. Especially the persistent smokers attract attention, as it appeared that relatively more persistent smokers were more active. A distinction in depression between the two categories can also be made: more depression was found in the less active group.

For Quetelet index at present, the model showed no differentiation between the two groups (table 4). Once again, more depression is found in the less active group.

Table 4: Relationship between physical activity and Quetelet index after a cardiac event

Variable	β	Se	Exp (B)	p-value
Gender	0.66	0.53	1.93	0.21
Age	-0.04	0.03	0.96	0.20
Anxiety	0.05	0.08	1.05	0.53
Depression	-0.33	0.15	0.72	0.03
Quetelet index	0.00	0.07	1.00	0.99

Discussion

This study investigated earlier findings about physical activity serving as a stimulus for modifying other changeable risk factors after a cardiac event. Although the earlier results could not be confirmed in the present study, some important differences between more active and equally/less active cardiac patients were found.
Comparison of the two categories of activity with regard to smoking habits, adjusting for gender and age, showed that the more active group, surprisingly, consisted of more persistent smokers, while the other group comprised a relatively high number of patients who had never smoked. On closer investigation a slight distinction can be made. The more physically active category (n=32) comprised 71.9% (n=23) smokers; about 69.6% (n=16) of these quitted smoking after the cardiac event. The equally/less active category comprised 49.1% (n=53) smokers; of these 84.9% (n=45) quitted smoking. In other words, smokers in general, and particularly persistent smokers, have a relatively higher probability of becoming physically active.

Considering physical activity as a healthy habit (5, 10) and smoking as an unhealthy habit (22-26), the two seem to be incompatible. Perhaps smokers use physical activity as a compensation for their unhealthy behavior, or perhaps quit smoking seems more difficult than walking another block?

Surprisingly, depression played a considerable role in the differentiation between the two categories of physical activity. The less active patients were more depressed than the more active patients. This concurs with other studies reporting that exercise is beneficial not only for physiological reasons but also for psychological well-being (27), depression (12) and anxiety (2). These psychological characteristics in cardiac patients in turn also influence changes in risk factors. Furthermore, depression has been shown to adversely affect prognosis in cardiac patients (28). Depressed patients have insufficient energy to increase their physical activities, while anxious patients may be too afraid to move. These patients should be encouraged to increase

their physical activities, in attempts to decrease their anxiety and depression. As exercise tolerance is reduced with advancing age a multidimensional approach, as used in the CAPRI program under study, is recommended for the treatment of older MI patients, at least (29).

This study aimed to contribute to the knowledge for supplying tailor-made intervention programs to support CHD patients in their endeavors to modify changeable risk factors for cardiovascular diseases. In investigating whether physical activity could serve as a stimulus to modify other changeable cardiac risk factors we found a differentiation between the two categories of physical activity. These results confirm the need to focus on physical activity in rehabilitation programs, not only for its benefit on physical well-being, but also to improve psychological and health behavior. Because the current study is based on a retrospective analysis in an actually small cardiac population at risk, we will be rather restrictive in our conclusions. Despite this, we would like to emphasize that cardiac patients should be encouraged to increase their physical activities to prevent depression, seen from a secondary prevention point of view (28). Unfortunately, increasing physical activity did not lead to quitting smoking, which confirms our earlier advice to deal with health behavior modification one step at a time after a cardiac event (4, 30). Yet, increasing physical activity seems to be the easiest step, even in older people. Being the most important predictors for decreased physical activity, attention for feelings of anxiety and depression might be part of risk factor modification. Further research is needed to identify a personal physical activity program for each cardiac patient and to investigate how to encourage the next step in health behavior modification.

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Chapter 7

General discussion

Introduction

In recent years, many studies have investigated the effects of intervention programs on traditional coronary heart disease (CHD) risk factors. The results show that primary and secondary prevention are generally effective and important in reducing cardiac risk factors and thereby decreasing morbidity and mortality rates in CHD (1-5). Gradually, most intervention programs developed a multidisciplinary approach and reported positive outcomes (6-9). However, it remains unclear which cardiac patients will benefit from an intervention program and which patients will persist in their unhealthy lifestyle. Cardiac rehabilitation might not in fact be necessary for some patients, whereas for others it may be insufficient or inappropriate (9).
To evaluate the effectiveness of these programs it is first necessary to identify cardiac patients who will improve their lifestyle after a cardiac event regardless of an intervention program, and those patients who will have difficulty in changing or modifying their risk factors by themselves. The latter group of patients might benefit from a tailor-made intervention program, as advised by their treating cardiologist and/or general practitioner.

