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Type D Personality

Psychometric Properties of the DS14 and Associations with Ill Health and Coronary Heart Disease in General and Clinical Populations

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Abstract
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Type D personality, or distressed personality, refers to the joint tendency to experience negative emotions and to inhibit self-expression in social interactions. The overall aims of this thesis were to examine the impact of Type D personality on adolescents' self-perceived health, to examine the factorial and temporal stability of the Type D personality construct DS14, and to clarify whether type D personality is an independent risk factor for recurrent myocardial infarction and all-cause mortality among patients with myocardial infarction.

The prevalence of Type D personality in the adolescent population was 10.4% for boys and 14.6% for girls. Boys and girls with Type D personality were approximately twice as likely to report musculoskeletal pain and five times as likely to report psychosomatic symptoms.

Adolescents with Type D personality were four times more likely to have sleep disturbances and to sleep fewer hours, especially on school nights.

Among patients with myocardial infarction, the Swedish DS14 had stable structural validity. Our measurements confirmed the two-factor model of the DS14. However, the DS14 exhibited low temporal stability, especially when comparing the measurement obtained during hospitalization with the 1- and 12-month follow-up measurements.

Among patients with myocardial infarction, the Framingham risk score had a strong predictive value for recurrent myocardial infarction, and a somewhat weaker predictive value for all-cause mortality. However, none of the previously proposed methods for the analysis of the DS14 Type D personality measurement predicted recurrent myocardial infarction or all-cause mortality, either in univariable analyses or in addition to the Framingham risk score.

In conclusion, the present thesis found significant associations between the DS14 and psychosomatic symptoms in adolescents. However, the measurement exhibited a low stability over time and no predictive value for recurrent myocardial infarction and mortality among patients with myocardial infarction. Taken together, these results raise the question of whether the Swedish DS14 really is a measure of personality. An alternative explanation for the strong cross-sectional associations observed between the DS14 and psychosomatic symptoms might be that the DS14 functions as a pseudo-measure of ill health, or co-varies with depressive or psychosomatic characteristics.

Keywords: adolescence, ill health, mortality, myocardial infarction, sleep, stability, Type D personality

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”Det viktigaste är osynligt för ögonen”

Antoine de Saint-Exupéry

Till Fredrik, Lovisa och Gustaf

List of Papers

This thesis is based on the following papers, which are referred to in the text by their Roman numerals.

I Condén E, Leppert J, Ekselius L, Åslund C. (2013) Type D personality is a risk factor for psychosomatic symptoms and musculoskeletal pain among adolescents: a cross-sectional study of a large population-based cohort of Swedish adolescents. *BMC Pediatrics*, 13:11 doi: 10.1186/1471-2431-13-11

II Condén E, Ekselius L, Aslund C. (2013) Type D personality is associated with sleep problems in adolescents. Results from a population-based cohort study of Swedish adolescents. *J Psychosom Res*. 74(4):290-5

III Condén E, Rosenblad A, Ekselius L, Åslund C. (2014) Prevalence of Type D Personality and Factorial and Temporal Stability of the DS14 after Myocardial Infarction in a Swedish Population. *Scand J Psychol.* 2014 Sep 22. doi: 10.1111/sjop.12162

IV Condén E, Wagner P, Leppert J, Ekselius L, Åslund C. Type D personality as an independent risk factor for recurrent myocardial infarction and all-cause mortality in addition to the Framingham risk score – a prospective cohort-study. Submitted

Contents

Abbreviations

AUDIT-C	The Alcohol Use Disorders Identification Test
BMI	Body mass index
CAD	Coronary artery disease
CFA	Confirmatory factor analysis
CFI	Comparative fit index
CHD	Coronary heart disease
CI	Confidence interval
CR	Cardiac rehabilitation
CVD	Cardiovascular disease
EFA	Exploratory factor analysis
FRS	Framingham risk score
GFI	Goodness-of-fit index
GLM	General linear model
HADS	Hospitality Anxiety and Depression Scale
HDL	High density lipoprotein
HPA	Hypothalamic-pituitary-adrenal
HR	Hazard ratio
ICC	Intra-class correlations
MACE	Major cardiac events
MBSR	Mindfulness-based stress reduction (programme)
MI	Myocardial infarction

NA	Negative affectivity
OR	Odds ratio
RMSEA	Root mean square error of approximation
SALVe	Survey of Adolescent life in Vestmanland
SAVa	Survey of Atherosclerosis in Vastmanland
SI	Social inhibition
SES	Socio-economic status
TLI	Tucker–Lewis index

Introduction

Type D personality, or distressed personality, was originally recognized after observations of patients with ischaemic heart disease. When I was working as a registered nurse in the Cardiac Intensive Care Unit, I observed patients with strong characteristics of this personality type. I was involved in these patients' struggles and was touched by their suffering. I started to wonder what had happened in their lives prior to their arrival at the hospital to be treated for their heart disease. Was their health already compromised as adolescents? Would these characteristics be of concern for the future of these individuals?

Personality

The roots of the clinical approach to personality can be traced to Sigmund Freud, although Hippocrates and Galen had long ago written about personality in terms of associations between bodily humours (blood, black bile, yellow bile and phlegm) and temperament (sanguine, melancholic, choleric and phlegmatic) [1]. Personality has been defined as the dynamic organization of the psychophysical systems that determine an individual's characteristic behaviour and thought [2]. Personality is reflected in lifestyle, how we look at ourselves and in relation to our surroundings [3, 4]. Personality characteristics are established early in life and develop into a mature personality around the age of 20 [4]. The basic personality characteristics are primarily biological in origin, including gene function, brain biochemical activity and physiological reactivity. Through a dynamic and complex interplay between genes and environment, each person's unique combination of basic traits composes his/her personality [3, 4]. A trait is a disposition to behave in a particular way, as expressed in one's behaviour over a range of situations [1]. Cultural context, the social environment and life experiences from infancy through late adolescence can strengthen or weaken traits. The history of personality research is vast, and has included several approaches to personality traits [1]. During the 1920s, Allport adopted the trait as the fundamental conceptual unit of personality [5, 6]. Cattell further refined the concept through methodological developments in personality research [7]. Eysenck argued that personality consists of three factors, namely extraversion, neuroticism and psychoticism [8]. However, the "Big Five" factor theory

presented by McCrae and Costa [9] dominates research in this field currently [4], and comprises the factors neuroticism, extraversion, conscientiousness, agreeableness and openness to experience.

Personality types

Type A and B personalities were identified in the 1950s. Individuals with Type A personality, as defined by Friedman and Rosenman, are hard-driving, competitive, aggressive and hurried [10]. It has been generally accepted that the Type A behaviour is a risk factor for the development of coronary heart disease (CHD). However, there have been conflicting results in the literature primarily because of differences in methods and measurements of Type A behaviour [11]. As a result, researchers have focused on subcomponents of the Type A behaviour pattern, particularly hostility and anger, which are more reliable predictors of CHD [11, 12]. Individuals with Type B personality are typically more relaxed, easy-going and satisfied [13]. Similarly, a Type C personality has been presented for individuals who tend to be overly co-operative, appeasing, over-patient and defensive, avoiding conflicts and seeking harmony [14]. Type C personality has been suggested to characterize cancer patients [14, 15].

Type D personality

Type D personality was proposed by the psychologist Denollet in 1996 and was originally identified after observations of patients with CHD [16]. Type D personality is characterized by two personality traits: negative affectivity (NA) and social inhibition (SI) [17]. NA is the tendency to experience negative emotions and feelings of dysphoria, anxiety, irritability and apprehension [18], including vulnerability to anxiety and depression [19]. SI is the tendency to inhibit the expression of emotions [17], paired with interpersonal stress and the failure to adapt [20]. The synergistic effect of NA and SI involves a higher risk of several emotional and social difficulties, such as depression, anxiety, a low level of subjective well-being, lack of social support and low quality of life [21]. The threat of negative reactions from others is a main source of stress [22], particularly in socially inhibited individuals [23]. Type D personality was originally calculated using a combined score based on the State-Trait Anxiety Inventory [24], in which the SI subscale originates from the Heart Patients Psychological Questionnaire [16, 25]. Denollet developed the Type D personality questionnaire, which assesses only the subscales of NA and SI and comprises 16, 22 or 14 items [17, 26]. The 14-item scale (DS14) is the one that is used most widely. In the Big Five personality theory, neuroticism has been described as resembling Type D personality, especially with respect to the NA subscale [27]. Moreover, Type D

personality has been associated with low levels of the sociability facet of the Big Five factors of extraversion, agreeableness and conscientiousness [26, 28].

Type D personality and general health

Type D personality was founded in the knowledge that psychosocial factors are associated with cardiovascular outcomes [29-32], and negative emotions and social inhibitions have been given special attention [33-35]. Type D personality has been associated with a variety of emotional and social difficulties, as well as increased morbidity and mortality in patients with established cardiovascular disease (CVD) [36-39]. Several studies have found associations between Type D personality and an increased number of health and somatic complaints, low self-rated health, sleeping problems, heightened perception of negative emotions, a negative impact on mental and physical health and a less healthy lifestyle [21, 40-42]. Type D personality has been associated with worse disease perception, lower treatment satisfaction, poor physical and mental health status and higher emotional distress [43]. Type D personality substantially affects the way in which patients with myocardial infarction (MI) perceive the availability of social support from different sources, including family, friends and others. Type D personality also plays a clinically relevant role in psychological health outcomes, as Type D patients report significantly higher levels of anxiety, depressive mood, perceived psychophysical stress, interpersonal difficulties, social anxiety and diminished psychophysical well-being and quality of life [44]. Moreover, Type D personality seems to be associated with more passive and maladaptive types of coping strategies [44-46]. A meta-analysis performed by Versteeg et al. [47] showed that Type D personality was an independent correlate of impaired patient-reported physical and mental health status in various cardiovascular patient groups. Moreover, those authors urge clinicians to be aware of the association between chronic psychological distress and poor patient-reported outcomes. However, that meta-analysis has been criticized for making assumptions that are too strong and based on small study populations [48].

Type D personality and adolescent health

There is a strong association between self-reported somatic complaints and poor psychological well-being in adolescents [49, 50]. Type D personality is related to maladaptive health behaviours and lower levels of social support in adults [51, 52], as well as in healthy younger individuals [52]. Children with the Type D pattern have more somatic complaints than non-Type D children [53]. Zhang et al. reported that Chinese adolescents with Type D personality were prone to depressive symptoms [54]. Among adolescents

with depression, those with Type D personality reported higher levels of distressed emotions and more unhappy life events [54]. Their social activities seem to be prone to self-inhibition over worries about being rejected, and the results emphasize the influence of NA [54]. Lee et al. reported that 18% of healthy Korean adolescents had a Type D personality [55]. These adolescents experienced various and more severe mental health problems, such as a greater risk of negative psychological well-being. Lee et al. further found that Type D personality was related to both internalizing, such as psychiatric problems, learning and attention, family relationships and self-control, and externalizing problems, such as conduct behaviour, sexual behaviour and sexual desire problems, albeit with a higher level of internalizing symptoms [55].

Type D personality and health in patients with CHD

Type D personality had its origin in the cardiovascular context. In 1996, Denollet et al. proposed that Type D personality was an independent predictor of long-term mortality in patients with CHD, independently of traditional biomedical factors [16]. A subsequent study demonstrated that Type D personality patients with CHD had a fourfold increased risk of major cardiac events over 5 years, independent of disease severity [56]. Another study found that Type D personality predicted mortality and recurrent MI in patients with acute MI after controlling for both disease and depression severity [57]. Type D personality has also been studied regarding the risk of CHD in populations without clinically established CHD [41, 58-60]. Denollet et al. recently reported that both the NA and SI interaction and dichotomized measures of Type D personality were associated with cardiovascular events in patients with CHD [61]. However, these studies have been criticized for including small populations and for predicting a small number of events. Findings across studies are inconsistent, as several studies have failed to find any associations between Type D personality and cardiovascular outcomes [62-65], and provided ambiguous evidence regarding whether Type D personality can predict CHD. For an overview, see Table 1.

Table 1. Studies assessing the prognostic value of the Type D personality regarding cardiac events and mortality.

