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Constructing a Coronary Scale for Ischemic Heart Disease: Case-Control Study

Andrej Marušič, Radovan Starc[1], Dorjan Marušič[2]

Institute of Psychiatry, University of London, London, UK; Institute of Public Health of Republic of Slovenia; [1]Clinical Department of Cardiology, Clinical Center; and [2]Ministry of Health of Republic of Slovenia, Ljubljana, Slovenia

Aim. To develop a scale measuring proneness to ischemic heart disease.

Methods. Ischemic heart disease was angiographically documented in 187 men. In 187 matched controls the diagnosis of ischemic heart disease was ruled out by examination of medical records and history data, and when necessary, clinical examination and specialized diagnostic procedures. Item analysis of the Eysenck Personality Questionnaire (EPQ) was performed on 100 men with ischemic heart disease and their male controls, and then a replication study was performed on the remaining 87 pairs.

Results. A Coronary Scale was constructed from 8 EPQ items significantly and consistently different between the groups. Most of these items were drawn from the neuroticism scale. The Coronary Scale yielded significant correlations with emotionally saturated psychological variables.

Conclusion. Coronary Scale may be useful in everyday practice to select patients with ischemic heart disease and those who are at higher risk to develop disease. It could be used for detecting a high-risk group of emotionally labile subjects to concentrate efforts for prevention of coronary disease.

Key words: *coronary disease; mass screening; questionnaires; risk factors; type A personality*

Several studies reported personality differences between patients with ischemic heart disease and healthy subjects (1-3). Established behavior pattern of a type A personality is characterized by excessive drive and ambition, impatience, competitiveness, sense of time urgency, and poorly contained aggression, and is more frequent among people suffering from ischemic heart disease (1). Instruments measuring type A behavior have been the most widely used in this field. However, by interpreting almost everything in terms of the type A behavior, one may lose appreciation for the multidimensional nature of the coronary-proneness, which should also include different personality traits and maladaptive coping styles. Indeed, recent research into the psychological and behavioral correlates of ischemic heart disease has gone beyond the traditional description of the type A behavior pattern and has focused on components that may be more sensitive predictors of ischemic heart disease endpoints (1). Most commonly investigated personality traits in patients with ischemic heart disease were emotional instability (2-4), competitiveness (5), hostility (6-8), impulsivity (9,10), cynicism (11), and sensitization (12). In terms of coping with stress, only emotional coping was predictive of deteriorated health (13,14).

Out of the investigated personality traits, emotional instability or neuroticism should be of particular importance as they imply increased reactivity to stressors, which might adversely affect bodily homeostasis (15,16) and thus promote the progression of ischemic heart disease (13). However, the notion that neuroticism and emotional instability precede ischemic heart disease was particularly criticized by Costa (17), who claimed that neuroticism was related to increased somatic complaints but was not causally related to objective signs or pathophysiological evidence of disease, especially ischemic heart disease. The best way to deal with this dilemma would be to investigate neuroticism together with a variable of over-reporting emotional reactions, determined by physiological measures of emotional reactivity as sensitization (18). In fact, our previous research showed that both sensitization and neuroticism were important traits of patients with cardiovascular disease (19).

The nature of relationship between these personality characteristics and development or consequences of ischemic heart disease is not clear. Mech-

anisms that may mediate psychosocial influences on ischemic heart disease have been investigated only recently (20). Apart from the well known alterations in health-related behavior (21), some other mechanisms have been suggested, such as increased myocardial oxygen demand (22), decreased coronary blood supply due to precipitating vasoconstriction of atherosclerotic coronary arteries (23), hemoconcentration (24), enhanced blood clotting (25), and increase in plasma lipoproteins (26). Each of the suggested mechanisms implied possible relationship between psychosocial and biological risk factors.

We looked in more detail into the nature of the personality differences between patients with ischemic heart disease and healthy control subjects. Following Gossop and Eysenck's study procedure, we applied the 1975 version of Eysenck Personality Questionnaire (EPQ), which was used in many studies on the biological foundation of personality (27-29). The EPQ is scored for three main axes of personality: extraversion (E), neuroticism (N), and psychoticism (P). Extraversion consists of sociability, activity, and assertiveness; neuroticism consists of anxiety, inferiority, and unhappiness; and psychoticism consists of risk-taking, impulsiveness, and irresponsibility. The Lie (L) scale, which indicates the extent of defensiveness, was also measured. It was hypothesized that it would be possible to single out a specific combination of items that would consistently discriminate between patients with ischemic heart disease and healthy subjects. It was expected that the majority of these items would be drawn from the neuroticism scale. The overall study was divided into two steps: first, the analyzed the EPQ items and then we investigated the associations between the suggested Coronary Scale and other variables.