In this thesis the main aim was to establish why, despite their best intentions, very few patients succeed in adopting a healthier lifestyle after a cardiac event. More specifically, we investigated whether there is a possible relationship between modifiable cardiac risk factors (i.e. smoking habits, physical activity and bodyweight) and biographical and personality characteristics.

The following sections discuss the main results, possible explanations and clinical relevance, methodological issues, and implications for future research and clinical practice.

Evaluation of the main results

Our first empirical study (chapter 2) explored the relationship between personality characteristics and spontaneous modification of smoking habits after a first myocardial infarction (MI) (10). In 164 post-MI patients, a structured interview was conducted and patients were asked to complete psychological questionnaires while still in hospital and again approximately five months later. Patients were categorized according to their smoking habits as: never smokers (n=90), ex-smokers (n=45) or persistent smokers (n=29). Using linear discriminant analysis the personality characteristics of the patients were also analyzed jointly to test whether they could differentiate between the three categories of smoking behavior. We found that persistent smokers could be differentiated from non-smokers and ex-smokers by a significantly higher level of state-anxiety and depression. Young persistent smokers had a high level of depression; elderly persistent smokers were highly anxious and also had a low level of somatization.

The second empirical study (chapter 3) demonstrated the relevance and impact of personality and biographical characteristics on the modification of physical activity after MI (3). Physical activity was (retrospectively) assessed before MI and again five months later in 166 survivors of a first MI. Patients were divided into three categories according to their current daily-life physical activities: less active than before MI (n=24), equally active as before MI (n=82), or more active than before MI (n=60). Multiple linear discriminant analysis revealed a significant difference between patients who became less physically active than before MI and those who became more active or stayed as active as before MI. The less active category was characterized by feelings of disability, a low level of vigor and feelings of anxiety; this group was on average also older and more often female.

The third empirical study (chapter 4) investigated changes in the Quetelet index (QI) after a first MI (11). QI was calculated (weight/(height)^2) for 166 patients a few days

after MI and again five months later. Mean QI after MI was 26.0 (sd 3.6) and after five months was 25.9 (sd 3.3). A QI score between 20 and 25 indicates a healthy weight. Multiple regression analysis was performed, with the QI after five months as dependent variable, and adjustment was made for gender, age and QI at baseline. It was found that strong feelings of vital exhaustion and lack of tension significantly contributed to the prediction of increased QI five months after a first MI.

The structural relationship between the studied risk factors (i.e. smoking, physical activity and bodyweight) was explored by structural equation modeling using the LISREL program (chapter 5) (12). All three risk factors were included at baseline and five months later. The results showed a good fit to the data. The identified model shows that former smoking habits, QI and physical activity were strongly and positively related with the corresponding risk factors five months later. It was found that smoking habits decreased in patients who undertook moderate physical activity such as walking or cycling, five months after MI. In addition, change in QI was also influenced by smoking habits and by moderate physical activity. This suggested that individuals who still smoked after five months had a higher chance of having a lower QI in that period. Moreover, individuals who were physically active in a moderate way five months after MI had a relatively low QI.

Therefore, the last, confirmatory, study (chapter 6) (13) focused on cardiac patients who participated in a physically oriented cardiac rehabilitation program (n=140). We were particularly interested in patients who increased their physical activity whilst participating in this program, and maintained their increased level of physical activity after the program. Participants were divided into two categories according to their present level of physical activity compared with that before the cardiac event. It appeared that the more physically active group (n=32) contained more smokers. Although many of them stopped smoking (69.6%), significantly more persisted (30.4%) in their smoking habits compared with the patients who did not increase their

physical activity (respectively 84.9% and 15.1%). While this study could not confirm that physical activity directly stimulated smoking cessation or a lowering of the QI, the more active patients appeared to be less depressed.

Possible explanations and clinical relevance

Although cigarette smoking is generally accepted as an important risk factor for cardiovascular disease, about 40% of the smokers in the study described in chapter 2 did not change their smoking habits after their first MI. This finding is in line with other reports (1, 14-18), which found that depression and anxiety might play an important role in maintaining smoking habits. Presumably, smoking is a consequence of operant conditioning by its relaxing properties in times of stress or nervousness. For most people, smoking cessation causes a great deal of tension if no alternative is offered to avoid, suppress or cope with feelings of stress.

