Journal of Health Psychology

Cloninger's Temperament Dimensions, Socio-economic and Lifestyle Factors and Metabolic Syndrome Markers at Age 31 Years in the Northern Finland Birth Cohort 1966

Ulla Sovio, Vanessa King, Jouko Miettunen, Ellen Ek, Jaana Laitinen, Matti Joukamaa, Juha Veijola and Marjo-Riitta Järvelin

Published by:

$SAGE

http://www.sagepublications.com

Cloninger's Temperament Dimensions, Socio-economic and Lifestyle Factors and Metabolic Syndrome Markers at Age 31 Years in the Northern Finland Birth Cohort 1966

ULLA SOVIO & VANESSA KING
Imperial College London, UK

JOUKO MIETTUNEN
Oulu University Hospital, Finland

ELLEN EK
Finnish Institute of Occupational Health, Finland

JAANA LAITINEN
Finnish Institute of Occupational Health, Finland

MATTI JOUKAMAA
University of Tampere and Tampere University Hospital, Finland

JUHA VEIJOLA
Oulu University Hospital and Academy of Finland, Finland

MARJO-RIITTA JÄRVELIN
Imperial College London, UK and University of Oulu, Finland

ADDRESS. Correspondence should be directed to:
ULLA SOVIO, Department of Epidemiology and Public Health, Imperial College London, Norfolk Place, London, W2 1PG, UK. [email: u.sovio@imperial.ac.uk]

Abstract

The aim of this study was to assess the association between temperament and metabolic syndrome markers. Cloninger's Temperament and Character Inventory and clinical examination were carried out in 1997 in the Northern Finland Birth Cohort 1966 (*N* = 4364 respondents). Novelty seeking was positively associated with waist circumference in both genders. Systolic blood pressure was highest in men with high harm avoidance and low persistence scores and lowest in women with high reward dependence and high persistence scores. Childhood socio-economic status did not confound these associations. Smoking and alcohol consumption were associated with higher novelty seeking. Our results suggest that temperament is associated with metabolic syndrome markers and this association may be partly mediated by lifestyle factors and socio-economic status in adulthood.

Keywords

- *cohort studies*
- *lifestyle*
- *metabolic syndrome*
- *social class*
- *temperament*

371

Introduction

THE RELATIONSHIP between psychosocial characteristics, such as type A behaviour and hostility (Williams, 2002), and cardiovascular disease risk factors have been extensively studied (Gallacher, Sweetnam, Yarnell, Elwood, & Stansfeld, 2003; Räikkönen, Matthews, & Salomon, 2003; Yan et al., 2003). However, little attention has been given to the factors influencing or associating with the development of these psychosocial and related biobehavioural risk factors. Considering the controversial results from the studies on type A behaviour and cardiovascular disease risk (Hemingway & Marmot, 1999; Myrtek, 2001; Ravaja, Keltikangas-Järvinen, & Viikari, 1996; Schum, Jorgensen, Verhaeghen, Sauro, & Thibodeau, 2003), it would be worthwhile investigating innate temperament instead. Different temperament dimensions may be linked with the risk of cardiovascular disease directly or through the development of adverse psychosocial and biobehavioural mediators (Jorgensen, Johnson, Kolodziej, & Schreer, 1996).

In this study, temperament was assessed using TCI (Temperament and Character Inventory; Cloninger, Przybeck, Svrakic, & Wetzel, 1994), which includes four genetically independent temperament dimensions: novelty seeking (NS), harm avoidance (HA), reward dependence (RD) and persistence (P). Each of the temperament dimensions is 54–61 per cent inheritable (Heath, Cloninger, & Martin, 1994) and there is evidence that temperament does not change essentially during life (Caspi et al., 2003).