Study	Methods		Type D assessment		Outcomes	Prevalence of Type D personality	Effect size (CI)
	Design (SD)	Sample Mean age (SD) (male %)	Measure	Settings			
Denollet et al. 1996 [16]	Prospective 6–10-year study	303 CAD patients 55.4 (7.9) (88%)	DS14 dic	Rehabilitation programme	All-cause mortality	28%	OR = 4.1 (1.9–8.8)
Denollet et al. 2000 [66]	Prospective 5-year study	319 CAD patients 56.7 (92%)	DS16 dic	Rehabilitation programme	Cardiac events	31%	OR = 4.7 (2.2–7.8)
Pedersen et al. 2004 [67]	Prospective 9-months study	875 PCI patients 62.2 (10.9) (72%)	DS14 dic	6 months after PCI	Cardiac events	29%	OR = 5.38 (2.06–13.66)
Denollet et al. 2006 [56]	Prospective 5-year study	337 CHD patients 57.0 (88%)	DS16	Rehabilitation programme	Cardiac events		OR= 4.84 (1.42-16.52)
Denollet et al. 2006 [68]	Prospective 9-months study	875 CHD patients 62.2 (75%)	DS14 dic	Rehabilitation programme	MACE		HR = 1.92 (1.22-3.01)
Denollet et al. 2008 [69]	Prospective 5-year study	337 CHD patients 57.0 (88%)	DS16	Rehabilitation programme	MACE	29%	OR = 2.44 (1.25-4.76)
Denollet et al. 2007 [70]	Prospective 5.4-years	51 heart transplant patients 54.1 (9.7) (75%)	DS14 dic	Before transplantation	All-cause mortality	29%	OR = 6.75 (1.47–30.97)
Aquarius et al. 2009 [71]	Prospective 4-year study	184 patients with peripheral arterial disease 64.8 (9.8) (63.6%)	DS14 dic	Before diagnosis	All-cause mortality	35%	OR = 3.5 (1.11–11.1)
Martens et al. 2010 [57]	Prospective 1.8 (0.8) years	473 MI patients 59 (12) (78%)	DS14 dic	Hospitalization for MI	Cardiac events	20%	OR = 2.23 (1.14–4.35)
Shiffer et al. 2010 [72]	Prospective 30.7 (11.1) months	232 CHF patients 65.5 (9.9) (75%)	DS14 dic	Consecutive CHF outpatients	Cardiac mortality	20.7%	OR = 1.40 (0.93–4.29)
Pedersen et al. 2010 [73]	Prospective 1.7 (0.5) years	371 patients with ICD 57.7 (12) (79.5%)	DS14 dic	Prior to implantation	All-cause mortality	22.4%	OR = 2.99 (1.30–6.87)

Pelle et al. 2010 [74]	Prospective 37.6 (15.6) months	641 CHF patients 66.6 (10) (74%)	DS14 dic	2 weeks after outpatient visit	All-cause mortality	20%	OR = 1.16 (0.72–1.87)
Volz et al. 2011 [62]	Prospective 2.8 (1.1) years	111 CHF rehab patients 57 (14) (88%)	DS14 dic	During rehabilitation programme	All-cause mortality	30%	OR = 1.40 (0.38–5.14)
Grande et al. 2011 [75]	Prospective 71.5 (3.6) months	977 CAD patients 63.3 (10.7) (77.5%)	NA, SI, NA × SI	Different settings	All-cause mortality	25%	HR : NA×SI = 0.99 (0.61–1.59), NA = 1.01 (0.97-1.05), SI = 1.03 (0.97-1.10)
Coyne et al. 2011 [64]	Prospective 18 months	706 CHF patients 70.7 (11.5) (61.8%)	DS14 dic, zNA, zSI, zNA × zSI	During hospitalization	All-cause mortality	13.5%	HR = 0.89 (0.58–1.37), zNA = 0.87 (0.72-1.05), zSI = 0.97 (0.83-1.02) zNA×zSI = 0.9 (0.79-1.04)
Denollet et al. 2013 [61]	Prospective 5-year study	541 patients with CAD 58.7 (10.5) (87%)	DS14 dic, *z*NA, *z*SI, *z*NA × *z*SI	Outpatient rehabilitation programme	MACE		OR : *z*NA = 0.99 (0.78–1.26), *z*SI = 1.16 (0.92–1.47), *z*NA × *z*SI = 1.36 (1.11–1.67), Dic = 1.74 (1.11–2.73)
Damen et al. 2013 [76]	Prospective 7-year (1.6) follow-up	Consecutive PCI patients 62.0 (11.1) (72%)	DS14 dic	6 months post-PCI	All-cause mortality	29.2%	HR = 1.19 (0.76–1.85)
Denollet et al. 2013 [77]	Prospective 3.2 years	455 patients with ICD 59.1 (8.9)	DS14 dic	Prior to implantation	All-cause mortality	23%	HR = 0 1.91 (1.09–3.34)
Meyer et al. 2014 [78]	Prospective 5-year follow-up	465 consecutive patients with CAD 62.0 (11.1) (72%)	NA, SI and NA × SI	Before undergoing stent implantation	MACE	31%	HR : NA = 1.02 (0.91–1.13), SI = 0.86 (0.75–1.00), NA × SI = 1.00 (0.99–1.01)

CAD, coronary artery disease; dic, dichotomous; OR, odds ratio; MI = myocardial infarction; PCI, percutaneous coronary intervention; QoL, quality of life; CHF = chronic heart failure ICD = implantable cardioverter defibrillator; MACE, major adverse cardiac event; HR, hazard ratio

Possible mechanisms of Type D personality and clinical outcomes

When exposed to the same health threat, people respond differently: psychologically, behaviourally, physiologically and, ultimately, in terms of prognosis and mortality [79]. Explaining this variability is of concern for medicine and health psychology in terms of diagnosis, treatment and prognosis. Several potential mechanisms may help explain the suggested adverse effect of Type D personality on health. To understand the psychological mechanisms that may link emotions with disease processes, it is important to distinguish states from traits [80].

States and traits

There has been a long-standing debate within the field of personality psychology regarding the importance of traits in understanding human behaviour. Traits are defined as stable, relatively enduring general characteristics of the self that are consistent during the lifespan. States are transient experiences that can change from moment to moment. Trait markers represent the properties of the behavioural and biological processes that may play an antecedent, possibly causal role in pathophysiology. The psychology of traits is based on the definition of personality as a sum of the characteristics of an individual, and that the analysis of these properties will allow the inference of an individual´s personality and, to some extent, the prediction of how that individual will behave in different situations [81]. A state marker is a reaction and reflects, for example, the status of clinical manifestations in patients.

Biological mechanisms

People vary regarding how they perceive emotions; moreover, their brain-activity patterns differ. The two subcomponents of Type D personality, negative affectivity and social inhibition, may be reflected differently in the brain, with different effects on the neural coding of threatening signals. Individuals with increased negative affectivity tend to deactivate the core emotion system, whereas socially inhibited individuals tend to overactivate the broad cortical network [23]. The amygdala is viewed as a key area in the social brain network, as it responds to salient signals, such as facial expressions [82]. One study reported a negative correlation between negative affectivity and amygdala activation after static threatening vs neutral facial and bodily expressions [83]. In the study performed by Kret et al., the orbitofrontal cortex and somatosensory cortex correlated positively with social inhibition and negatively with negative affectivity [23]. The orbito-frontal cortex is connected with areas that underlie emotional function and empathy

[84] and interprets somatic sensations [85]. The orbito-frontal cortex plays a role in the choice between fight or flight during stressful events by linking events in positive or negative valuation, presumably depending on the personality and the stressor of concern [86]. Denollet et al. made the assumption that Type D personality is a significant predictor of cardiovascular events after adjustment for depressive symptoms because of the fact that the subcomponents of Type D personality, NA and SI, activate different brain parts and result in different cortisol responses after exposure to social threats [61].

Researchers who noted a relationship between Type D personality and CVD have suggested a possible pathway to disease via an association with physiological hyper reactivity [87]. This suggests that a weak myocardial response to an active stressor in Type D individuals is indicative of a haemodynamic maladaptation to stress, which may be one of the mechanisms underlying Type D–cardiovascular health associations [88]. Patients with heart failure and Type D personality may show an inadequate response to acute social stress, characterized by a blunted heart-rate response [89]. The biological and behavioural mechanisms that mediate Type D personality can lead to poor health outcomes. Although several researchers have tried to explain the relationship between Type D personality and adverse health effects, the results of their research were inconsistent. Howard et al. [88] reported a weak myocardial response to an active stressor in Type D individuals, which suggests that cardiovascular reactivity to psychological stress is a possible mechanism involved in the development of cardiovascular health problems in Type D individuals. However, Nyklíček et al. examined the relationship between Type D personality and cardiovascular functioning in the everyday lives of people without documented CVD and found that Type D personality is generally not associated with unfavourable cardiovascular functioning [90]. Research on the relationship between Type D personality and laboratory indices of cardiovascular health indicates that socially inhibited men have heightened blood pressure reactivity and that NA is related to a dampened heart-rate change during stress [87]. Both Type D dimensions (NA and SI) were associated with greater cortisol reactivity to stress [87]. Williams et al. compared males with and without Type D personality and found that the former group exhibited a significantly higher cardiac output during a stress condition [91]. However, there was no relationship between Type D personality and cardiovascular reactivity in females. In addition, Type D individuals exhibited significantly higher feelings of subjective stress compared with non-Type D individuals in a laboratory test [91]. A high level of both NA and SI seems to involve a susceptibility to chronic distress [16, 92]. As shown in Figure 1, the mechanisms underlying the illness process based on personality are complex and multifaceted. Within this context, personality traits are conceived as distal predictors of health outcomes that influence these outcomes either directly or via various mechanisms [93].

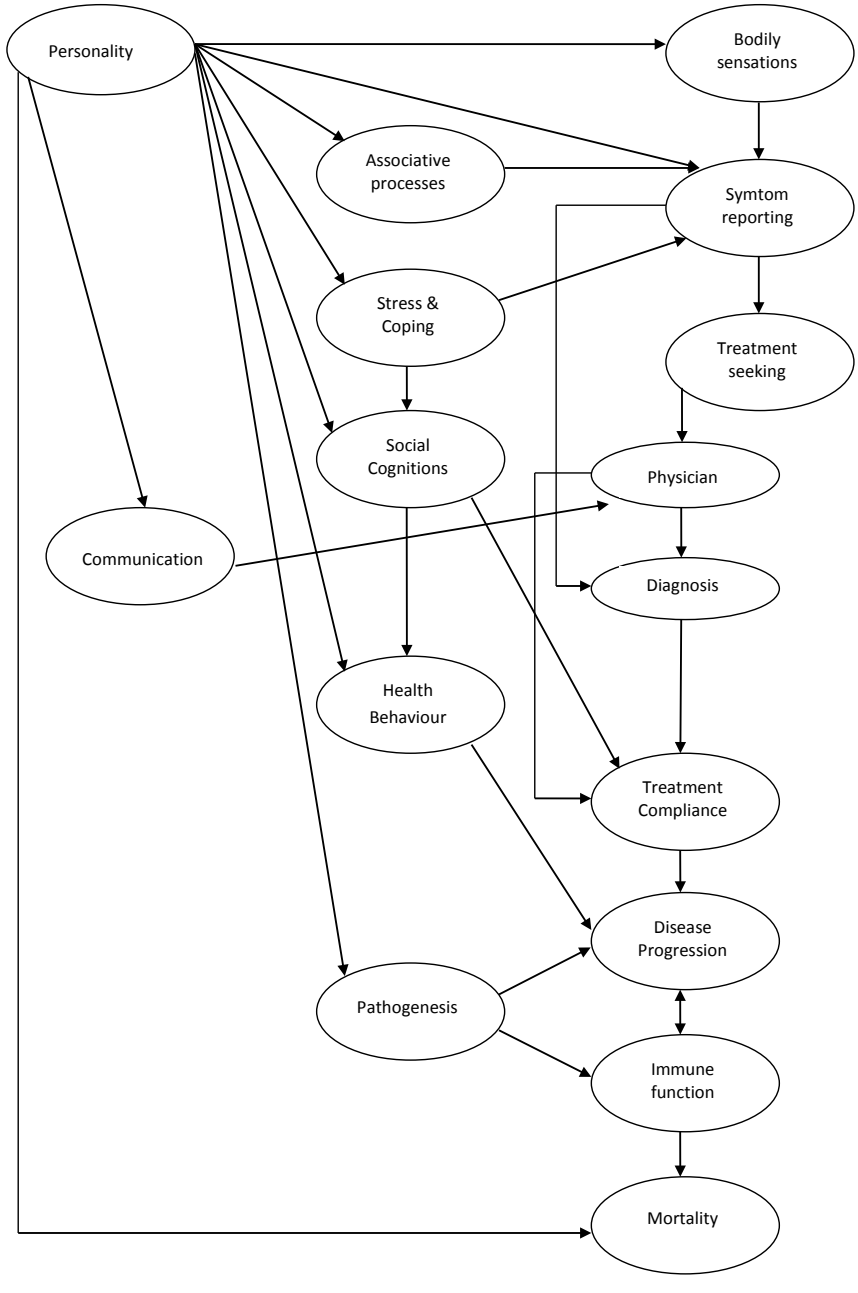

Figure 1. The illness process: personality and mechanism. Adapted from Ferguson, p. S34, Health Psychology Review (2013) [79].