Besides smoking, a sedentary lifestyle is also considered a major risk factor for cardiovascular diseases (19). Although the patients described in chapter 3 were not specifically asked about their knowledge on risk factors, it is assumed that this generally accepted notion about a sedentary lifestyle is probably the reason why 36% of the patients in that study became physically more active of their own accord after their first MI. Although 49% remained on the same level, 15% became less active or stayed as inactive as before MI. The less active group had feelings of disability, a low level of vigor and feelings of anxiety, and was, on average, older and more often female.

Perceiving more feelings of anxiety and less vigor is in accordance with the general finding that women experience more emotional symptoms than men (20). Additionally, the relationship between being older and experiencing less vigor appears to be self-evident. The presence of strong feelings of disability after MI in this particular group can probably be explained by the combination of biographical and personality characteristics.

Thus, biographical characteristics may also play a major role in physical inactivity: the high mean age and, thus, the negative work status of this sedentary 'less active' category may explain why these patients have less opportunity to improve their physical activity level. The proportionally high prevalence of mostly elderly female patients in this sedentary category concurs with other reports (21-23). Particularly older women may have difficulty in overcoming patterns of socialization that underestimate the importance of leisure and physical activity for females (23, 24). A healthy weight is generally reflected in a QI score of 20-25. Because 57% of the patients in chapter 4 had a QI of 25 or more at baseline, this indicates that the sample population is relatively overweight (in 40% of the general Dutch population a QI of 25 or more is found, (25)). Considering QI as an isolated risk factor (chapter 4) indicates that vital exhaustion and lack of tension are important characteristics for being overweight.

A possible (but speculative) explanation for the association between a rise in QI after MI and vital exhaustion could be the occurrence of a vicious cycle: feelings of vital exhaustion and a relaxed, sedentary lifestyle might lead to eating in excess of the physical need, and finding relief in eating. This in turn can lead to weight gain, body dissatisfaction, possible disappointment about own one's 'weak' attitude and lack of perseverance, and persistence of feelings of vital exhaustion. It should be stated that an investigation of the eating pattern of our cardiac patients was beyond the scope of this study.

That relatively less tension contributes to a relative increase in QI may be explained by feelings of convenience: "Everything is under control." Patients may deny the severity of the cardiac problems, refuse to improve their current lifestyle and neglect to reduce their bodyweight. This attitude is supported by a study in which the treatment of the physically healthy obese patients was determined with the help of a personality classification system (26).

Using both the Rorschach test and interviews by psychiatrists, types of personality were classified into four groups according to the healthiness of personalities. Type Ia was

classified as 'indifferent type'. These patients were always passive and indifferent to everything, including their appearance and bodyshape; they had a tendency to deny undesirable realities. This patient group seemed to be the most common type in obese patients. Type Ib was classified as 'immature type'; this type was found in younger patients and therefore not applicable to the present study. Type II was classified as 'false stable type'. These patients seemed apparently stable but were suffering from psychological distress; they often ate to escape from distress. Type III was classified as 'maladjusted type'; they were unable to adjust to their situation. The lack of tension found in the present study conforms with the 'indifferent' Type Ia, while the relatively strong feelings of vital exhaustion conforms with both Type II and Type III. Patients experienced psychological distress due to their cardiac history and had problems in adapting to their new situation because of their inability to give up their unhealthy eating habits (26).

For research purposes, considering the cardiac risk factors separately might be relevant to formulate theories about risk factor modification. Thus, biographical and personality characteristics are examined and determined in order to differentiate between cardiac patients who modify their smoking habits, increase their physical activity and try to lose weight, and those patients who persist in unhealthy behavior. However, in real life, the individual risk factors influence or even reinforce each other (27) and cannot be considered as isolated behavior. Therefore, a model was constructed (using the LISREL program) to explore the underlying relationship between the different risk factors and personality characteristics (chapter 5). It was found that smoking habits played an intervening role between the risk factors, indicating that an intervention should focus on a positive change in smoking habits, even though this is difficult. Because an increase of moderate physical activity, such as walking and cycling, had a positive impact on smoking habits and QI, the intervention should perhaps also focus on changes in physical activity. This implies that if the cardiac patient is physically more active in a moderate way, the greater the

chance for a positive effect on both smoking habits and/or bodyweight (28). This is in accordance with the theory of a global readiness to change, in which the cognitive processes leading to a change in one behavior may lead to sequential change in other behaviors (29). According to this theory, increased self-efficacy in one behavior may positively affect another; this concept is in agreement with a social cognitive theory, in which the weighing of positive and negative beliefs is supposed to result in outcome expectations (30). It is noteworthy that in the model found in the present study (chapter 5), contrary to expectations, psychological characteristics (e.g. depression) played no role at all.