Of these temperament dimensions, high NS and low HA have been found to be related to early onset of alcohol consumption (Cloninger, Sigvardsson, & Bohman, 1988) and substance use (Masse & Tremblay, 1997). As far as we know, only one study has been published regarding Cloninger's temperament dimensions in relation to determinants of cardiovascular disease (Cardiovascular Risk in Young Finns (CRYF) study; Keltikangas-Järvinen, Ravaja, & Viikari, 1999). In contrast to researchers' expectations, this study of young Finnish men found that a temperament profile, characterized by a high level of P and RD, an average level of NS and a low level of HA, was related to several physiological coronary heart disease risk factors including serum insulin, lipids, systolic blood pressure (SBP), body mass index (BMI) and subscapular skinfold thickness.

We hypothesized that there is a relationship between temperament and metabolic syndrome markers. Specifically, we expected high NS and high HA

to be associated with adverse metabolic outcomes and these associations to be mediated by lifestyle factors (Laitinen, Pietiläinen, Wadsworth, Sovio, & Järvelin, 2004). We examined the associations between temperament dimensions and metabolic syndrome markers (Expert Panel on Detection, 2001) including SBP, fasting glucose, HDL cholesterol and waist circumference in a Finnish cohort of similar age to the CRYF study to compare the results, and to test to what extent smoking, alcohol consumption and socio-economic status (SES) mediate these associations.

Materials and methods

Study population

The study population, derived from a geographically defined prospective birth cohort from Northern Finland (NFBC 1966), consists of 12,058 persons with expected dates of birth in 1966, born alive, in the two northernmost provinces of Finland (96.3 per cent of all births in the area registered at the Finnish Central Statistical Office (Rantakallio, 1988)). Mothers were recruited during a routine check at the maternity health centre. Data on socio-demographic, behavioural and other background factors were collected using a structured questionnaire administered to women in the 24th to 28th gestational week.

The latest follow-up was completed in 1997–1998, when 8463 cohort members (73 per cent of those alive), were still living in the two northernmost provinces of Finland or in the capital area, and were invited to a clinical examination. A total of 6007 (71%) of them attended and signed an informed consent form and 5973 of them also completed a postal questionnaire regarding socio-economic and lifestyle factors and health. A questionnaire including Cloninger's TCI items was given to participants at clinical appointment; 5113 (85%) returned it. In total 4364 participants (1983 men, 2381 women) with complete information on childhood SES, SBP and TCI items, formed the final sample of the present study. The ethics committee of the faculty of medicine, University of Oulu, approved the study.

Early life factors

SES in 1966 was based on father's occupation reported in the structured questionnaire given to the mother during pregnancy (mother's if father's occupation unknown): I = occupations with highest education and prestige; II = occupations with lower prestige and shorter education than in class I; III = skilled

372

workers; IV = unskilled workers; and as a separate group farmers by larger- and smaller-scale farms (≥ or < eight hectares) (Alestalo & Uusitalo, 1978; Mäkikyrö et al., 1997; Rantakallio, 1979). Mother's age, parity, smoking during pregnancy, attitude towards public authority help and wantedness of pregnancy were extracted from the questionnaire. Information on child's gender, birth weight, gestational age and twin/singleton status was completed by midwives after the delivery.

Temperament

The TCI (version IX) used in the study has 107 true/false temperament questions (40 NS, 35 HA, 24 RD and 8 P). NS is a disposition in the activation or initiation of behaviours such as exploratory activity in response to novelty, impulsive decision making, extravagance in approach to cues of reward, quick loss of temper and active avoidance of frustration. HA is a tendency to respond intensively to signals of aversive stimuli, thereby inhibiting/stopping behaviour. It includes pessimistic worry in anticipation of future problems, fear of uncertainty, shyness of strangers and rapid fatigability. RD is a tendency to respond intensely to signals of reward, especially social rewards, thereby maintaining/continuing behaviour. It appears as sentimentality, social attachment and dependence of approval on others. P, measured in terms of perseverance despite frustration, was originally thought to be a part of RD but later emerged as a distinct fourth dimension. A detailed description of the temperament dimensions and their subscales can be found in the TCI guide book (Cloninger et al., 1994). The psychometric properties of the temperament dimension scales have been evaluated and the distributions of scores for men and women in the NFBC 1966 described elsewhere (Miettunen et al., 2004).