Criticism of the Type D personality measure

The findings of relationships between Type D personality and health outcomes have been inconsistent, and there is an ongoing debate regarding the most appropriate statistical methods for analysing the Type D personality measurement DS14: the dichotomized NA and SI ≥10 [17], continuous measures of NA and SI [64, 65, 94], the interaction term of NA × SI [64] and their z scores zNA × zSI [64, 95]. For example, in a study that investigated beat-to-beat blood pressure and heart rate during exposure to multitasking stress, mood and background stress were both associated with Type D personality when Type D was conceptualized as a dimensional construct; however, less robust findings were obtained using the traditional dichotomous typological approach [96]. Furthermore, an inverse relationship between the continuous Type D construct and blood pressure reactivity to multitasking stress was observed. These findings suggest that Type D personality is predictive of blunted cardiovascular reactivity to stress when Type D personality is considered as a dimensional construct. However, Type D personality did not predict additional variance in mood and background stress above that predicted by NA and SI independently [96]. Morover, several studies that examined the utility of the multiplicative term (NA × SI) failed to find associations between Type D personality and mortality in cardiac patients [64, 97], or to predict health behaviours [98].

Rationale of the present thesis

Given the relationship between psychological well-being and self-perceived physical health [49, 50], it seems possible that personality traits are associated with somatic complaints. De Fruyt and Denollet identified Type D personality as a significant predictor of sleeping problems in adults [28]. Type D personality with its subcomponents of negative affectivity and social inhibition may also be a risk factor for poor sleep among adolescents. Poor health at a young age may have a significant impact on an individual's clinical situation in adulthood. However, studies investigating the association between personality and physical and mental health in adolescents are scarce. Regarding the relationships between Type D personality and CHD, several studies have reported an increased risk of mortality in cardiovascular patient groups [16, 61, 70, 71, 73, 74]. However, other studies have failed to predict negative outcomes in relation to Type D personality [62, 63, 74]. Moreover, there is an ongoing debate regarding the most appropriate statistical methods for analysing Type D personality using the DS14 tool; therefore, it is important to study the validity of the DS14 in terms of factorial and temporal stability in a Swedish setting.

General and specific aims

The overall aims of this thesis were to examine the impact of Type D personality on adolescents' self-perceived health, to examine the factorial and temporal stability of the DS14 and to clarify whether Type D personality is an independent risk factor for recurrent myocardial infarction and all-cause mortality among patients with myocardial infarction.

Specific aims

I To investigate the prevalence of Type D personality in adolescents, as well as the associations between Type D personality and self-reported psychosomatic symptoms and musculoskeletal pain.

II To investigate the associations between Type D personality and sleep problems in adolescents.

III To examine the prevalence of Type D personality, as well as the construct validity, temporal stability and internal consistency of the DS14 during hospitalization and 1 and 12 months after myocardial infarction.

IV To evaluate whether Type D personality, in addition to the Framingham risk score, is an independent predictor of recurrent myocardial infarction and all-cause mortality in a population of patients with post-acute myocardial infarction.

Method

Study design

Papers I and II

A population-based, cross-sectional study based on self-reported data from the Survey of Adolescent Life in Vestmanland 2008 (SALVe 2008).

Papers III and IV

A prospective cohort study using data from the Survey of Atherosclerosis in Vastmanland (SAVa).

Participants and data collection

Papers I and II

Papers I and II are based on data from a questionnaire study of school students in Västmanland, Sweden, during 2008. All students in the ninth grade (15–16 years of age) and second year of secondary school (17–18 years of age) were asked to complete a self-report questionnaire during school time. The questionnaire was part of the Survey of Adolescent Life in Vestmanland 2008 (SALVe 2008), which is a survey that is distributed biennially by the County Council of Västmanland to monitor the psychosocial health of the adolescents in the county. The questionnaire was administered by teachers in the classroom during a 1 h session. The questionnaire included dichotomous yes/no answers, multiple-choice questions with a list of possible answers and ranking scales. The survey included questions about demographic background, psychosomatic and musculoskeletal symptoms, sleep habits and Type D personality. Of the 5129 adolescents who completed the questionnaire, 58 late responders returned their questionnaires by mail because they were absent from school on the day of the survey. The distribution of the study population is presented in Figure 2.

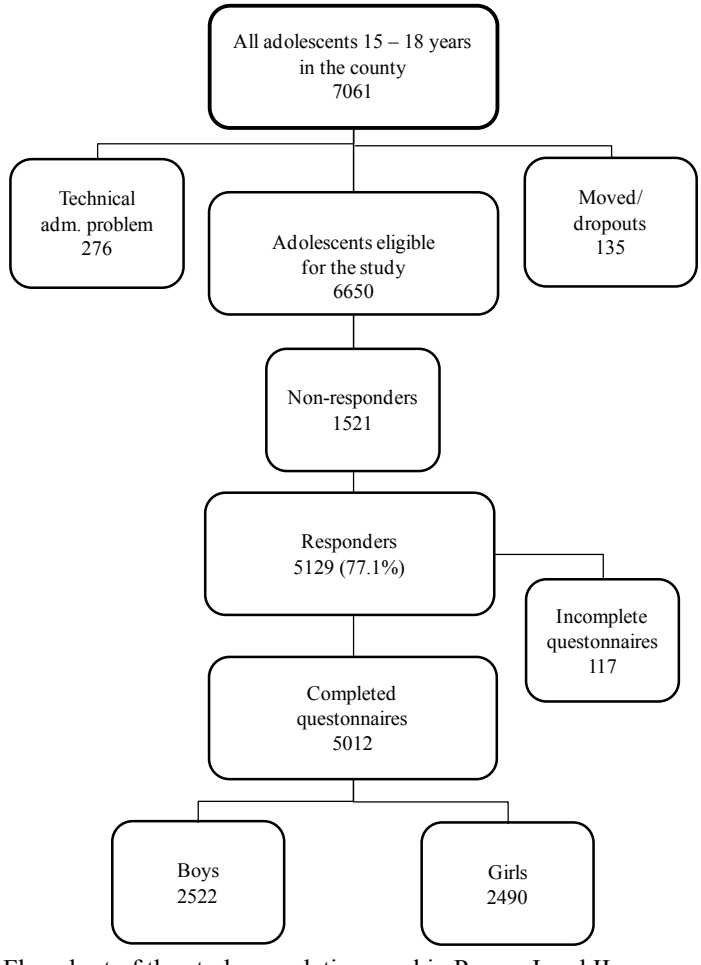

Figure 2. Flowchart of the study population used in Papers I and II.

Papers III and IV

Patients were recruited consecutively from the Department of Cardiology at the Västmanland County Hospital, Västerås, Sweden, and were eligible if they met the following inclusion criteria. 1) A diagnosis of acute MI, i.e., an increase in serum concentration of troponin I to ≥ 0.4 μg/L and a later decline in combination with one of the following: a) ischaemic symptoms, b) development of Q waves on ECG, c) ECG changes indicating ischaemia (ST-segment elevation or depression), or d) coronary artery intervention [99]; and 2) the patient was a resident in the catchment area of the Västmanland County Hospital and was aged 18 years or older.

The exclusion criteria included previous enrolment in the SAVa study, inability to provide informed consent, language difficulties or the presence of another severe disease. The first data collection (questionnaire, clinical ex-

amination and medical records) occurred during the hospital stay with the help of a research assistant who met the patients in the ward. A questionnaire was distributed to the participants, including the DS14 and questions on sex, age, smoking habits, educational level, marital status and origin. Disease history, such as diabetes, hypertension and previous MI, was obtained via questionnaire, medical records and clinical examination in the ward during hospitalization.

The 1-month and 12-months follow-up assessments were performed via a postal survey, which was sent by regular mail to the participants.

Paper III

Data were collected at three separate time points. First, 946 patients were included during hospitalization for acute MI from November 2005 to May 2010. In a preliminary prevalence analysis of the hospitalization data performed 1.5 years after the onset of the study, an unexpected low prevalence of Type D personality was found (14.3%) compared with the previously reported prevalence of 24%–28% [17, 89]. Consequently, additional data were collected at 1 month and 12 months after hospitalization among subgroups of participants who were included in the study after a specific date. Among the 946 participants included at hospitalization, 490 were eligible for the 1-month follow-up and 594 were eligible for the 12-months follow-up (Figure 3). In total, 313 patients participated in data collection at all three time points.

Paper IV

Information on recurrent MI was extracted in February 2014 from the Swedeheart Register, which is a national register of cardiac intensive care, coronary angiography, percutaneous coronary intervention (PCI), cardiac surgery and secondary prevention. Concomitantly, information regarding mortality was extracted from the Swedish population register.

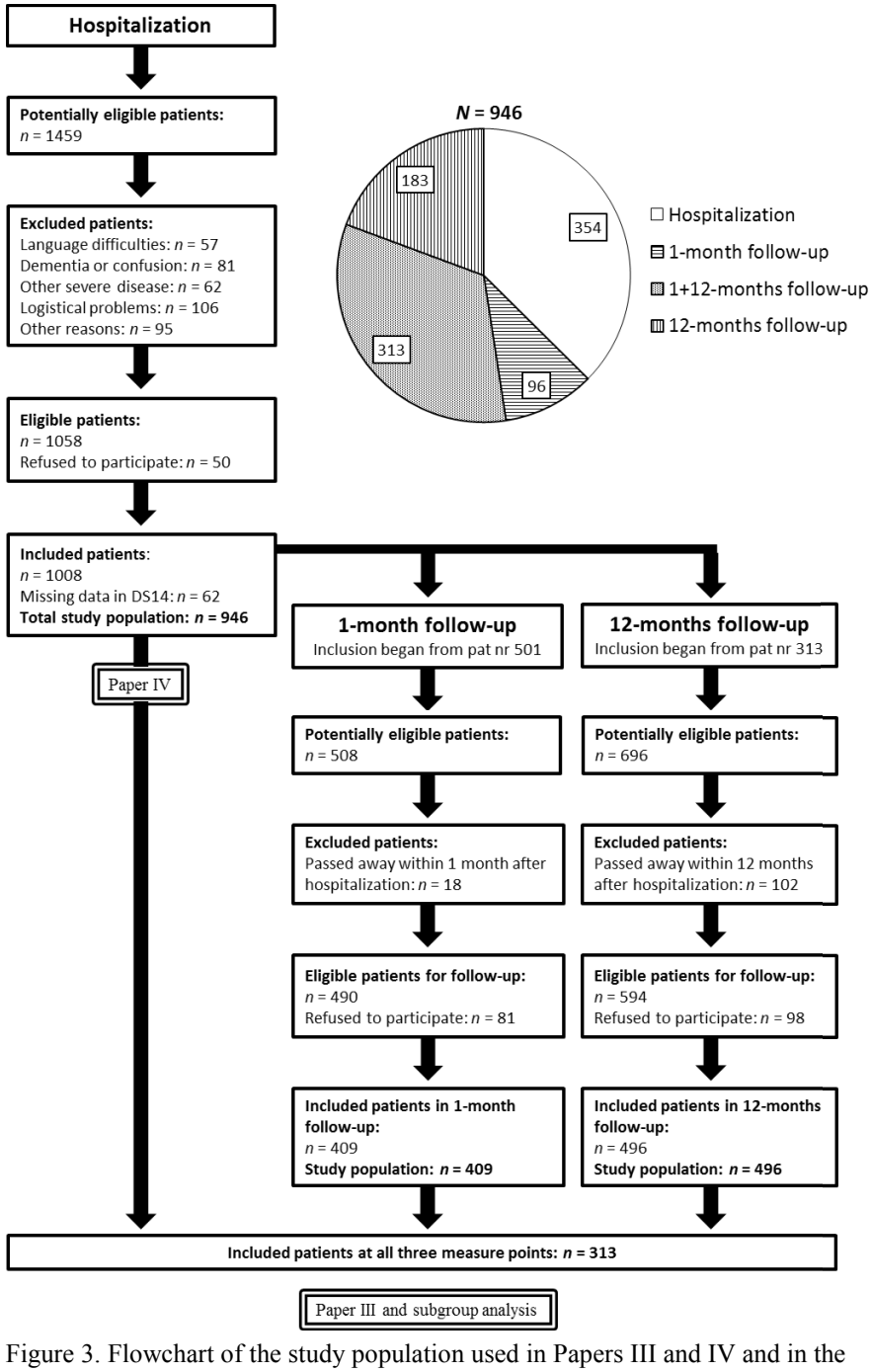

Figure 3. Flowchart of the study population used in Papers III and IV and in the subgroup analyses.