To confirm and elucidate the found model, cardiac risk factors were investigated in patients who participated in a cardiac rehabilitation program. This program consists of physical activity twice a week for about three months (chapter 6). Current feelings of anxiety and depression were also assessed. In this study, the hypothesis derived from the previous model was that the patients who maintain their increased physical activity after the program has ended, are more likely to modify other risk factors than those patients who revert to their usual sedentary life. However, it appeared that the more physically active group contained more smokers. Although many of them did stop smoking (69.6%), significantly more persisted in their smoking habits than those who did not increase their physical activity. An explanation can be found in the personality trait 'sensation seeking' (31, 32). Patients with high scores on this trait tend to find internal 'drugs' or external stimuli, supposedly in order to maintain a mental equilibrium. It is possible that this trait is the underlying factor both for smoking and engaging in physical activities.

While there is some evidence to suggest that participation in physical activity may have a positive impact on smoking cessation (33, 34), there is still much to learn about the relationship between cognitive-behavioral (self-efficacy) and motivational mechanisms (stage of change), which have been shown to mediate changes in both physical activity and smoking cessation.

Finally, significantly less depression was found in the more active patients. This concurs with other studies reporting that exercise serves to decrease both the physiological and the psychological responses to stress and helps to temper mood changes, such as depression (35), well-being (36) and anxiety (3), which often accompany smoking cessation. These latter results are in line with our studies focusing on smoking habits and physical activity separately (chapters 2 and 3).

Methodological limitations

In the current study, some related concepts were not investigated. The personality characteristics that we included are reported in literature (37-39) to be representative for the three risk factors under investigation as predictors for secondary prevention. Other characteristics, for example hostility, did not play a role in our study, although hostility has been reported to be a particular personality characteristic of persistent smokers (40-43). This latter characteristic has proven its value as a predictor for CHD focused on a first acute coronary syndrome, but not with respect to secondary prevention.

Research findings concerning the Type D personality are also not addressed. Very recently, and therefore not discussed in this study, psychological distress has been associated with increased morbidity and mortality in cardiac patients. The tendency to experience negative affectivity and the propensity to inhibit self-expression in social interaction designates a personality type (i.e. Type D) of coronary patients with an increased risk of fatal and nonfatal cardiac events (44, 45).

It is generally assumed that all patients try to avoid a second cardiac event; moreover, whilst they are still in hospital they are highly motivated to positively influence their cardiac risk factors. Therefore, in addition to personality characteristics, it seems worthwhile to focus on the structure of the motives of cardiac patients to change existing risk factors and, thus, on the development of motivation techniques for intervention. Some patients persist in their unhealthy smoking habits to avoid gaining weight (46, 47), but other reasons, such as habituation, may also play a

role in maintaining risk behavior. The motivation of patients to e.g. increase their physical activity and/or take advantage of nearby sports facilities can depend on unknown (maybe practical) reasons. Motivation can also be influenced or reinforced by persons close to the patient. It is known that lack of social support (e.g. from the partner, family members and/or others in the patient's environment) is considered a risk factor for CHD and that social support can improve the smoking cessation rate (48-50). The influence of social support was, however, not included in this study.

Another methodological consideration is the choice of measurements. In the present studies, individual habits were reported subjectively and retrospectively by the patients. However, because it is known that the deception rate of smokers with regard to their smoking habits ranges from 16% to 40% while participating in a smoking cessation program (51, 52) one should not overrate the significance of the results of these programs. On the other hand, biochemical measures used to try and avoid this problem are also unreliable (53-55). Comparing self-reports with biochemical measurements among respondents not involved in a smoking cessation program shows a high correspondence between the different methods. Knowing this, and in spite of the shortcomings of the method, a choice was made for the method which is less burdensome for the patient and is less costly, i.e. a structured interview.

Considering the relatively high age of the patients in relation to sports activities, those who maintained 'sport' activities at a level adjusted to their age were also included in the physically active group. Furthermore, it is noteworthy that in the 'more active' and the 'equally active' categories, the scores of the personality characteristics were very similar. This may be due to a 'ceiling effect' in which the 'equally active' category was already physically active and could not demonstrate much more improvement. It is possible that the three categories we defined were too crude to differentiate between the different levels of physical activity and may misrepresent the real activity levels of the patients.

The psychological variables were also based on self-reported questionnaires. A major problem of self-report questionnaires is that they are prone to be influenced by

social desirability and may, therefore, not always be helpful in identifying real distress (56). A concomitant problem is that gender can influence socio-cultural differences. For example, it seems more acceptable for women to express their feelings, and deal with discomfort and dependency, whereas men tend to deny and rationalize their feelings (20). All these problems can threaten the validity and interpretation of the results of the questionnaires.