Method

The study consisted of three parts: two case-control studies and a correlation study.

Case-Control Study I: Development of Coronary Scale

There were 200 subjects included in the first case-control study. The subjects were divided into two groups. The ischemic heart disease group 1 included 100 men (mean ± SD age, 56.8 ± 9.4 years) with ischemic heart disease who underwent coronary angiography at the Clinical Center in Ljubljana and had at least 50% narrowing of at least one coronary artery and/or had been diagnosed with myocardial infarction. The control group 1 was composed of 100 healthy men (mean ± SD age, 56.6 ± 10.3 years), of whom 77 were inpatients from other departments in the same institution and 23 were outpatients invited for a preventive medical examination. There were no important differences between the outpatient and inpatient control subjects (data not shown). In all controls, the diagnosis of ischemic heart disease was ruled out by the examination of medical records and history data and, when necessary, clinical examination and specialized diagnostic procedures. The ischemic heart disease group and control group were well matched for sex, age, place of data acquisition, and testing. In addition, all exclusions or restrictions made in the identification of the ischemic heart disease cases applied equally to both groups. Only men were included in the study because of the lower percentage of women with ischemic heart disease. The exclusion criteria were a history of terminal illness, head injury, and mental illness. All participants gave informed consent to participate in the study.

The outcome variable of the initial case-control study was the presence or absence of evidence of ischemic heart disease. The exploratory variables consisted of all items of the Eysenck Personality Questionnaire, version 1975 (28), which has been standardized and widely used in Slovenia since the late 1970s (30). The E, N, and P scales used in this questionnaire were developed in several factorial studies, each using slightly different items, selected partly on the basis of the results obtained in previous analyses, partly on the theoretical basis.

The Coronary Scale was developed from the EPQ items in which the two study groups differed most. Chi-square test was used to assess the significant difference in EPQ items between the ischemic heart disease group 1 and control group 1, and coefficient Phi was calculated for every single item. The Cronbach's alpha for internal consistency reliability was calculated for the Coronary Scale.

Case-Control Study II: Testing Coronary Scale

Out of a total of 174 subjects who took part in the second case-control study, 87 were men (mean ± SD age, 56.9 ± 9.6 years) with ischemic heart disease. They constituted the ischemic heart disease group 2 according to the same criteria as for the ischemic heart disease group 1. Out of the remaining 87 patients, who constituted the control group 2 (mean ± SD age, 56.4 ± 10.2 years) according to the same criteria as those for the control group 1, 67 were inpatients from other departments in the same institution and 20 were outpatients invited for a preventive medical examination. Again, there were no significant differences between the outpatients and inpatients in the control group 2 (data not shown).

Like in the case-control study 1, the outcome variable was the presence or absence of evidence of ischemic heart disease. On the other hand, the exploratory variables consisted of only 18 items from 1975 version of the EPQ, which significantly discriminated between the two groups in the first study.

The item analysis of the case-control study 2 was conducted again on 87 pairs of patients with ischemic heart disease and their controls. The final coronary-proneness scale was composed of all the items that continued to differentiate between the two groups. The independent sample t-test was performed to compare mean scores of Coronary Scale for patients with ischemic heart disease and their controls. Cronbach's alpha was calculated to measure the internal reliability of the scale.

Correlation Study

Data on all 374 subjects included in the first and second case-control studies were analyzed. The overall ischemic heart disease group included 187 men (N = 100 + 87; mean ± SD age 56.8 ± 9.5), and the overall control sample included 187 healthy controls (N = 100 + 87; mean ± SD age 56.5 ± 10.2). The main variable studied in this correlation analysis was the Coronary Scale (Cor). Other variables were psychological variables and biological risk factors for ischemic heart disease.