Measurements

Type D personality (Papers I-IV)

The DS14 questionnaire, which is a 14-item questionnaire that measures NA and SI, was used to assess Type D personality [100]. Participants respond to each item on a 5-point Likert scale (0 = false, 1 = rather false, 2 = neutral, 3 = rather true and 4 = true). The NA and SI scales can be scored as continuous variables (0–28) to assess these personality traits independently. According to Denollet, a score of 10 or more on both scales is used to classify respondents as having a Type D personality [17]. Denollet based the cut-off value on the median split in representative samples; moreover, clinical evidence for this cut-off value-based classification was obtained in longitudinal clinical studies, and empirical evidence was obtained from a latent class cluster analysis [101]. The DS14 has been validated in several European countries [102] and is regarded as being valid and reliable, with a reported Cronbach's α of 0.88/0.86 and a 3-month test–retest reliability of (r) = 0.72/0.82 for the NA and SI subscales, respectively, in an adult population [17]. We used the Swedish version of the DS14 [103] (Papers I–IV). To examine stability over time and to explore movement around the cut-off value of the dichotomized Type D scale, alternative divisions of the NA and SI scales were made in an attempt to explain possible variations in classification. For the alternative divisions, the NA and SI subscales were each divided into three levels (< 8, 8–12 and > 12 points) for comparison with the dichotomized Type D scale (Paper III).

Psychosomatic symptoms (Paper I)

The participants were asked how often they suffered from: 1) headache, 2) stomach-ache, 3) feelings of nervousness, 4) feelings of irritation and 5) sleep problems. The participants rated these items on a 5-point scale: never = 0, seldom = 1, sometimes = 2, often = 3 and always = 4, and a 0–20 point summation index was created for each participant. The internal consistency (Cronbach's α) of the psychosomatic symptoms questions was 0.75. The index was then divided by standard deviations, and +1 SD was used as the cut-off for many psychosomatic symptoms and –1 SD was used as the cut-off for few psychosomatic symptoms. Subsequently, we merged the intermediate (medium symptoms) and few psychosomatic symptoms groups into a single group, namely those with few-to-medium psychosomatic symptoms.

Musculoskeletal pain (Paper I)

The participants were asked how often they suffered from: 1) pain in the shoulders/neck, 2) pain in the back/hips and 3) pain in the

hands/knees/legs/feet. The participants rated these items on a 5-point scale: never = 0, seldom = 1, sometimes = 2, often = 3 and always = 4, and a 0–12 point summation index was created for each participant. The internal consistency of the musculoskeletal pain symptoms questions was $\alpha = 0.69$. The index was then divided by standard deviations, and +1 SD was used as the cut-off for many musculoskeletal pain symptoms and –1 SD was used as the cut-off for few musculoskeletal pain symptoms. Subsequently, we merged the intermediate (medium symptoms) and few musculoskeletal pain symptoms groups into a single group, namely those with few-to-medium musculoskeletal pain symptoms.

Sleep disturbances (Paper II)

To measure sleep disturbances, we used a modified version of the Karolinska Sleep Questionnaire [104], which asks about the frequency of sleep disturbances and subjective sleep quality. The questionnaire queried the frequency of the following disturbances during the last 3 months as follows: "How often have you experienced: difficulties waking up?; insufficient sleep?; not being thoroughly rested?; disturbed sleep?; feeling exhausted when waking?; sleepiness during school work?; sleepiness during your spare time?; drowsiness/prolonged fatigue?" The participants responded to these items on a 6-point scale: never = 0; seldom, occasional moments = 1; sometimes, a few times per month = 2; often, 1–2 times per week = 3; mostly, 3–4 times per week = 4; almost always, 5 times per week or more = 5. A 0–40 point summation index was created. The internal consistency of the index items was $\alpha = 0.90$. A few/many sleep disturbances dichotomous variable was created using +1 SD as the cut-off for many sleep disturbances.

Sleep hours (Paper II)

We chose to distinguish between school nights and weekend nights in the analyses. The participants rated their sleep hours based on the following questions: 1) How long do you sleep, on average, on school nights? 2) How long do you sleep, on average, on weekends? The answer alternatives were: less than 3 h = 1, about 3–4 h = 2, about 5–6 h = 3, about 7–8 h = 4, about 9–10 h = 5 and 11 h or more = 6. A dichotomous sleep variable for the school nights and for the weekend nights using ≤ 6 h of sleep per night as the cut-off for too little sleep was created.

Demographic data and control variables (Papers I-IV)

The demographic factors and control variables in the populations were measured using several different variables, to adjust for the effects of potentially confounding factors:

Sex (Papers I–IV).

Parental employment status (Paper I).

Ethnicity (Paper I).

Housing conditions (Paper I).

Family socio-economic status (Papers I and II).

Smoking habits (Papers II, III and IV).

Computer use (Paper II).

Exercise habits (Papers I and II).

Body mass index (BMI) (Papers I, II and IV).

Current smoking (Papers III and IV).

Highest educational level (Paper IV).

Marital status (Papers III and IV).

Systolic and diastolic blood pressure (Papers III and IV).

Blood samples, to measure parameters such as total cholesterol and high-density lipoprotein (HDL), were collected by venepuncture in the morning 4 days after admission to the hospital, if possible in a fasting state (Paper IV).

Depression was identified through the depression subscale of the Hospital Anxiety and Depression Scale (HADS-D), which is a widely used self-report questionnaire comprising seven questions. The HADS-D is scored on a 4-point Likert scale; a HADS-D score > 7 indicates depression [105]. The control analyses excluded individuals with severe depression (HADS-D score > 10) (Paper III).

Alcohol consumption: The participants answered the first three questions of the structured Alcohol Use Disorders Identification Test (AUDIT-C) to measure risk consumption [106]. This scale was modified according to Nilsson et al. [107] for adjustment to the adolescent population (Paper II).

Framingham risk score: The covariates used to estimate the Framingham risk score (FRS) are age, sex, total cholesterol, HDL, systolic blood pressure and smoking habits [108, 109]. The gender-specific formulae created from the Framingham Heart Study weight and sum the risk factors to generate an individual's risk of CHD over a 10-year period [110] and have shown a high ability to separate high- from low-risk individuals with an area under the curve ranging from 0.73 to 0.88 [111] (Paper IV).

Ethical considerations

Papers I and II

Participation in the study was anonymous and voluntary. The participants were given written and verbal information regarding the study and were assured that they could refuse to participate at any time without providing an explanation. According to Swedish law (Ethical Review Act 2003:460), application for ethical approval by a medical faculty is not required for this type of anonymous study. The Helsinki Declaration's [112] ethical standards for scientific work were followed throughout the project.

Papers III and IV

All included subjects signed a written informed consent form and the study was approved by the Regional Medical Ethics Committee of Uppsala University. The study was conducted in accordance with the Helsinki Declaration and is registered at ClinicalTrials.gov (NCT 01452178 nr (2005:169)).

Statistical analyses

The statistical analyses reported in Papers I–IV were performed using IBM SPSS Statistics (IBM Corp., Armonk, New York, USA) versions 17, 18 and 20. The confirmatory factor analysis reported in Paper III was performed using the SEM package in R 3.0.1 (R Foundation for Statistical Computing, Vienna, Austria), and the analysis presented in Paper IV was performed using StataCorp. 2013. Stata Statistical Software: Release 13 (College Station, TX: StataCorp LP) was used for Harrell's C analysis. All statistical analyses used in Papers I–IV of this thesis are presented in Table 2.

Significance, which is expressed as a *p*-value, is the probability of wrongly rejecting the null hypothesis, if it is in fact true. The *p*-value is compared with the actual significance level of the test and, if it is smaller, the result is significant. The null hypothesis was rejected at the 5% significance level, which implies a significance threshold $p < 0.05$.

The Kruskal–Wallis test was used for the analysis of missing cases for subjects who only completed the DS14 during hospitalization (Paper III). The Kruskal–Wallis test is a non-parametric test of whether three or more groups differ in median rank.

The Mann–Whitney U *test* was used to analyse sex differences in the demographic factors, prevalence of Type D personality, differences in characteris-

tics between the sexes and between Type D and non-Type D individuals and sleep problems and reported sleep time in the late respondent group compared with the remainder of the study population (Papers I–III). The Mann–Whitney *U* test determines the difference in rank between two independent variables that are not normally distributed and measured on an ordinal scale. It is a non-parametric test based on median values, similar to the Kruskal–Wallis test, although the nominal variable that distinguishes the groups is limited to two groups.

The χ^2 test was used to examine the differences in characteristics between the Type D and non-Type D individuals (Papers II–IV), as well as between participants with and without DS14 follow-up investigations (Paper III). The χ^2 test examines group differences in dichotomous measures by comparing the differences between expected frequencies (assuming an absence of relationship between the two variables) and the observed values for each category through a cross-tabulation. The χ^2 test does not require a normal distribution of the sample data.

An exploratory principal component factor analysis, varimax rotation with Kaiser normalization, was used to examine the structural validity of the DS14 and its two subscales, NA and SI (Paper III). The Kaiser–Guttman rule was applied, and an eigenvalue > 1 was used to extract several factors. The Kaiser–Guttman rule implies that only components with eigenvalues > 1 are considered, which means that a factor extracts at least as much as the equivalent of one original variable. Eigenvalues represent the variance explained by the factors that are eigenvectors of a matrix that is given by the variables and the factors. A principal factor analysis extracts the underlying interrelation between the variables to obtain a smaller number of factors. The factors extracted are those that account for most of the variance in the variables. The first component accounts for the largest possible amount of the variance, and the following components account for increasingly less of the variability. Varimax rotation is a method that is used to minimize the complexity of the components.

A confirmatory factor analysis was performed to confirm the internal structure of the NA and SI subscales (Paper III). The objective of the confirmatory factor analysis was to test whether the data fit a hypothesized measurement model. This hypothesized model was based on theory and/or previous analytical research. A model was assumed to fit the data with a goodness-of-fit index (GFI) > 0.9, a root mean square error of approximation (RMSEA) < 0.08, a Tucker–Lewis index (TLI) > 0.90 and a comparative fit index (CFI) > 0.90 [113].

Spearman's rho, which is a non-parametric correlation test, was performed to investigate correlations between outcomes and control variables in the models in Papers I and II.

Cronbach's α was used to analyse the within-indexes reliability of the indexes used in the studies, and for measuring the internal consistency of the NA and SI subscales (Papers I–III). Cronbach's α represents the consistency or the internal reliability of a measure, and values of 0.7 to 0.8 are considered acceptable.

Cohen's κ was used to examine the temporal stability of the dichotomized Type D personality scale and the dichotomized NA and SI subscales (Paper III). Cohen's κ coefficient measures the concordance between two categorical dichotomous variables rating the same object, thus giving a value of the inter-rater agreement using a non-parametric approach.

Intra-class correlation (ICC) was used to examine the temporal stability of the Type D personality index, the NA and SI subscales and each item (Paper III). It was calculated using two-way random-effects models [114]. The ICC assesses the consistency between measures of the same class. The strength of the agreement of the ICC values was classified according to Bland and Altman [115], in which a GFI ≥ 0.9, and RMSEA index < 0.08, a Tucker–Lewis NNFI > 0.9 and a Bentler CFI > 0.9 are acceptable for a reasonable fit of the model.

Binary logistic regression was used to investigate the associations between Type D personality, psychosomatic symptoms and musculoskeletal pain (Paper I). Univariable, multivariable and interaction models were used to identify odds ratios of Type D personality and the control variables of alcohol consumption, exercise habits, computer use, smoking habits and family socio-economic status in relation to sleep problems (Paper II). Binary logistic regression is used to test if a dichotomized dependent variable can be predicted on the basis of values of a set of predictor variables and their interaction effects. The binary logistic regression resulted in an odds ratio (OR) to compare whether the probability of a certain event was the same for two groups.

The general linear model (GLM) was used to investigate direct and interaction effects of Type D personality and control variables for sleep disturbances, the summation index of the two subscales and the Type D personality index (Paper II). The GLM estimates the value of the dependent variable corresponding to a given value of the independent variable. The GLM investigates the effects of individual factors and interactions between factors. The F-test indicates if the means of the groups formed by values of the independ-

ent variable are sufficiently different to not have occurred by chance. The assumption of the test is that data should be normally distributed. The *R*-Square is a statistical measure of how well a regression line approximates real data points, and measures the relative prediction power of the model. An R^2 of 1.0 indicates a perfect fit.

Z-score transformations of the NA and SI scales were made and tested for interaction effects. The interaction terms in the binary logistic regressions were based on the Z-transformed NA (*z*NA) × Z-transformed SI (*z*SI) scores (Papers I and IV). The Z-score conversion process is called standardizing or normalizing and is used to compare a sample to a standard normal deviate, thus enabling the comparison of two scores that stem from different normal distributions (with $\mu = 0$ and $\sigma = 1$). It can be defined without assumptions of normality.