The study design, with its two measurement points can, of course, only give a limited impression of the patient: first in hospital, and then again about five months later. A 5-month interval before the second measurement was chosen because it allowed a reasonable number of patients to participate in a cardiac rehabilitation program (lasting about 3 months) after discharge from hospital. After five the possible influences of such a program are assumed to be stabilized.

Another procedural item is that, for the second measurement patients were asked to fill in the questionnaires at home and return them by mail. Although we expected patients to complete the questionnaires themselves, we have no way of verifying this.

Another limitation of this study is that it was not possible to ascertain what advice was given to the patients by their cardiologist and/or general practitioner to change their risk factors after discharge; particularly because the study involved different cardiologists from three different hospitals. Although such advice will have some influence (but is not quantifiable by us), any possible effect will nevertheless be equally divided among the patients.

Future research

To replicate, confirm and differentiate our findings, more studies are needed on the modeling of risk factors and the determinants of risk factors. Especially the structural modeling approach (LISREL), with competing models, seemed to be of clinical

relevance. A strategy of epidemiological studies of risk factor modification, leading to intervention studies could be useful to test causal relationships. The LISREL structural modeling approach should be used for longitudinal study designs with repeated measurements to elucidate the interrelationships of the determinants of risk factors.

It is necessary to identify additional determinants of risk factors, either theoretically or empirically. A prospective, longitudinal study is needed in which all relevant factors are measured over time.

It was striking that, contrary to our expectations, the final model in this study comprised none of the psychological characteristics of the patients at all. According to our earlier studies (chapters 2 and 3), feelings of anxiety and depression apparently play a crucial role in cardiac patients. Other cardiac studies also found that strong feelings of anxiety and depression play a major role in recovery after CABG (57), and in non-cardiac patients with chest pain feelings of anxiety, depression and somatization were found to be stronger than in cardiac patients (58). Therefore, in spite of our negative finding regarding their role in the found model, psychological characteristics such as anxiety and depression should not be left out of the model.

In the model found in this study (chapter 5), smoking habits play an intervening role between the risk factors. Thus, it seems rational that an intervention should focus on a positive change in smoking habits. However, the recent EUROASPIRE study on the status of secondary prevention of coronary heart disease in nine European countries has shown that success in smoking cessation among CHD patients is far from satisfactory (59). Perhaps other forms of intervention such as psychological counseling, nicotine substitution or psychopharmaca need to be included in the investigation. Further, to avoid subjective error, it is recommended to measure smoking habits by means of biochemical measurements (51-55) and physical activity by means of a physiological test (60, 61).

Besides smoking habits, moderate physical activity such as walking or cycling appeared to modify other risk factors (chapter 5). When considering cardiac rehabilitation (chapter 6), it seems that patients who maintain their increased physical activity level after the program ends are more able to modify other risk factors, e.g. smoking. Why do not all cardiac patients maintain their improved level of physical activity and modify their other risk factors?

There is some evidence that once an individual is highly motivated to change one risk factor, changing another risk factor becomes more feasible. Successful modification of one risk factor seems to boost self-efficacy, which in turn can enhance motivation to change a second risk factor (29). Level of self-efficacy represents the degree to which an individual believes he can successfully change a particular behavior. Low self-efficacy combined with no intervention generally resulted in a relapse after initial smoking cessation (62), whereas matching smoking cessation interventions to the stage of change improves its success (63, 64).

This 'Stages of change' construct, developed from the Transtheoretical Model of Change (65), comprises five categories of change ranging from not being ready, to taking action, to maintenance. By means of a few simple questions, a patient's stage of change can be assessed and a tailor-made strategy for intervention can be developed. Thus, it is important for intervention programs to identify a patient's readiness to change by using this stage of change construct.

Studies investigating the modification of two or more risk factors simultaneously found that smokers were significantly more likely to lead a sedentary life than non-smokers (33, 34). Moreover, smokers higher in motivation for smoking cessation were more physically active than those less motivated to quit (66). Further, it was found that smokers '*in action*' to quit smoking were significantly more confident in their ability to exercise than smokers '*in preparation*' to quit. In addition, smokers who exercised regularly were significantly more confident in their ability to quit smoking than smokers exercising less regularly.