Psychological variables included personality traits and coping styles, which are among the most important variables in the field of the health psychology. The EPQ was used to measure main personality traits (E, N, and P) and defensiveness (L). Another variable that originated from EPQ scores was sensitization of emotion (Sen). According to Gudjonsson's criteria (18), sensitization is present when the subject has the N score above and the L score below the median. The Coping Styles Questionnaire (CSQ) (31) was used to measure four main coping styles: rational (RATCOP), emotional (EMCOP), avoidance (AVCOP), and detached (DETCOP) coping. The Coping Styles Questionnaire was adapted for the Slovene population just before the beginning of this study; psychometric and statistical techniques used to establish the equivalence of the source and target language of the instrument, as well as the evaluation of their validity, are described elsewhere (32).

In the group of biological variables, most standard risk factors for ischemic heart disease were included, as follows: family history of ischemic heart disease (percentage of relatives with ischemic heart disease), lipid profile (total cholesterol, high-density lipoproteins, and low-density lipoproteins), presence or absence of hypertension, plasma fibrinogen as a measurement of risk associated with blood clotting, and presence or absence of smoking history.

The final traits of the scale were assessed by calculating Pearson's and bivariate correlation coefficients between the Coronary Scale and all other variables, and for ischemic heart disease

patients and control subjects. For all statistical analyses, we used SPSS 7.5 for Windows (SPSS Inc., Chicago, IL, USA).

Results

Construction of the Coronary Scale

The item analysis revealed 18 items discriminating between the groups beyond the 0.05 level of significance (Table 1). The most obvious pattern was the predominance of neuroticism scale items in the ischemic heart disease patients, who endorsed a large number of items expressing feelings of anxiety and depression. The L scale also discriminated between the groups, accounting for one third of the items (6/18). Five of L scale items could be described as low defensiveness. The remaining items included four from the E scale, and only a single item from the P scale. Three of the E items implied introversion, whereas the fourth indicated extraversion, ambition, and chronic sense of time urgency. The P item indicated a willingness to reject a conventional habit.

At this point of analysis, two coronary-proneness scales were suggested, consisting of EPQ items by which the groups differed most. The Coronary Scale 1 was shorter and constructed from 6 items that discriminated between the ischemic heart disease group and the control group with Phi >0.20 ($p<0.005$). These items were drawn from the N scale only. These 6 and the remaining 18 items were included in the Coronary Scale 2 discriminating beyond the 0.05 level of significance (Table 1). Higher alpha coefficients were obtained for the Coronary Scale 1 (0.84 for the control group and 0.73 for ischemic heart disease group). For the Coronary Scale 2, both alpha coefficients were below 0.70 (0.65 for the ischemic heart disease group, and 0.64 for controls).

Table 1. Items from the Eysenck Personality Questionnaire (EPQ), which significantly differed ($p<0.05$) between patients with ischemic heart disease (IHD) and controls

Scale (n = 200)	EPQ scale and item number[a]	Score (%)[b] IHD patients	controls	p[c]
Coronary Scale 1[d]	N 15	71	37	<0.001
	N 41	59	34	<0.001
	N 31	56	33	<0.05
	N 75	58	35	<0.05
	N 3	59	37	<0.05
	N 72	81	63	<0.05
Additional items to Coronary Scale 2[e]	E 14	59	40	<0.05
	L 55	39	22	<0.05
	P 9	33	18	<0.05
	L 20	56	39	<0.05
	L 73	44	28	<0.05
	E 36	68	53	<0.05
	L 35	64	49	<0.05
	L 16	4	12	<0.05
	E 64	24	37	<0.05
	L 24	52	38	<0.05
	N 84	53	39	<0.05
	E 70	39	26	<0.05

[a]N – neuroticism scale; E – extroversion scale; L – defensiveness scale; and P – psychoticism scale.
[b]Score indicates percentage in the direction towards neuroticism on the N scale, nondefensive direction on the L scale, introverted direction on the E scale, and psyschoticism direction on the P scale.
[c]Chi-square test.
[d]Coronary scale 1 includes first 6 items (Phi > 0.20; irrespectively of p-value).
[e]Coronary scale 2 includes the coronary scale 1 and additional 12 items (Phi < 0.20; $p<0.05$).

Table 2. Repeated item analysis of the Eysenck Personality Questionnaire (EPQ) and construction of the final Coronary Scale (Cor) (n = 174)

EPQ scale and item number[a]	Score (%)[b] IHD cases	controls	p[c]
N 15	62	36	<0.001
N 41	56	35	<0.001
N 31	59	26	<0.001
N 75	49	29	<0.001
N 3	52	32	<0.001
N 72	64	51	<0.05
L 20	46	31	<0.05
E 64	71	56	<0.05

[a]N – neuroticism scale; E – extroversion scale; L – defensiveness scale; and P – psychoticism scale.
[b]Score indicates percentage in the direction towards neuroticism on the N scale, nondefensive direction on the L scale, introverted direction on the E scale, and psyschoticism direction on the P scale.
[c]Independent samples t-test.