Lifestyle factors at 31 years

Questions on alcohol use were designed to measure the average frequency of consumption of beer, wine and spirits during the last year, and the usual amount of each consumed on one occasion. The average amount of alcohol consumed per day was calculated using the following estimates of alcohol content (Vol-%): beer 4.8; light wines 5.0; wines 14.5 and spirits 37.0 (Poikolainen & Vartiainen, 1997). Because of the highly skewed distribution the subjects were then assigned to four groups by quartiles of alcohol intake. The validity of the instrument used has proved to be good (Laitinen et al., 2004).

Smoking was classified according to the average number of cigarettes smoked per day (1–10 or over 10) reported in the postal questionnaire. Irregular smokers and those who had stopped smoking were considered as non-smokers.

SES at 31 years

Classification of SES was based on occupation and current activity reported in the postal questionnaire. Self-employed people, except farmers, together with a higher white-collar group formed class I. Lower white-collar workers formed class II and blue-collar workers class III. Farmers were considered as a separate group. Students, pensioners, long-term unemployed and those whose SES was unknown formed the class 'others'.

Metabolic outcomes

The physiological intermediate factors of cardiovascular disease studied were SBP, waist circumference and overnight fasting samples for total HDL cholesterol, triglyceride and glucose, measured at clinical examination. BP was measured twice (averages used in the analyses) with a mercury sphygmomanometer in a sitting position from the right arm after 15 minutes' rest, by trained nurses using a standardized procedure (Vartiainen et al., 2000). Observer variation was monitored on a weekly basis. The correlation between repeated SBP measurements with a one-month interval gave an intra-class correlation of 0.83, 95 per cent CI 0.73–0.89. Waist circumference was measured to the nearest 0.5 cm. Subjects who had not fasted were excluded from the analyses of glucose and triglyceride ($n = 159$), and those who were on diabetes medication ($n = 10$) were excluded from the analyses of glucose.

Statistical methods

Based on preliminary analyses, father's SES in 1966 was considered as a potential confounder. In addition, smoking and drinking habits, and own SES were studied in relation to temperament dimensions, since they represent psychosocial resources and health-related behaviours that have been found to be related to cardiovascular disease (Ketola, Sipilä, & Mäkelä, 2000; Marmot & Bartley, 2002; Spies et al., 2001) and may mediate the association between temperament and metabolic syndrome markers (Marmot & Bartley, 2002; Spies et al., 2001).

Men and women were considered separately to make the comparisons with the CRYF study easier and to allow for the possible gender differences in the

373

associations between temperament and metabolic syndrome markers. Temperament dimension scores were fairly normally distributed and were treated as continuous variables in the statistical models, although quintiles were used in some comparisons where the relationship between the temperament dimension and the outcome was non-linear. The relationship between each of the temperament dimensions and early life factors as well as metabolic outcomes was studied using plots, linear and polynomial regression models for continuous variables, and variance analysis models for categorical variables. Explanatory variables were centred for polynomial regression. Log-transformations were used for triglyceride due to its skewed distribution. The regression analysis results are presented with and without adjustment for father's SES in 1966 and own SES, smoking and drinking habits in 1997. Statistical significance was considered at the level $p < .05$. All p-values are reported two-sided. Data were analysed using SAS/STAT software version 8.2.

Missing data

Selection bias was investigated in relation to area of residence, SES at birth, gender and register-based variables on education and unemployment history representing SES at 31 years. Those who attended clinical examination ($n = 6007$) were compared with those who were not invited or were invited but did not attend ($n = 2456 + 3174 = 5630$). Farmers' children were slightly over-represented among attendees compared to the remainder alive at 31 years (21% vs 16%) as were women (52% vs 46%). Subjects who had completed only basic education by the age of 31 years were considerably under-represented among attendees (10% vs 30%) and subjects with unemployment history over six months were slightly under-represented (12% vs 15%).

Unit non-response Attendees of clinical examination who returned the questionnaire containing Cloninger's TCI items had slightly higher education than those who did not. The response rate was higher in women (90%) than in men (80%), but did not vary considerably by area of residence or unemployment history.