Thus, exercise may be a more effective intervention strategy for smokers who have already made some changes in their smoking habits (29).
These findings in the general population are in line with our model (chapter 5) and study results (chapter 6) in post-MI patients. Cardiac rehabilitation based on physical activity seems to be beneficial not only for physiological reasons and psychological well-being, but also as a motivation to change other risk factors.
Thus, the reasons why post-MI patients do not participate in a rehabilitation program, or lead a sedentary life (even when not restricted by their physical health) also need to be included in the investigation.

Recommendations for clinical practice

Based on the results of this study some recommendations can be made regarding public health policy. Generally, after MI cardiologists and/or general practitioners should focus on secondary prevention and therefore encourage patients to change their risk factors. Such prevention might be accomplished by giving adequate information about the somatic aspects of the experienced coronary event, the benefits of existing cardiac rehabilitation programs, and emotion- and problem-focused coping strategies in daily life. According to our findings and those of others, increasing moderate physical activity such as walking and cycling seems to be the easiest step. In particular, patients who do not have the opportunity to participate in standardized exercise rehabilitation programs (because of their physical health status, age or other practical circumstances) should be encouraged to become more physically active in daily life. Patients should receive advice from their cardiologist or general practitioner about physical activity programs applicable in daily life. This particularly applies to older women, because they may have difficulty in overcoming patterns of socialization that underestimate the importance of leisure and physical activity for females (23, 24).
The results of this study also have implications for psychological aspects of the convalescent period after MI, such as possible early detection of feelings of anxiety, depression, disability, and diminishing vigor. Depressed patients have insufficient

energy to increase their activities, while anxious patients may be too afraid to move. Especially these latter patients should be encouraged (again, individually) to increase their physical activities, in an attempt to decrease their anxiety and depression. Being the most important predictors for decreased physical activity, paying attention to these feelings is a necessary part of risk factor modification. Therefore, before the start of cardiac rehabilitation, the intake interview should focus on each underlying emotional aspect mentioned by the patient in order to offer an individual tailor-made rehabilitation program.

Once the step to increase moderate physical activity has been taken, the second step (according to our findings) should be to deal with another risk factor, for example smoking. The easiest and most successful way to achieve this would be an intervention program aimed specifically at smokers with high levels of anxiety and depression. Use of both a psychological questionnaire and the 'stages of change construct' can reveal the underlying psychological problems that need to be taken into account. Psychological counseling or other aids can help to avoid increased feelings of depression after smoking cessation. Such an intervention program should also focus on related thoughts and behavior, and encourage patients to improve or change in a positive way. Because particularly cardiac patients are expected to translate (unconsciously) their problems into somatic terms, an intervention focused on their bodily awareness (with, e.g. breathing therapy (67) as an alternative to smoking) may be useful. Because participation in physical activity does have a positive impact on smoking cessation (33, 34), it seems obvious that cardiac rehabilitation programs should offer smoking cessation groups in addition to their physical activity programs.

The next step is to deal with another risk factor, such as being overweight. In the present study group 47.5% of the patients participated in a cardiac rehabilitation program focused on physical activity. Of the 30 patients that had an increased QI, 15 participated in such a program. Unfortunately, participation in a cardiac rehabilitation

program does not guarantee any success with respect to loss of bodyweight (4). These overweight patients should be encouraged to change their diet whilst increasing their physical activity. Again, a diet intervention group seems feasible within a rehabilitation program that also offers physical activity and smoking cessation interventions.

In conclusion, the findings of the present studies indicate that, as a first step in secondary prevention, a patient should be offered a comprehensive psycho-diagnostic investigation immediately after the cardiac event. To avoid the bias of one measurement method, a multi-method approach is recommended including psychological questionnaires, structured interviews and clinical ratings. Psychological problems (e.g. depression and anxiety), psychosocial factors (e.g. self-efficacy, stage of change, motivational aspects and health belief), and personal needs to change risk factors can be identified. Having assessed the patient's level of motivation, targets can be formulated and a tailor-made rehabilitation program can be composed, starting with increasing moderate physical activity. The ultimate goal is to achieve the necessary and realistic risk factor modifications suited to the limitations of each patient.

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Summary

Primary and secondary prevention seem very effective and important in reducing cardiac risk factors and therefore decreasing morbidity and mortality rates in coronary heart disease. However, it is unclear which cardiac patients benefit from intervention programs and which patients will sustain in their unhealthy behavior. Cardiac rehabilitation might not be necessary for some patients and is not sufficient for others.