Validation of Coronary Scale

Similar results were obtained in the second case-control study where we used the Coronary Scale on 87 age-matched pairs of patients with ischemic heart disease and their controls. Only two additional items from the Coronary Scale 2 discriminated between the two groups (Table 2). Thus, the final version of suggested Coronary Scale contained 8 items: 6 from N scale, one from L scale, and one from E scale.

All N items and the E item were scored as indicated in the EPQ manual (29). The L item was scored in the reverse direction since it was found significantly more in controls than in patients with ischemic heart disease. These 8 items may be regarded as the final Coronary Scale or *Cor* (Table 3). The word "coronary" here refers to the origin of the ischemic heart disease, coronary arteries and their atherosclerosis. There are two reasons to use the abbreviation "cor": first, the letter C has already been used in another EPQ scale, and second, the Latin word "cor" means heart.

Table 3. The coronary scale. All items but item 7 are given a point for "yes" and none for "no" answer. Item 7 is given a point for "no" and none for "yes"

1. Are you an irritable person?	YES	NO
2. Would you call yourself tense or "highly-strung"?	YES	NO
3. Would you call yourself a nervous person?	YES	NO
4. Do you suffer from "nerves"?	YES	NO
5. Does your mood often go up and down?	YES	NO
6. Do you worry too long after an embarrassing experience?	YES	NO
7. Are all your habits good and desirable ones?	YES	NO
8. Do you often take on more activities than you have time for?	YES	NO

The mean ± SD scores on the *Cor* scale were 5.3 ± 2.3 for patients with ischemic heart disease and 3.4 ± 2.4 for control subjects. Discrimination between the two groups was distinct ($t = 5.27$; $p < 0.001$), and alpha coefficients for patients with ischemic heart disease and controls were sufficiently high (0.77 and 0.76, respectively).

Correlation Study

Positive correlations were obtained between high N and low L on the one side, and *Cor* on the

Table 4. Pearson's correlation coefficients (r) between personality traits according to the Eysenck Personality Questionnaire, sensitization, and coping styles according to the Coping Styles Questionnaire, and the Coronary Scale in patients with ischemic heart disease (IHD) (n = 187) and the controls (n = 187)

	Correlation coefficients	
Parameter[a]	IHD patients	controls
Psychoticism	0.28[b]	0.27[b]
Extraversion	-0.11	-0.05
Neuroticism	0.84[b]	0.83b
Lie scale	-0.38[b]	-0.22[c]
Sensitisation	0.56[b]	0.50[b]
RATCOP	-0.07	-0.04
DETCOP	-0.12	-0.01
EMCOP	0.44[b]	0.32[b]
AVCOP	0.08	0.10

[a]Abbreviations: RATCOP – rational coping style; DETCOP – detachment coping style; EMCOP – emotional coping style; and AVCOP – avoidance coping style.
[b]$p < 0.001$.
[c]$p < 0.01$.

other, as *Cor* yielded the items drawn from the same EPQ scales (Table 4). *Cor* scale was also found to be associated with the emotional coping style (EMCOP), sensitization, and P scale. Similar results were obtained for patients with ischemic heart disease and control group.

Association between *Cor* and standard biological risk factors for ischemic heart disease could be helpful in suggesting the biological mechanisms of pathogenicity. The only significant correlation was obtained between *Cor* scale and hypertension, but only in the control group of patients free of ischemic heart disease (Table 5).

Table 5. Pearson's correlation coefficients (r) between standard risk factors for ischemic heart disease and the Coronary Scale in patients with ischemic heart disease (IHD) (n = 187) and the control group (n = 187)

	Correlation coefficients	
Parameter[a]	IHD patients	controls
Family history	0.08	0.05
Cholesterol	0.02	0.04
HDL	0.09	-0.03
LDL	-0.04	0.04
Hypertension	-0.04	0.24[b]
Fibrinogen	0.11	0.09
Smoking history	0.06	0.02

[a]Abbreviations: HDL – high density lipoproteins; LDL – low density lipoproteins.
[b]$p < 0.01$.