Item non-response Of those who returned the questionnaire, 4409 (86%) answered all 107 TCI questions. These subjects were slightly more educated than those who left at least one question unanswered. There were no considerable differences

regarding gender, area of residence or unemployment history.

Results

Gender and temperament

Women had higher mean scores than men in NS (20.9 vs 19.7), HA (14.9 vs 13.0) and RD (16.0 vs 13.2). Men had a higher mean P score than women (4.5 vs 4.1). All differences were highly statistically significant ($p < .0001$).

Early life factors and temperament

Of the early life factors examined, the only factor consistently associated with the temperament dimensions was father's SES in 1966 (Table 1). High social class was related to high NS score. Farmers' sons had the lowest NS score. High social class was also associated with low HA and high RD.

Temperament and SES at 31 years

The association between high SES at 31 years and NS score was stronger in women than in men (Table 1). Farmers had the lowest NS score in both genders. There was a strong negative gradient between SES and HA. In men the 'others' group had the highest HA score (15.4) and class I the lowest (11.4). In women farmers had the highest HA score (17.6) and class I the lowest (13.4). There was a tendency towards higher RD with increasing SES in both genders and a clear positive association between P score and SES. In women, class I had higher P score (4.6) than other classes (range 3.9–4.1). In men the association was more linear.

Temperament and lifestyle factors at 31 years

NS had a strong positive association with smoking and alcohol consumption in both genders ($p < .0001$). Mean scores in the lowest and highest quartiles of alcohol consumption were 17.9 and 21.3 in men and 18.9 and 22.6 in women. Smokers had about two points higher NS score than non-smokers in both genders ($p < .0001$). HA score was negatively associated with alcohol consumption. Men in the lowest alcohol consumption quartile had significantly higher HA score (13.7) compared to men in quartiles two to four (12.4, 12.9, 12.9) (1st vs other groups $p = .0029$). In women the corresponding figures were 15.6, 15.0, 14.6 and 14.5 (1st vs other groups $p < .0001$). There was no significant association between smoking and

Table 1. Means of temperament dimension scores at 31 years by gender, childhood and own socio-economic status

	N	N	NS	NS	HA	HA	RD	RD	P	P
	Men	*Women*	*Men*	*Women*	*Men*	*Women*	*Men*	*Women*	*Men*	*Women*
SES 1966[a]										
Class I	144	146	21.0	21.6	12.0	13.6	13.3	16.5	4.7	4.3
Class II	327	396	19.5	21.2	12.9	14.7	13.6	16.1	4.5	4.1
Class III	656	784	20.2	21.3	12.4	14.5	13.5	16.2	4.6	4.0
Class IV	426	514	19.7	20.5	13.7	15.6	12.8	15.9	4.4	4.1
Farmer, ≥ 8 ha	188	248	18.9	20.1	13.1	15.3	12.9	15.8	4.5	4.2
Farmer, < 8 ha	242	293	18.5	20.0	14.0	15.7	12.9	15.7	4.3	4.3
Global *p*-value[b]			0.0001	0.0004	0.0002	0.0001	0.0080	0.16	0.17	0.24
SES 1997										
Class I	531	495	20.1	21.8	11.4	13.4	13.4	16.3	4.9	4.6
Class II	356	1053	20.0	20.8	12.2	14.7	13.8	16.3	4.7	4.1
Class III	708	343	19.5	20.7	13.6	16.0	13.1	15.4	4.3	3.9
Farmer	92	71	18.0	19.0	13.7	17.6	12.7	15.2	4.4	3.9
Other	277	401	19.4	20.3	15.4	16.1	12.9	15.6	4.0	4.1
Global *p*-value[b]			0.013	< 0.0001	< 0.0001	< 0.0001	0.0059	< 0.0001	< 0.0001	< 0.0001

Note: NS = novelty seeking, HA = harm avoidance, RD = reward dependence, P = persistence

[a] Socio-economic status in 1966 (primarily father's, replaced by mother's if missing). Farmers in two classes according to the farm size in hectares (ha)

[b] *p*-value for *F*-test from variance analysis between socio-economic status and temperament dimension score

375

HA, or alcohol consumption and RD. Heavy smoking (> 10 cigarettes per day) women had lower RD score than non-smoking women ($p = .0020$). There was a slight inverse association between P score and alcohol consumption in men ($p = .040$) but no association between P score and smoking in either gender.