To evaluate the effectiveness of these programs it is of great importance to identify cardiac patients who improve their lifestyle after a cardiac event regardless an intervention program, and patients who have difficulty managing a change in their risk factors by themselves. The last group of patients could be helped by a tailor-made intervention program, advised and offered by their treating cardiologist and/or general practitioner.

This thesis presents the results of an investigation for the relationship between modifiable cardiac risk factors (smoking habits, physical activity and bodyweight) and biographical and personality characteristics. The general goal was to find out why, despite all good intentions, only few patients succeed in adapting a healthy lifestyle after a cardiac event. If specific characteristics and personal needs to change risk factors can be identified, targets can be formulated and a tailor-made rehabilitation program can be composed and offered. With as ultimate goal to achieve necessary and realistic risk factor modifications within the physical and psychological limitations of the patient.

Chapter 1 is a general introduction in cardiac rehabilitation, which leads to the conclusion that only a small amount of patients actually change their risk factors. This results in the aim to investigation the reason why only few patients succeed in adapting a healthier life-style after a cardiac event.

determinants of risk factors jointly seems relevant. It was surprising that, contrary to our expectations, the final model in this study comprised none of the psychological characteristics of the patients at all. According to our earlier findings (chapter 2, 3 and 4) feelings of anxiety and depression apparently play a crucial role in cardiac patients. The fact that psychological characteristics were left out the LISREL model does not mean they have no significance.

Psychological problems, psychosocial factors, and personal needs to change risk factors can be identified together with the patient's level of motivation. Having assessed the patient's level of motivation, targets can be formulated and a tailor-made rehabilitation program can be composed, starting with increasing moderate physical activity. The ultimate goal is to achieve the necessary and realistic risk factor modifications suited to the limitations of each patient.

Samenvatting

Primaire en secundaire preventie blijken effectief in het reduceren van risicofactoren voor hart- en vaatziekten. Het vóórkomen van hart- en vaatziekten wordt hierdoor verminderd en het sterftecijfer daalt. Toch blijft het vooralsnog onduidelijk welke hartpatiënten profijt hebben van hartrevalidatieprogramma's en welke patiënten volharden in ongezond gedrag. Hartrevalidatie blijkt niet noodzakelijk voor elke patiënt en is tegelijkertijd niet voldoende effectief voor anderen.
Om het effect van hartrevalidatie programma's te kunnen vaststellen, is het belangrijk die patiënten te kunnen identificeren die hun levensstijl adequaat verbeteren na een cardiale gebeurtenis, ongeacht een interventieprogramma, en patiënten die juist problemen ondervinden bij het zelf veranderen van risicofactoren. Deze laatste groep patiënten zou geholpen zijn met een op maat gemaakt interventieprogramma, geadviseerd en aangereikt door hun behandelende cardioloog en/of huisarts.

Dit proefschrift presenteert de resultaten van een onderzoek naar de relatie tussen risicofactoren voor hart- en vaatziekten die te veranderen zijn (rookgewoonten, lichamelijke activiteit en lichaamsgewicht) en biografische en persoonlijkheids-kenmerken. Het doel was uit te vinden waarom, ondanks alle goede voornemens, het slechts weinig patiënten lukt om na een cardiale gebeurtenis een gezonde levensstijl aan te nemen. Wanneer specifieke kenmerken en persoonlijke voorkeuren om risicofactoren te veranderen kunnen worden geïdentificeerd, kunnen doelen worden geformuleerd en op maat gemaakte interventieprogramma's worden samengesteld en aangeboden. Het uiteindelijke doel is noodzakelijke en realistische veranderingen in risicofactoren te bewerkstelligen, rekening houdend met de fysieke en mentale beperkingen van de patiënt.

Hoofdstuk 1 is een algemene introductie over hartrevalidatie, waarbij geconcludeerd wordt dat het slechts een gering aantal patiënten lukt om risicofactoren te veranderen. Dit leidt tot de doelstelling van het onderzoek om na te gaan wat de

rookgewoonten in vergelijking met de minder actieve groep (n=108). De actieve groep was significant minder depressief.
Ondanks het feit dat dit onderzoek niet kon bevestigen dat lichamelijke activiteit een stimulans is om te stoppen met roken of om het lichaamsgewicht te verlagen, bleken de actieve patiënten wel minder depressief te zijn.