Discussion

Personality traits were investigated independently in ischemic heart disease patients and their controls, and a large body of results were reported on this matter (1-9). It has been suggested that patients with ischemic heart disease are characterized with high levels of emotional instability, competitiveness, hostility, impulsivity, cynicism, and sensitization (1-9). However, not many studies have looked in more detail at the nature of these personality differences. We performed a thorough investigation of the personality of patients with ischemic heart disease by analyzing in detail the EPQ items in order to construct a coronary-proneness scale.

The process of scale development showed that patients with ischemic heart disease seemed particularly troubled by enhanced emotionality. Out of 8 EPQ items that discriminated between the men with ischemic heart disease and their controls in both studies, 6 were drawn from the N scale. Most N scale items dealt with emotional instability. Patients with ischemic heart disease clearly regarded themselves as irritable, tense, and moody worriers. The results of the analysis of the remaining two items could be interpreted as low defensiveness and overactivity. Sensitization was another characteristic often found in patients with ischemic heart disease (12,19), confirming both the ambition and a chronic sense of time urgency, which were listed in the early notion of the Type A behavior by Friedman and Rosenman (33). The combination of the above items might support Byrne's view that manifest coronary-prone behaviors arising from an underlying existence of competitiveness achieve their greatest pathophysiological toxicity if their expression and realization are frustrated (5).

As expected, neuroticism played a major role in the Coronary Scale. Indeed, some studies related it to individual differences in excitability and emotional responsiveness, which are reflected in autonomic activation (15,16). As it represents a personality trait of increased reactivity to stressors, it may contribute to the progression of ischemic heart disease by adversely affecting bodily homeostasis in stressful situations (13).

Other associations obtained for the Coronary Scale actually represent an "extract" of global psychosocial risk for ischemic heart disease. Not surprisingly, the Coronary Scale showed strong positive correlations with emotional coping style, which is a known predictor for deteriorated health (13,14). Furthermore, a significant correlation was obtained between the Coronary Scale and psychoticism, although no P items were included in the final Coronary Scale. This association is in line with previous reports on traits of hostility (6-8) and impulsivity (9,10) as important risk factors for ischemic heart disease. Hostility and impulsivity are among the other intercorrelating traits forming a higher-order factor of psychoticism (34).

As far as biological risk factors are concerned, we obtained a single significant association – between hypertension and the Coronary Scale. Since it was found in the control group only, no conclusion could be made about the biological correlates of the Coronary Scale.

The generalizability of these findings is somewhat limited because the study sample included male patients only. Furthermore, the behavior and morbidity of patients residing outside Slovenia may be different. One may also argue that these findings could only be a suggestion obtained by a retrospective design, as it is difficult to disentangle factors preceding and factors resulting from the ischemic heart disease. However, both psychological and classical risk factors for ischemic heart disease are characterized by a certain degree of stability throughout the adult life. People are likely to display their usual way of coping

with stress (35) and reflect enduring personality traits (36) when confronted with life-threatening diseases, such as ischemic heart disease. Our results connect status of ischemic heart disease with underlying atherosclerosis, on one side, and the presence of many personality-related risk factors for ischemic heart disease, on the other.

In summary, the results of the Coronary Scale seem promising. They are based on angiographically confirmed diagnosis of ischemic heart disease and are therefore immune to a certain extent to the suggestion that neuroticism is related to the increased somatic complaints rather than the organic illness itself (17). When the study was replicated, the score on the Coronary Scale was found to be a good predictor of ischemic heart disease. However, replication was done on the sample of subjects selected in the same way as the initial ones. In view of this fact, the Coronary Scale needs an independent replication. With a short scale of 8 items this should not be a problem, although taking the 8 items out of the EPQ rather than administering the entire questionnaire might produce different results. In any case, once proven reliable and valid in terms of prediction of ischemic heart disease on another sample of subjects, Coronary Scale could be useful in everyday practice in distinguishing patients with ischemic heart disease and those at higher risk to develop the disease from the population not at risk. It could be used for detecting the high risk group of emotionally labile subjects in order to concentrate efforts on prevention of ischemic heart disease.

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Correspondence to:
Andrej Marušič
Institute of Public Health of the Republic of Slovenia
Trubarjeva 2
1000 Ljubljana, Slovenia
andrej.marusic@ivz-rs.si