The Cox proportional hazards regression model was used to estimate the relative risk of recurrent myocardial infarction (MI) or mortality from all causes associated with the covariates in the Framingham risk score (FRS) and the subscales of Type D personality (Paper IV). The Cox proportional hazards regression models, or proportional hazards models, are a class of survival models. Survival models relate the time that passes before some event occurs to one or more covariates that may be associated with that quantity of time. In a proportional hazards model, the unique effect of a unit increase in a covariate is multiplicative with respect to the hazard rate. A Cox model provides an estimate of the treatment effect on survival after adjustment for other explanatory variables. In addition, it allows the estimation of the hazard (or risk) of death or other event for an individual based on prognostic variables. For each patient, person-months of follow-up to recurrent MI or mortality were calculated as the difference between the time of the event and the time of the baseline assessment. The time from hospitalization for MI to recurrent MI or mortality was entered into a Cox proportional hazards regression model. In the first model, univariable analyses of the DS14 applying the traditional cut-off of ≥ 10 for both NA and SI [17], the continuous measures of NA and SI [64, 65, 94], the dichotomized NA and SI, the interaction term of NA × SI, the interaction term of the Z-scored NA and SI (*z*NA × *z*SI) [64], the FRS scores and the control variables were performed. In the second model, all control factors that obtained a $p < 0.05$ in the univariable analyses were included in multiple regression analyses, together with the FRS score and the recommended Type D personality measure of *z*NA × *z*SI [95], to test for its additional prognostic value. All variables satisfied the proportional hazard assumption. The results of the Cox regression analyses were reported as hazard ratios (HRs) and 95% confidence intervals (CIs). A pseudo R^2 was calculated in the final Cox regression

models according to Aldrich and Nelson [116]. Harrell's *C* index was used to measure the ordinal predictive power of the regression models [117].

Table 2. Statistical analyses used in Papers I–IV of this thesis.

Statistical method	Paper I	Paper II	Paper III	Paper IV
Kruskal–Wallis test			X	
Mann–Whitney *U* test	X	X	X	X
Chi-squared test		X	X	X
Exploratory principal component factor analysis			X[e]	
Confirmatory factor analysis			X	
Cronbach's α	X	X	X	
Spearman's rho	X[a]	X[a]		
Cohen's κ			X	
Intra-class correlations			X	
Binary logistic regression	X[b]	X[c]		
General linear regression	X[d]	X[d]		
Z-score transformation	X			X
Cox proportional hazards regression				X[f]

[a] Based on raw scores
[b] Based on both raw and Z-transformed scores
[c] Univariable, multivariable and interaction models
[d] Based on a summation index of the NA and SI subscales
[e] Varimax rotation with Kaiser normalization
[f] Univariable and multivariable

Results

Paper I

A total of 10.4% of the boys and 14.6% of the girls aged between 15 and 18 years were classified as having Type D personality.

Girls were three times as likely as boys to have many psychosomatic symptoms, and they were twice as likely to have many musculoskeletal pain symptoms. Type D personality was moderately correlated with psychosomatic symptoms (boys: $r = 0.467$, $p < 0.001$; girls: $r = 0.513$, $p < 0.001$) and exhibited a somewhat weaker correlation with musculoskeletal pain (boys: $r = 0.289$, $p < 0.001$; girls $r = 0.294$, $p < 0.001$). A binary logistic regression analysis revealed that both boys and girls with a traditionally labelled Type D personality (NA and SI > 10) were approximately twice as likely to have musculoskeletal pain and five times as likely to have psychosomatic symptoms as non-Type D adolescents (Table 3). The logistic regression analyses explained more variance in the psychosomatic symptoms than in the musculoskeletal pain symptoms, and, in general, the analyses explained more variance in the girls' responses. A binary logistic regression interaction model of Z-score transformations of the NA and SI scales indicated that a high score on the NA scale was associated with increased odds of having many musculoskeletal pain symptoms (OR = 2.04, $p < 0.001$ for boys; and OR = 2.25, $p < 0.001$ for girls), whereas a high score on the SI scale was associated with a decreased risk of musculoskeletal symptoms for girls (OR = 0.79, $p < 0.001$). However, no interaction effects between NA and SI were found. A similar pattern was found regarding psychosomatic symptoms, in which NA and SI > 10 were associated with a fivefold increased odds for boys and girls (OR = 5.47, $p < 0.001$ for boys; and OR = 5.43, $p < 0.001$ for girls); however, no effect was detected for SI or the interaction between NA and SI in the adjusted models.

Table 3. Binary logistic regression models of the relationship between Type D personality and many musculoskeletal symptoms, and between Type D personality and many psychosomatic symptoms for boys and girls. Odds ratio (OR), 95% CI and *p*-values are shown for both unadjusted models and for models adjusted for confounding factors.

	Boys						**Girls**					
	Unadjusted model			Adjusted model[a]			Unadjusted model			Adjusted model[a]		
	OR	95% CI	*p* (R^2)[b]	OR	95% CI	*p* (R^2)[b]	OR	95% CI	*p* (R^2)[b]	OR	95% CI	*p* (R^2)[b]
Many musculoskeletal symptoms												
Type D personality	2.42	1.70–3.44	<0.001 (1.8%)	2.39	1.62–3.52	<0.001 (3.4%)	2.46	1.93–3.13	<0.001 (3.1%)	2.38	1.82–3.11	<0.001 (4.4%)
Many psychosomatic symptoms												
Type D personality	5.74	4.23–7.80	<0.001 (9.0%)	5.39	3.83–7.57	<0.001 (11.7%)	5.43	4.29–6.88	<0.001 (11.4%)	5.54	4.26–7.21	<0.001 (14.4%)

[a] Adjusted for living conditions, parental employment status, ethnicity, socio-economic status, BMI and exercise habits.
[b] Nagelkerke R^2 is given for the analysis of each symptom category by sex.

Paper II

A correlation analysis between variables showed that only the association between NA and sleep disturbances was moderately strong (r = 0.48). A binary logistic regression analysis of sleep hours during school nights revealed that Type D personality was associated with increased odds of sleeping fewer hours in an unadjusted model (OR = 2.314; 95% CI = 1.938–2.763; $p < 0.001$). However, after adjusting for alcohol use, exercise habits, everyday smoking, excessive computer use and family SES, the main effect of Type D personality disappeared.

Regarding sleep hours during weekend nights, Type D personality was associated with increased odds of sleeping fewer hours in an unadjusted model (OR = 1.683; 95% CI = 1.355–2.090; $p < 0.001$). The main effect remained after adjusting for the control variables (Type D personality: OR = 1.574; 95% CI = 1.252–1.980; $p < 0.001$).

In binary logistic regression models, adolescents with a Type D personality were four times as likely to have sleep disturbances. This finding was stable in uni- and multivariate models, as well as in the model that controlled for interaction effects (Type D personality: OR = 4.381; 95% CI = 3.481–5.514; $p < 0.001$; $R^2 = 0.131$). In a separate analysis of the two Type D personality subscales, NA contributed more than did SI to sleep problems.

Paper III

In Paper III, we aimed to examine the prevalence of Type D personality and the construct validity, temporal stability and internal consistency of the DS14 during hospitalization and 1 and 12 months after MI. The baseline reliability, validity and temporal stability of the Swedish version of the DS14 were analysed according to the traditional dichotomization [17]. Moreover, explorative analyses were performed by comparing the temporal stability of the traditional dichotomized scoring of DS14 with alternative types of dichotomized or non-dichotomized scorings of DS14, to study the movements of scoring around the cut-off value.

The prevalence of Type D personality was 14.0% during hospitalization, 25.1% at 1 month and 19.2% at 12 months after hospitalization. Sex distribution, age and BMI did not differ between patients with and without Type D personality. Individuals with Type D personality reported more depression according to the HADS-D scale ($\chi^2 = 25.5$, $p < 0.001$), had more often a history of smoking ($\chi^2 = 9.34$, $p < 0.001$) and were more often not born in Sweden ($\chi^2 = 8.06$, $p = 0.005$). No other significant differences were found.

A total of 6.1% of the patients were classified as having Type D personality at all three assessments, whereas 68.4% of the patients were classified as having stable non-Type D personality and 25.6% changed between personal-

ity classifications. The exploratory principal component factor analysis validated the two-factor structure of the DS14 at hospitalization and 1 month and 12 months after hospitalization. The two factors accounted for 46.54%–62.79% of the variance. The two-factor solution was validated by a confirmatory factor analysis. During hospitalization, the overall data model fit was acceptable. At 1 month after hospitalization, the model fit was better and remained acceptable. At 12 months after hospitalization, the values provided limited support for a reasonable model fit. Cronbach's α indicated higher internal consistency for the NA subscale compared with the SI subscale. Cohen's κ values for the dichotomized Type D scale were slight to fair, indicating low temporal stability over time, especially from hospitalization to the 1-month and 12-months follow-ups ($\kappa = 0.365$ and 0.397, respectively). The ICCs for the Type D index were generally high, with the highest occurring between 1 and 12 months after hospitalization. The ICCs between hospitalization and the 1-month follow-up ranged from 0.494 ("I often feel unhappy") to 0.758 ("I often find myself worrying about something"). The ICCs between hospitalization and the 12-months follow-up ranged from 0.507 ("I often feel inhibited in social interactions") to 0.700 ("I often talk to strangers"). The ICCs between the 1-month and 12-months follow-up assessments ranged from 0.619 ("I would rather keep other people at a distance") to 0.805 ("I make contact easily when I meet people"). The item "I often feel unhappy" was the item with the lowest stability over time.

To explore further the movements around the cut-off point in relation to the dichotomized Type D scale, we used alternative divisions of the NA and SI subscales (< 8, 8–12 and > 12 points) on all patients at each time point. Among the participants in whom the Type D personality classification differed between hospitalization and the 1-month follow-up, 40.4% scored 8–12 points on the NA subscale and 45.6% scored 8–12 points on the SI subscale at 1 month, suggesting that individuals with an unstable Type D personality classification often scored close to the Type D personality classification cut-off (≥ 10 points) in the NA and SI subscales. Because severe depression might influence the stability of the DS14 and be a strong confounding factor, control analyses were performed by excluding patients with severe depression, as expressed by an HADS-D score > 10 ($n = 18$). Cohen's κ and the ICC for stability remained generally unchanged.

Paper IV

In study IV, we investigated whether Type D personality, in addition to the FRS, is an independent predictor of recurrent MI and all-cause mortality in a population of patients with post-acute MI. A total of 822 patients with MI were included in this study, with a predominance of men (67.2%, $n = 552$, $p < 0.001$). The mean age was 70.25 years (range = 38–96 years; SD = 11.66

years). The prevalence of Type D personality, according to the traditional cut-off of ≥ 10 for NA and SI, was 14.7% (n = 81) for men and 13.7% (n = 47) for women ($p < 0.001$). The mean value of NA was 6.65 (SD = 5.54) and that of SI was 7.91 (SD = 5.74).

The follow-up interval was M = 73.3 months (range = 44.4–98.9 months). FRS had a strong predictive value for recurrent MI and a somewhat weaker predictive value for all-cause mortality. However, none of the previously proposed methods used in the analysis of the DS14 measurement of Type D personality had a predictive value for recurrent MI or all-cause mortality, either in univariable analyses or in addition to the FRS (Tables 4 and 5).

Table 4. Cox regression analysis of recurrent MI.

	Univariable			Multivariable[i]			
	HR	95% CI	*p*	HR	95% CI	*p*	Pseudo R^2
FRS[a]	4.89	1.89–12.64	0.001	4.95	1.91–12.80	0.001	
Type D[b]	1.25	0.76–2.04	0.381				
SI index[c]	1.01	0.98–1.04	0.501				
NA index[d]	1.01	0.97–1.04	0.774				
SI[e]	1.20	0.82–1.76	0.339				
NA[f]	1.27	0.86–1.88	0.238				
NA × SI[g]	1.00	0.99–1.00	0.432				
*z*NA × *z*SI[h]	1.06	0.91–1.23	0.438	1.07	0.92–1.24	0.384	
Swedish born	1.00	0.61–1.62	0.990				
Marital status	0.94	0.63–1.39	0.743				
Educational level	0.86	0.67–1.12	0.267				
BMI	1.03	0.99–1.07	0.145				
							0.017

[a] Framingham risk score
[b] Dichotomized using NA and SI ≥ 10
[c] Social inhibition raw score
[d] Negative affectivity raw score
[e] Social inhibition ≥ 10
[f] Negative affectivity ≥ 10
[g] Type D personality total raw score based on the NA × SI interaction term
[h] Interaction of Z-score transformation with NA and SI
[i] Only the significant control variables in the univariable analysis and *z*NA × *z*SI were included in the multivariate Cox regression analysis

Table 5. Cox regression analysis of mortality.