Tot slot bevat *hoofdstuk 7* een algemene discussie waarin de belangrijkste bevindingen worden becommentarieerd. Verder worden methodologische beperkingen van het onderzoek, suggesties voor toekomstig onderzoek en aanbevelingen voor de klinische praktijk besproken.
Individuele risicofactoren beïnvloeden of versterken elkaar en kunnen om die reden niet geïsoleerd beschouwd worden. Dus lijkt de benadering van het modelleren van risicofactoren en determinanten van risicofactoren gezamenlijk, relevant. Het was verrassend dat, in tegenstelling tot onze verwachting, het uiteindelijke model in dit onderzoek geen psychologische kenmerken van de patiënt bevatte. Volgens onze eerdere bevindingen (hoofdstuk 2, 3 en 4) spelen gevoelens zoals angst en depressie namelijk wel degelijk een cruciale rol. Het feit dat psychologische kenmerken niet in het LISREL model opgenomen worden, impliceert echter niet dat ze geen rol van betekenis kunnen spelen.
Psychologische problemen, psychosociale factoren en persoonlijke voorkeuren om risicofactoren te veranderen kunnen vastgesteld worden, samen met de motivatie van de patiënt. Door het bepalen van de motivatie van de patiënt, kunnen doelen worden geformuleerd en kan een revalidatieprogramma op maat worden samengesteld, beginnend met het verhogen van de gematigde lichamelijke activiteit. Het uiteindelijke doel is noodzakelijke en realistische veranderingen te bereiken, rekening houdend met de individuele beperkingen van de patiënt.

Dankwoord

Gedurende je leven ontmoet je veel mensen. Sommigen maken je mee als familielid, anderen als collega, vriendin of kroegmaatje. Het schrijven van een proefschrift gebeurt parallel aan deze contacten en dit heeft, bewust en onbewust, een bepaalde invloed. Zeker als het proces langzaam maar gestaag vordert. Een aantal mensen wil ik dan ook in het bijzonder bedanken voor hun aandeel in de totstandkoming van dit proefschrift.

Allereerst natuurlijk mijn promotor, Jan Passchier. Toen ik lang geleden aan het onderzoek begon bij de afdeling Medische Psychologie en Psychotherapie, konden we beiden niet vermoeden wat een lange periode van samenwerking er in het verschiet lag. Jan, ik wil je graag bedanken voor de mogelijkheden die je me geboden hebt. Eerst, door na afronding van het onderzoek me alle tijd, ruimte en energie te geven om verder te gaan en het traject voor het schrijven van een proefschrift in te zetten. Later, om je lange adem om samen de boel weer op te pakken en alsnog af te ronden. Bedankt voor je kritische commentaar op mijn stukken, waarbij je altijd precies díe alinea wist aan te wijzen waar ik zelf ook niet helemaal blij mee was. Ook het blijven zien van de grote lijnen en niet verzanden in details en het kritisch kijken naar je eigen werk wist je me bij te brengen.
Mijn co-promotor, Ruud Erdman, die me net als Jan vanaf dag één heeft bijgestaan in het opzetten, uitvoeren en opschrijven van het onderzoek. Je hebt me gedurende het onderzoek dagelijks begeleid in het omgaan met hartpatiënten en wist, door je kennis en ervaring op dat gebied, van ieder cijfertje een patiënt te maken met zijn eigen verhaal. Ook bij het opschrijven van de resultaten wist je steeds de link te leggen naar de klinische relevantie van het onderzoek. Dankjewel voor het vertrouwen dat je in me hebt gehouden en je steun en adviezen bij de laatste loodjes.
Mijn andere co-promoter: Jaap Deckers. Je was vanuit het Erasmus MC (toen nog Dijkzigt-ziekenhuis) erg betrokken bij het implementeren van het onderzoek op de afdelingen cardiologie en het vanuit cardiologisch oogpunt benaderen van het

Curriculum vitae

Irma Huijbrechts was born on January 4th, 1966. After completing grammar school she studied experimental psychology at Leiden University. For her graduation she participated in a clinical trial at the department of Psychiatry of the Sophia Children's Hospital, Rotterdam. She graduated in 1990 on dysfunctional attention in children diagnosed 'Attentional Deficit Disorder with Hyperactivity (ADHD)'. After graduation she worked for several months for a project engaged in long-term unemployment in the city of The Hague.

In 1991 she participated in a research project concerning quality of life in patients after a myocardial infarction or a stroke, at the department of Epidemiology and Biostatistics of the Erasmus University, Rotterdam. From 1992 until 1995 she was a researcher at the Department of Medical Psychology and Psychotherapy of the Erasmus University Rotterdam and at the departments of Cardiology of the Rotterdam University Hospital, the Havenziekenhuis, Rotterdam and the Holy-ziekenhuis, Vlaardingen. Supported by a grant of the Netherlands Heart Foundation she carried out the study described in this thesis.

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