	Univariable			Multivariable[i]			
	HR	95% CI	*p*	HR	95% CI	*p*	Pseudo R^2
FRS[a]	4.61	2.38–8.93	< 0.001	4.20	2.14–8.25	<0.001	
Type D[b]	0.99	0.68–1.42	0.941				
SI index[c]	1.03	1.00–1.05	0.018				
NA index[d]	0.99	0.97–1.02	0.487				
SI[e]	1.22	0.94–1.58	0.130				
NA[f]	0.82	0.61–1.10	0.184				
NA × SI[g]	1.00	1.00–1.00	0.389				
*z*NA × *z*SI[h]	1.02	0.92–1.14	0.705	1.07	0.96–1.18	0.22	
Swedish born	0.96	0.69–1.34	0.814				
Marital status	2.23	1.73–2.87	<0.001	2.02	1.56–2.62	<0.001	
Educational level	0.66	0.55–0.80	<0.001	0.74	0.61–0.90	0.002	
BMI	0.93	0.90–0.96	<0.001	0.93	0.91–0.96	<0.001	
							0.10

[a] Framingham risk score
[b] Dichotomized using NA and SI ≥ 10
[c] Social inhibition raw score
[d] Negative affectivity raw score
[e] Social inhibition ≥ 10
[f] Negative affectivity ≥ 10
[g] Type D personality total raw score based on the NA × SI interaction term
[h] Interaction of Z-score transformation with NA and SI
[i] Only the significant control variables in the univariable analysis and *z*NA × *z*SI were included in the multivariate Cox regression analysis

Subgroup analysis

(Not presented in papers)

To address earlier criticism regarding the timing of the data collection [118], and to examine whether the settings of the data collection during hospitalization for MI affected the results, a subgroup analysis of the patients who completed DS14 1 month after hospitalization (n = 409) was performed. No predictive value was found for either FRS (HR = 4.10, p = 0.84) or Type D personality measured at 1 month after hospitalization, as analysed by zNA × zSI (HR = 0.97, p = 0.84) regarding recurrent MI (n of events = 41). The results for mortality were similar for FRS (HR = 4.68, p = 0.10) and Type D personality measured at 1 month after hospitalization, as analysed by zNA × zSI (HR = 1.12, p = 0.26; n of events = 74).

Discussion

The overall aims of this thesis were to examine the impact of Type D personality on adolescents' self-perceived health, to examine the factorial and temporal stability of the DS14 and to clarify whether Type D personality is an independent risk factor for recurrent myocardial infarction and all-cause mortality among patients with myocardial infarction.

Among adolescents, we found associations between Type D personality, psychosomatic symptoms and musculoskeletal pain. Moreover, adolescents with Type D personality were four times as likely to have sleep problems, and they were also more likely to sleep less, especially on school nights. However, when we examined the stability of the Type D personality in a population of patients suffering from myocardial infarction, only 6.1% of the patients were classified as Type D personality at all three assessments, whereas 68.4% of the patients were stable non-Type D and 25.6% changed between personality classifications. Although the DS14 had stable structural validity, its temporal stability was low, especially from hospitalization to the 1-month and 12-months follow-up assessments. Regarding predictive value for recurrent MI and mortality, Type D personality had no further value to the Framingham risk score. Together, these results provide a contradictory picture. They show robust associations between Type D personality and several negative health outcomes among adolescents, but low burden of proof of the predictive value of Type D personality regarding hard endpoints, such as recurrent MI or mortality. How can these findings be interpreted in relation to the Type D personality measure and personality theory?

Type D personality and adolescent health

The results presented in Papers I and II suggest that adolescents with Type D personality are prone to ill health expressed as psychosomatic symptoms, musculoskeletal pain and sleep problems.

Green and Walker, suggested that psychosomatic symptoms are caused by psychosocial factors, such as stress and lack of social support [119]. The characteristics of social inhibition might be mediating factors of the associations between psychosocial stress and psychosomatic symptoms. It is possible that associations between Type D personality and adolescents' psychosomatic symptoms are partially attributable to less effective strategies for

coping with stress. Type D personality has been associated with repressive coping [17], avoidance coping and low levels of problem-focused coping [120]. The suppression of emotions associated with repressive coping strategies may instead lead to other symptoms. Adolescents with Type D personality may be more distressed than other adolescents, and the vulnerability associated with this personality type may affect their experience of pain.

The adolescents with Type D personality included in this sample reported more sleep problems than did the other adolescents. Optimal sleep allows the physiological unwinding of the stress-hormone system. Studies have suggested associations between sleep and activity in the hypothalamic–pituitary–adrenal (HPA) axis [121, 122]. The HPA axis is activated in response to stress via central processes that lead to increases in circulating cortisol [121, 123]. Poor sleep quality is associated with social factors such as difficulty in dealing with problems, increased anxiety and tension, behavioral problems and stress [124]. Poor sleep has been related to reduced physical, social and emotional functioning and well-being [125, 126]. In one study, adults with sleep problems experienced lower quality of life and higher scores on measures of depression, anxiety, neuroticism, extraversion and stress perception compared with good sleepers [127]. Generally, individuals with sleep problems are more likely to report a range of health problems [128], and adults with pain-related disorders also report increased sleep problems [129, 130]. Buckner reported that many patients with insomnia had an anxious and avoidant profile [131], which is similar to individuals with Type D personality. In particular, social anxiety has been correlated with sleep dissatisfaction, sleep-related functional impairment and the perception of and distress about sleep problems [132]. In the studies mentioned above, neuroticism-related personality traits, similar to those of Type D personality, were associated with sleep problems. Individuals with Type D personality may regard ambiguous or neutral situations as more distressing than do non-Type D individuals. This perceptual bias of Type D individuals likely increases their vulnerability to stress [133, 134]. Moreover, it seems plausible that the subjective experience of sleep problems has a mediating effect on psychosomatic symptoms and musculoskeletal pain, and vice versa.

Although the present thesis described several associations between Type D personality and ill-health outcomes, no direction of the links of the associations and health outcomes was shown. Are adolescents with Type D personality and sleep problems more vulnerable to the negative health effects that may be associated with their heightened sensitivity to stress? Or do high levels of negative affectivity and social inhibition increase subjective experiences of sleep problems? For example, people with Type D personality are more likely to interpret life events, symptoms of pain and sleep problems more negatively than those with non-Type D personality, and they report more of these events [135]. Moreover, individuals with Type D personality

possess a distinct profile of illness beliefs, such as believing their illness will last longer, is less under their control and is less treatable [136].

Consequently, subjective feelings of ill health may increase the tendency to report higher values on the DS14.

Prevalence of Type D personality

In the adolescent sample, 10.4% of the boys and 14.6% of the girls were classified as having Type D personality. Other studies have presented a higher prevalence of Type D personality among adolescents, including 18% in a study of Korean adolescents with a mean age of 14.3 years [55], and 27.5% in a Dutch study of subjects with a mean age of 10.3 years [53]. However, the difference in the mean age of participants across these studies limits the possibility of making direct comparisons. Interestingly, the prevalence of Type D personality among patients with myocardial infarction reported in Paper IV (14.0%) was similar to that of the adolescent population and was relatively lower than that reported by other studies [17, 137, 138].

Stability of personality and the DS14

In Paper III, we determined that the Swedish DS14 presented low temporal stability, especially when comparing the measurement obtained during hospitalization with the two follow-up measurements. This suggests that the DS14 is not an optimal personality measurement during critical life events that require psychological adaptation, such as suffering from a myocardial infarction. According to Robert et al. [139], personality traits are stable patterns in each individual that distinguish him/her from other individuals. It has also been suggested that personality can change, especially across certain life courses [140]. There has been some debate regarding whether personality changes because of maturation [141] or social demands and experiences such as adverse life events [142-144]. The interaction of personality traits with major life events has been widely analysed, with mixed results. For example, Vaidya et al. [145] found that individuals with a high score on extraversion had a higher probability of experiencing positive life events, and individuals with a high score on neuroticism had a higher probability of experiencing negative life events. Conversely, a longitudinal study of personality and life events found that individuals who experienced an extremely unpleasant life event changed personality, mainly by an increase in neuroticism [142]. However, the same study found no relation between baseline personality and future events. Specht et al. [146] found personality changes throughout life, with more pronounced changes in young and old age, and that the changes were partly attributable to social demands and life experiences. The above-mentioned studies all examined the stability of the NEO-PI (the Big Five personality scale). The variability observed between traits dif-

fered. For example, extraversion, neuroticism and openness to experience declined over the lifespan, whereas agreeableness increased among young cohorts [147, 148]. In light of these findings, a discussion regarding the stability of personality is necessary, especially regarding whether personality predicts the occurrence of specific major life events and whether those experiences alter personality or its stability.

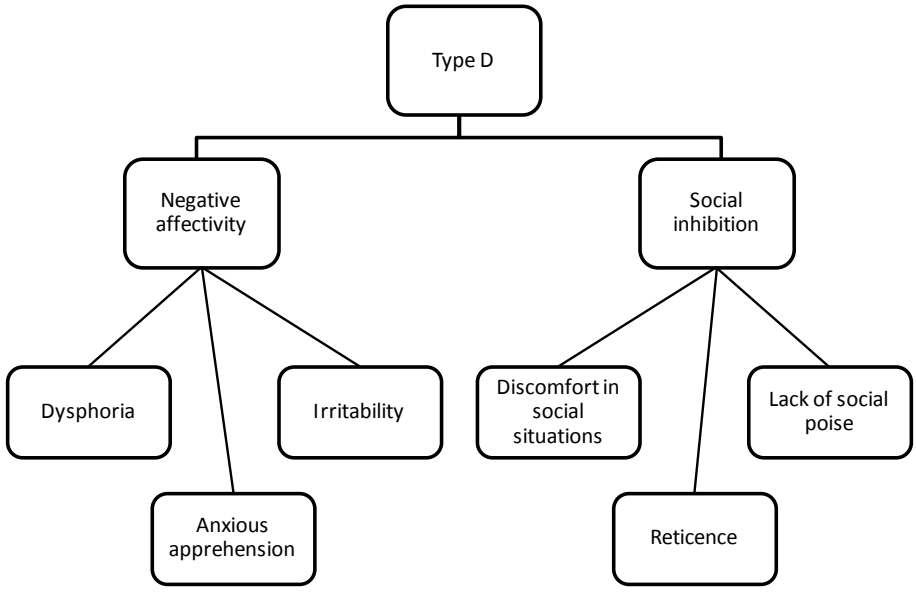

Figure 4. Adapted from Straat et al., Journal of Psychosomatic Research 72 (2012) [149].

Internal structure of the DS14

The two-factor structure of the DS14 was confirmed in the present thesis. In general, the factor loadings increased over time, and the highest factor loadings occurred at the 12-months follow-up. However, a confirmatory factor analysis yielded the lowest confirmatory values at the 12-months follow-up, suggesting a poor model fit. The Cronbach's α values exhibited acceptable internal consistency, but were highest at the 12-months follow-up. The NA subscale exhibited higher internal consistency at all three time points compared with the SI subscale. Straat et al. [149] described the NA and SI subtrait triplets. This position supports the three-level model as the candidate theory to explain Type D personality (Figure 4). Using exploratory factor analysis (EFA), confirmatory factor analysis (CFA) and Mokken analysis, Straat et al. assessed the internal structure of the DS14 [149]. The results of the CFA method support a three-level hierarchical model. However, the EFA model suggested a two-factor structure, without evidence of low-level fac-

tors. Straat et al. [149] stated that the three-level hierarchical model is the conceptual model for Type D personality.

The predictive value of Type D personality

According to Mommersteeg et al., Type D personality is associated with poor patient-perceived symptoms in patients with mild coronary abnormalities, which can be hypothesized as being detrimental in the long term [43]. Moreover, Type D personality has been associated with an adverse health status among Japanese elderly people in terms of mental and physical risk factors [150]. In Papers I and II, we investigated the associations between Type D personality and subjective outcomes of ill health. However, it is important to investigate the predictive value of a measure to verify its clinical significance. Mortality reflects the ultimate outcome of the illness process and is a key objective marker that is used to state that a risk factor is important [151]. Therefore, mortality and recurrent MI were used as objective clinical outcomes in Paper IV. Furthermore, we analysed Type D personality in relation to a well-used risk inventory of biological risk factors for CHD, namely Framingham risk score, to investigate whether Type D personality would add predictive value in relation to recurrent MI and mortality. Although some studies have suggested an association between Type D personality and major adverse cardiac events, the findings reported across studies are inconsistent [16, 61, 64, 74, 152, 153], providing ambiguous evidence as to whether Type D personality can predict recurrent MI or mortality in patients with CHD. Several of these previous studies suffered from low power, a non-predictive study design or other weaknesses. The present study reported 111 events of recurrent MI and 271 events of all-cause mortality, which might be considered as an acceptable power.

In the present study, no significant relationship was found between Type D personality and recurrent MI or mortality, independent of the statistical methods applied to analyse the DS14. The results of the present study were consistent with those of previous studies that reported null findings regarding Type D personality as a predictor of recurrent MI and mortality [57, 60, 75]. Interestingly, a recent study performed by Meyer et al. [78] reported almost identical hazard ratios (HR). However, the findings are in contrast with those of studies that reported a predictive value of Type D personality regarding adverse cardiac events or mortality [17, 61, 92]. It has been suggested that there are age-related differences regarding the effects of Type D personality on mortality, as the influence of psychological distress on cardiovascular outcomes may be more potent in younger individuals (< 70 years) [77]. However, the effect of personality should be present throughout the lifespan to be considered as a true risk factor. Based on a meta-analysis, Grande et al. [97] suggested that Type D personality affects prognosis negatively only in patients with CHD, and not in patients with heart failure.

However, considering the lack of prognostic value among CHD patients reported in Paper IV, that assumption seems questionable. Moreover, it has been suggested that NA and SI have antagonistic effects on major cardiac events (MACE), as SI was linked to better outcomes [78]. However, the results of the present thesis do not support that assumption.

Contradictory methodological opinions regarding the DS14

O'Dell et al. [154] and Grande et al. [97] recommended that investigations should be performed by diverse groups of unaffiliated scientists (outside of the Denollet Tilburggroup) to facilitate the development of research on Type D personality. Dannemann further recommended additional research regarding the cut-off point of Type D personality [155]. Several researchers have suggested that the distressed personality type is more appropriately measured along a continuum, rather than as a categorical variable based on values > 10 that assigns individuals to Type D or non-Type D categories [64, 65, 94]. The grouping of continuous variables into dichotomous categories entails a risk of losing information. Coyne and de Voodg [152] highlighted the problem of isolating the high NA/high SI quadrant to construct Type D personality. As NA and SI are moderately correlated, patients who are selected because they score high on both factors are likely to be in greater distress than if either factor was considered separately. Furthermore, there have been suggestions that Type D personality research should focus on the additive and multiplicative effects of NA and SI [152], which has resulted in a debate regarding the proper statistical methods that should be used to analyse Type D personality.

Thus, in Papers I and IV, we tested the interaction effects of negative affectivity and social inhibition (measured as continuous Z-transformed variables). Using Z-transformed scores in analyses facilitates the comparison of values from different distributions. However, information about individuals located on the tails of the distribution is lost—in this case, those with the most negative affectivity and the most social inhibition. Stevenson and Williams [153] investigated quality of life and physical symptoms using the traditional categorical analysis of DS14 and found that individuals with Type D personality reported more symptoms and lower quality of life. However, when analysed as a dimensional construct (NA × SI) using multiple regression analysis, no interaction effect was found after controlling for the main effects of NA and SI separately [153]. Similar to the results reported by Stevenson and Williams, no interaction effect of NA × SI was found in the present thesis in relation to musculoskeletal pain or psychosomatic symptoms, although an effect was observed when using the traditional cut-off value. One possible explanation for this observation may be the strong influence of negative affect in relation to the outcome variables. According to Denollet, the interaction effect of social inhibition and negative emotions, rather than

negative emotions per se, predicted poor clinical outcome after percutaneous coronary intervention (PCI) [68]. In Paper IV, we investigated all of the previously proposed application methods of the Type D personality measurement DS14: the dichotomized NA and SI ≥ 10 [17], continuous measures of NA and SI [64, 65, 94], the interaction term of NA × SI [64, 94] and their Z-scores zNA × zSI [64, 95].

Further, inconsistent results should lead researchers to consider the usefulness of specifying multiple thresholds rather than only a single threshold on a dimensional assessment [156]. Bergvik et al. have suggested testing the DS14 for various cut-off levels [157]. According to Emons et al. [101], it is most relevant clinically to identify the individuals at the high end of each subscale of NA and SI. An alternative use of the DS14 with several cut-off points compared with the usual dichotomization might increase the clinical relevance.

Type D personality, negative affectivity or depression?

Denollet asserted that Type D personality is independent of mood [17]. However, in Paper III, we found associations between Type D personality and depression. Also, others have reported an overlap in the content of the measures that assess depressive symptoms and Type D personality, as well as that Type D personality is related to the prevalence and persistence of depression [41, 158]. It has also been suggested that Type D personality and depressive symptoms are two facets of negative affectivity, and that the predictive value of Type D personality is independent of depressive symptoms [94]. However, Type D personality has been presented as an explanation for the relationship between depressive symptoms and mortality observed in patients with stable chronic obstructive pulmonary disease [63, 159]. Depression and anxiety have also been associated with coronary artery disease (CAD) [160, 161] and premature mortality [162, 163]. Coyne et al. [64] suggested that the NA scale should be replaced by a depression scale based on the similarities between them. However, several studies have shown that, although Type D personality is associated with an increased risk of depression, these factors are not interchangeable [118, 164-166]. Type D personality has been related to emotional distress, and NA and SI share considerable variance in depression/stress scores [164]. The interaction of NA and SI has been shown to predict increased stress levels [167]. However, NA and SI seem to represent two distinct categories of psychological distress [168]. Depression and anxiety are temporal and episodic, and people differ in their propensity to mood disorders. Depression is a particular form of psychopathology that is considered to be related to, but distinct from, personality traits, i.e., neuroticism. Depression is defined as an episodic cluster of symptoms that reflect a change in mood and function relative to a person's normal baseline. However, people who are prone to negative emotions may be more

likely to develop a depressed mood [169]. When analysing prediction models of Type D personality, it is important to discuss the potential impact of different forms of distress on health outcomes. For example, negative affectivity seemed to be the most important factor in the associations between Type D personality, psychosomatic symptoms, musculoskeletal pain and sleep problems. Other studies have examined Type D personality and coronary heart disease and have reported that NA contributed the most to these presentations [60, 64]. It has been suggested that SI is the modulating factor of the negative outcomes of the NA [68]. In the present thesis, neither NA nor SI made significant contributions to the recurrent MI or all-cause mortality outcome.

Stress

Although Type D personality is suggested to be independent of mood, there might be a risk of simultaneous thresholds for diagnosis of psychopathological disorders, especially during times of elevated stress. Even though the personality traits of individuals with Type D personality are not pathological by themselves, some of these individuals will display subclinical levels of emotional distress all their lives [37]. Regarding the findings reported in Papers I and II, the aetiology of psychosomatic symptoms and sleep problems may be rooted in emotional distress.

Can the negative effects of Type D personality be anticipated?

In a recent study, individuals with Type D personality underwent an 8-week mindfulness-based stress reduction (MBSR) programme with the aim of reducing Type D personality characteristics; the mindfulness intervention was compared with a wait-list control. Although changes in Type D characteristics did not differ between the groups, the intervention group showed reductions of both the NA and SI dimensions after MBSR. These effects were mediated by changes in self-reported mindfulness [170]. It has also been suggested that individuals with Type D personality can learn new coping strategies via cognitive behavioural therapy, social skills training and stress management to reduce their distress and improve emotional expression [171, 172]. The point of these interventions is not to reduce the risk of recurrent MI or mortality, but to relieve some of the negative stress that these individuals carry. Stress is a potential mediator of increased health care utilization among patients with Type D personality [158, 173]. However, it is difficult to determine whether it is the individual's personality trait that is modified, or whether it is the behaviour that the trait generates (the state) that is modified. The results of this thesis provide the perspective that the Swedish DS14 measures more a state dimension rather than the aimed trait dimension.

Methodological considerations

The major strength of the SALVe 2008 data used in Papers I and II is the large population-based design. The study solicited information from practically all students in the target population who were in school on the day of the investigation, as well as from several non-attending students who participated in the study after their return to school. The study population included adolescents from the town as well as from the countryside, and can be considered representative of Swedish society. These factors increase the generalizability of the results to other adolescent populations. The major strength of the SAVa study, which was used in Papers III and IV, is the relatively large population included in the analyses and its long-term follow-up. The restriction to one centre serving a defined geographical area enabled the study to be conducted in a highly standardized way, albeit at the expense of the generalizability of the results.

However, the findings of the present thesis must be considered in light of several limitations.

Self-report questionnaires

Self-report questionnaires always involve a risk of information bias associated with false or inaccurate responses or recollections of the participants. Although self-reports must be interpreted carefully, their accuracy increases with age and self-reports of adolescents are considered to be more reliable than those of younger children [174]. An additional manner to investigate the credibility of the answers could have been to use parent reports for the DS14 items. In fact, Connelly et al. showed that observers' ratings of personality predict performance behaviours better than self-rated questionnaires [175]. An even more desirable way to study these phenomena may be the use of a triangular method that combines self-reports with parental ratings and results of examinations performed by qualified personnel [176]. The DS14 has two so-called "reversed questions" that may reduce the effects of deliberately false answers. It has been demonstrated that response formats with several possible answers have better psychometric properties than dichotomous formats [177]. However, as individuals with Type D personality are more likely to interpret life events, symptoms, pain and sleep problems more negatively and report more of these [135], self-reported data involved a risk of overestimating negative symptoms in this group. This may have affected the results reported in Papers I and II.

Also of note was the longitudinal design used in Paper III, as individuals with Type D personality may be less prone to take part in follow-up assessments. In one study, participants who did not complete the follow-up protocol had higher scores of depression, anxiety and negative affectivity compared with completers [178].

Confounding and bias

Another limitation was the possibility of confounding effects of medical conditions or diagnosis that were not measured. In addition, the nature of the school population used in Papers I and II may be a limitation, as students with the most psychosomatic symptoms, musculoskeletal pain and sleep problems are more likely to be absent from school. However, teachers distributed questionnaires to the missing students, and this late-responding group did not differ from the remaining students regarding the prevalence of Type D personality. Nevertheless, the late-responding group had significantly more sleep disturbances and slept less on school nights. Regarding the SAVa population used in Papers III and IV, the relatively high level of troponin I (≥ 0.4 μg/L) used as a diagnostic marker of MI, which excluded MI with small myocardial damage, was a limitation. Conversely, we can estimate that our patients were more ill, with significant atherosclerosis. Moreover, patients with severe illness were excluded, although the inclusion of their information in the study would have been desirable.

In addition, given their inhibited nature and passive coping style, it is possible that individuals with Type D personality were less likely to participate in the studies [64, 179].

Limitations of the study design

The cross-sectional design used in Papers I and II precludes the determination of the directionality of the association between Type D personality and the outcome variables. Regarding Papers III and IV, the lack of information on personality prior to the onset of the MI limits the interpretation of the results. It is difficult to determine whether single events such as MI have unique effects on the stability of personality. It would have been desirable to include a longer follow-up time to create a more complete overview of the impact of the variables on the stability of personality during a life event.

Methodological considerations regarding the DS14

One of the major limitations of Papers I and II of this thesis was that the DS14 was developed for adult patients with ischemic heart disease. Adolescents undergo dramatic biological, psychological and social transformations as they grow into adulthood. Accordingly, there may be differences in the interpretation and psychological meaning of the DS14 when it is applied to adolescents. Although the DS14 was used to investigate healthy young adults in a previous study [55], the clinical utility of Type D personality has not been established for adolescents. According to Caspi [180], the Big Five personality dimensions can be measured in childhood and adolescence because "the child is the father of the man" (p. 158) [181]. However, there is

evidence of a trend towards lower scores on neuroticism in adolescence compared with adulthood [182]. This could explain the low prevalence of Type D personality observed in our adolescent population.

The most frequently debated aspect of Type D personality is the validity of the scales that are used to measure it [95]. Coyne and de Voogd pointed out the lack of validity of the early studies of type D personality, largely because of their small sample size and low statistical power [152]. The studies described in the present thesis included larger sample sizes and a relatively high rate of participation, which provides a substantial statistical power compared with earlier studies.

Considering the large sample size and the relatively few analyses that were performed, the risk of finding significant results by chance because of multiple comparisons is likely to be small. Given the number of control variables, we could have used Bonferroni corrections to minimize the likelihood of Type I errors; however, this approach would have led to an increased risk of Type II errors [183].

Conclusions

The main findings of the present thesis were:

- The prevalence of Type D personality in the adolescent populations was 10.4% for boys and 14.6% for girls. Boys and girls with Type D personality were approximately twice as likely to report musculoskeletal pain and five times more likely to report psychosomatic symptoms.
- Adolescents with Type D personality were four times more likely to have sleep disturbances and slept fewer hours.
- Among patients with myocardial infarction, the Swedish DS14 exhibited stable structural validity. Our measurements confirmed the two-factor model of the DS14. However, the DS14 showed low temporal stability, especially when comparing the measurement obtained during hospitalization with the 1- and 12-months follow-up measurements.
- Among patients with MI, the Framingham risk score had a strong predictive value for recurrent myocardial infarction and a somewhat weaker predictive value for all-cause mortality. However, none of the previously proposed methods for the analysis of the DS14 measurement of Type D personality predicted recurrent myocardial infarction or all-cause mortality, either in univariable analyses or in addition to the Framingham risk score.

Personality traits may give health care workers comprehensive information that could be useful for the personalization of medical treatment. It may also be beneficial to the identification of adolescents with Type D personality and, via the development of targeted behavioural interventions, it may decrease their stress and lower their negative emotions. However, individuals with increased negative emotions may not share their emotions easily with others because of a fear of rejection or disapproval.

The present thesis found significant associations between DS14 and psychosomatic symptoms in adolescents. However, we detected a low stability over time for the measurement, and no predictive value for recurrent MI and mortality among patients with MI. Taken together, these results raise the question of whether the Swedish DS14 is really a measure of personality? An alternative explanation for the strong cross-sectional associations ob-

served between DS14 and psychosomatic symptoms might be that DS14 functions as a pseudo-measure of ill health, or co-varies with depressive or psychosomatic characteristics. Moreover, the present thesis reported a quite low prevalence of Type D personality compared with studies performed in other countries, which can possibly be explained by the Swedish settings. The Swedish DS14 might profit from the use of an extended number of questions in each subscale that measures the traits of negative affectivity and social inhibition. Compared with other personality scales, such as the NEO-PI (the Big Five personality scale), the DS14 consists of a limited number of questions—possibly too few to cover a phenomenon as complex as personality. These results raise the suspicion that the DS14 may not actually measure personality; rather, it may measure a state and not a trait. Thus, there is a need for further development of reliable and valid assessments of personality that are also practical in clinical settings.

Implications and future studies

The most appropriate way to clarify the predictive value of the DS14 would be to follow a population over a longer period of time and measure Type D personality before illness occurs. The cognitive and affective processes of Type D personality need to be studied in longitudinal research, in addition to cross-sectional and retrospective studies. A longitudinal approach would help us understand better the causal relationships between Type D personality, stress, mood and sleep, as well as possible impacts on health. Because individuals with Type D personality tend to use maladaptive coping strategies, interventions aimed at improving their health appear to be especially important. Although it seems plausible that Type D personality exists as a phenotype that might be associated with an increased risk of ill health, it is uncertain whether the DS14 really measures this phenotype.

Svensk sammanfattning

Typ D personlighet eller ”The distressed personality” kännetecknas av höjd negativ affekt (NA) och hög social hämning (SI). NA är tendensen att uppleva negativa känslor, och SI är tendensen att vara hämmad i sina uttryck av känslor i samvaro med andra människor. Typ D personlighet var från början utvecklad för att studera personlighetsdrag och utfall hos patienter med hjärt-kärlsjukdom. Majoriteten av studier har således fokuserat på relationen mellan typ D personlighet och negativa utfall hos populationer med hjärt-kärlsjukdom. Resultat av studier har visat att prevalensen av typ D personlighet hos hjärt-kärlsjuka är mellan 27-31%, jämfört med 13-24% hos den övriga befolkningen. Vidare har typ D personlighet kopplats samman med flertalet andra sjukdomstillstånd samt sämre självupplevd hälsa, sämre livskvalitet, depressiva symptom och ångest. Typ D personlighet mäts med självskattningsformuläret DS14. Studier som mäter typ D personlighet och dess hälsokonsekvenser hos ungdomar är ett relativt outforskat område. Vidare har tidigare resultat rörande Typ D personlighetens prediktiva värde för hjärt-kärlsjukdomar visat på tvetydiga resultat.

Metod

Delstudie I och II är tvärsnittsstudier baserat på data från Liv och Hälsa ung 2008 (SALVe 2008) där alla Västmanländska skolelever i årskurs 9 i grundskolan och år 2 på gymnasiet erbjöds att besvara ett frågeformulär (n = 5012). Delstudie III och IV är prospektiva kohort-studier med populationer från Västmanland hjärtinfarktsstudie (SAVa) där 1008 patienter med akut hjärtinfarkt inkluderades under vårdtiden och sedan följdes upp efter en och 12 månader samt i register.

Studie I

I studie I undersökte vi förekomsten av typ D personlighet hos ungdomar och associationer mellan typ D personlighet, självrapporterade psykosomatiska symptom och muskuloskeletal smärta. Mer än var tionde ungdom klassificerades som typ D personlighet. Det fanns ett starkt samband mellan denna personlighetstyp och både psykosomatiska symtom och muskuloske-

letal smärta. Pojkar och flickor med en typ D-personlighet hade ett cirka 2-faldigt ökat odds för muskuloskeletal smärta och ett 5-faldigt ökat odds för psykosomatiska symptom. Underskalan NA förklarade den största delen av associationerna i förhållandet mellan typ D personlighet och psykosomatiska symptom och muskuloskeletal smärta. Dock hittades inga interaktionseffekter av NA × SI. Denna personlighetstyp, och i synnerhet NA, kan vara en faktor som ökar risken för att drabbas av muskuloskeletal smärta och, framför allt, psykosomatiska symptom bland ungdomar.

Studie II

Mängden sömn och sömnkvalitet är viktiga indikatorer på hälsa och välbefinnande bland ungdomar. Tonåren är en känslig period, under vilken många fysiologiska, kognitiva och psykologiska processer mognar. Dåliga sömnvanor etableras ofta under ungdomen, och kan få konsekvenser senare i livet.

Ungdomar med typ D personlighet hade ungefär fyra gånger ökade odds för att ha sömnstörningar. Avseende sömntimmar under skolnätter, var typ D personlighet associerat med ökade odds för att sova färre timmar i en ojusterad modell, men vid justering för alkoholanvändning, motionsvanor, rökning, datoranvändning och familjens socioekonomiska status, försvann den huvudsakliga effekten av typ D personlighet. Beträffande sömntimmar under helgnätter, var typ D personlighet associerat med att sova färre timmar i en ojusterad modell. Den huvudsakliga effekten kvarstod även efter justering för kontrollvariablerna. Fynden rörande sömnstörningar var stabila i uni- och multivariata modeller. I separata analyser av de två underskalorna i typ D personlighetsmåttet, bidrog NA mer än SI till att förklara variansen av sömnproblem.

Individer med typ D personlighet är särskilt utsatta för de negativa effekterna av generell stress. Dessa egenskaper kan ha stor betydelse för sömnkvaliteten, och kan vara en möjlig förklaring till sambanden mellan typ D personlighet och ökade sömnproblem bland ungdomar. Dessutom kan stress vara en medierade faktor i relationen mellan typ D personlighet och sömnproblem.

Studie III

I studie III undersökte vi förekomst av typ D personlighet, temporal stabilitet, intern reliabilitet och konstruktvaliditet för typ D personlighetsformuläret DS14 vid tre tidpunkter i en population av patienter som vårdats för hjärtinfarkt. Prevalensen av typ D personlighet var 14.0% under sjukhusvistelse, 25.1% efter 1 månad och 19.2% 12 månader efter hjärtinfarkten. Totalt 6.1

% av patienterna klassificerades som typ D personlighet vid alla tre bedömningar, medan 68.4% var stabila icke-typ D personligheter, och 25.6% förändrades i sin klassificering mellan de tre mättillfällena. Den svenska DS14 skalan hade stabil strukturell validitet och resultaten bekräftade en två-faktor modell av mätskalan. DS14 uppvisade dock en låg temporal stabilitet, särskilt när man jämförde mätningen under sjukhusvistelsen med de två uppföljande mätningarna (Från sjukhusvistelsen till 1-månaders ($\kappa = 0.365$) och 12 månaders uppföljning ($\kappa = 0.397$)). Dessa resultat tyder på att DS14 kanske inte är en optimal personlighetsmätning att använda under kritiska livshändelser som kräver psykologisk anpassning.

Studie IV

Syftet med studie IV var att utvärdera om typ D personlighet, utöver Framingham risk score (FRS), är en oberoende prediktor för att återinsjukna i hjärtinfarkt eller avlida, i en population av patienter med hjärtinfarkt. En enkät med typ D personlighetsformuläret DS14 besvarades under sjukhusvistelsen. Uppföljningsintervallet var M = 73.3 månader (intervall 44.4-98.9 månader). Information rörande återinsjuknande i hjärtinfarkt hämtades från Swedeheartregistret, och uppgifter om dödligheten hämtades från folkbokföringsregistret. Ingen av de tidigare förslagna statistiska analysmetoderna av typ D personlighet (dikotom NA och SI $\geq$10, NA×SI, zNA×zSI) visade något ytterligare prediktivt värde i förhållande till FRS avseende återinsjuknande i hjärtinfarkt eller total mortalitet hos patienterna. Den aktuella studien fann således inga bevis för att typ D personlighet kan vara en oberoende riskfaktor för återinsjuknande i hjärtinfarkt eller total mortalitet.

Konklusion

Denna avhandling fann associationer mellan typ D personlighet och psykosomatiska symtom, muskuloskeletala smärtor och sömnproblem hos ungdomar. Dock uppvisade typ D personlighetsskattningsskalan DS14 låg stabilitet över tid i mätningar av patienter som drabbats av hjärtinfarkt, samt inget prediktivt värde för risken av att återinsjukna i hjärtinfarkt eller dödlighet hos dessa patienter. Detta väcker frågan om den svenska DS14 verkligen är ett mått på personlighet? En alternativ förklaring till de starka associationerna mellan typ D personlighet och psykosomatiska symtom kan vara att DS14 fungerar som ett pseudo-mått på ohälsa, eller samvarierar med depressiva eller psykosomatiska uttryck. Avhandlingen presenterar vidare relativt låga prevalenser av typ D personlighet jämfört med studier i andra länder, vilket möjligen kan förklaras av den svenska kontexten. Den svenska DS14 kanske skulle dra nytta av ett utökat antal frågor på varje delskala för att mäta drag

av negativa affekter och social hämning. I jämförelse med andra personlighetsskalor, till exempel NEO-PI (Big Five personlighetsskala), består DS14 av ett begränsat antal frågor, kanske för få för att täcka ett så komplext fenomen som personlighet. Dessa resultat ger anledning till misstanke om att DS14 faktiskt inte mäter personlighet, utan ett temporärt tillstånd, snarare än de eftersökta personlighetsegenskaperna.

Personlighetskarakterisering kan dock ge individen nyttig kunskap och självinsikt. Det kan även ge vårdpersonal information som kan vara till nytta för att anpassa medicinsk behandling, till exempel minska stress genom förbättrade copingstrategier. Individer med typ D personlighet delar inte sina känslor enkelt med andra på grund av rädsla för ogillande från omgivningen. Genom att identifiera ungdomar och vuxna med typ D personlighet och genom beteendemässiga interventioner kan stressen och de negativa känslor som de upplever minska.

Resultaten i dessa studier begränsas av att delstudie I och II är tvärsnittsstudier, ur vilka ingen kausalitet kan fastställas. Vidare är typ D personlighetsanalyserna baserade på självrapporterade data vilket kan påverka resultaten. I delstudie III svarade endast en subpopulation på de uppföljande enkäterna. I delstudie IV fanns ingen kännedom kring förekomst av typ D personlighet innan insjuknandet i hjärtinfarkt.

Det finns ett behov av vidareutveckling av tillförlitliga och giltiga bedömningar av personlighet som också är praktiskt genomförbara i kliniska sammanhang.

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Appendix

- The Swedish Type D personality questionnaire, DS14

The Swedish DS14

Personlighet.

Här följer ett antal påståenden som man ofta använder för att beskriva sig själv. Var vänlig och läs varje påstående och ***ringa in*** den siffra som bäst beskriver Dig. Det finns inga rätta eller felaktiga svar:

Din egna uppfattning är det enda som räknas.

0=FALSKT **1**=GANSKA FALSKT **2**=NEUTRALT **3**=GANSKA SANT **4**=SANT

1. Jag har lätt att få kontakt med människor jag träffar →	**0**	**1**	**2**	**3**	**4**
2. Jag gör ofta stort väsen av småsaker →	**0**	**1**	**2**	**3**	**4**
3. Jag pratar ofta med människor jag inte känner →	**0**	**1**	**2**	**3**	**4**
4. Jag känner mig ofta olycklig →	**0**	**1**	**2**	**3**	**4**
5. Jag är ofta irriterad →	**0**	**1**	**2**	**3**	**4**
6. Jag känner mig ofta hämmad när jag är tillsammans med andra →	**0**	**1**	**2**	**3**	**4**
7. Jag har en dyster syn på saker och ting →	**0**	**1**	**2**	**3**	**4**
8. Jag tycker det är svårt att starta en konversation →	**0**	**1**	**2**	**3**	**4**
9. Jag är ofta på dåligt humör →	**0**	**1**	**2**	**3**	**4**
10. Jag är en inbunden person →	**0**	**1**	**2**	**3**	**4**
11. Jag håller helst andra människor på ett visst avstånd →	**0**	**1**	**2**	**3**	**4**
12. Jag oroar mig ofta för något →	**0**	**1**	**2**	**3**	**4**
13. Jag är ofta nedstämnd →	**0**	**1**	**2**	**3**	**4**
14. När jag umgås med andra har jag svårt att komma på rätt saker att prata om →	**0**	**1**	**2**	**3**	**4**

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