Temperament and metabolic outcomes at 31 years

Of all the metabolic outcomes studied, SBP showed the clearest unadjusted associations with more than one temperament dimension (Table 2). NS was not associated with SBP in either gender. HA was related to increasing SBP in men ($p = .0012$) but not in women (Fig. 1a). The estimate in men was 1.5 mmHg higher SBP per 10-point increase in HA score. An inverse trend between RD and SBP was found in both genders but it was statistically significant only in women (Fig. 1b). The estimate was 1.2 mmHg lower SBP per 10-point increase in RD score in men ($p = .12$) and 2.2 mmHg in women ($p = .0025$). An inverse relationship between SBP and P was found in both genders (Figs 1c and 1d). In men the estimate was 6.0 mmHg lower SBP per 10-point increase in P score ($p = .0003$) and in women it was 3.9 mmHg lower ($p = .0068$). In men the association was slightly inverse J-shaped and a quadratic term of P score was added into the regression model to give a better fit (linear coefficient $p = .0002$, quadratic coefficient $p = .032$). Adjusting for father's and own SES, alcohol consumption and smoking weakened some of the associations (fully adjusted results, Table 3).

Table 2 shows a positive unadjusted association between NS and waist circumference ($p = .0024$ in men, $p = .031$ in women). NS was also positively related to triglyceride in men ($p < .0001$). HA showed a slight positive association with HDL cholesterol and glucose in women (in both $p = .036$). RD showed an inverse, non-significant trend with glucose in men ($p = .066$) and triglyceride ($p = .11$) in women. It was non-linearly associated with HDL cholesterol in men (linear coefficient $p = .51$, quadratic coefficient $p = .015$) and with glucose in women (linear coefficient $p = .45$, quadratic coefficient $p = .016$). An inverse trend was found between P and glucose in women ($p = .019$), and P and triglyceride ($p = .023$ in men, $p = .068$ in women). In women, a non-linear association between P and waist circumference was found (linear coefficient $p < .0001$, quadratic coefficient $p = .027$). HDL cholesterol was associated with P score so that in women with P score 0–2 mean HDL was 1.65 and in women

with P score 3–8 it was 1.71 (linear coefficient $p = .042$, quadratic coefficient $p = .012$).

The associations between temperament dimensions and metabolic outcomes were partly mediated by SES, smoking and alcohol consumption (fully adjusted results, Table 3). On average, the observed statistically significant associations were 20 per cent weaker after adjusting for these factors (data not shown). Adjustment for childhood SES did not change the unadjusted associations between temperament dimensions and metabolic syndrome markers, which indicates that childhood SES is not a confounding factor (Table 2). On the other hand, adjustment for own SES at 31 years weakened some of the associations, e.g. the association between HA and glucose and P and glucose in women, and P and triglyceride in men.

Discussion

This first large population-based study on the relationship between innate temperament using the TCI scale and metabolic syndrome markers showed weak but statistically significant associations between temperament dimensions and metabolic syndrome markers in both genders. SBP was highest in men with high HA and low P score, and lowest in women with high RD and high P score. Low P was associated with several unfavourable metabolic syndrome markers especially in women.

Childhood SES was positively related to NS, RD and P and inversely to HA in both genders but did not confound the associations between temperament dimensions and metabolic syndrome markers. Association between own adult SES and temperament was similar but stronger, especially in women. Smoking was related to high NS in both genders and low RD in women. Alcohol consumption had a strong, positive relationship with NS. Low alcohol consumption was associated with high HA and high alcohol consumption with low RD in both genders. Own SES and lifestyle factors mediated the associations between temperament and metabolic syndrome markers to a small extent.

Our results are in line with previous studies on temperament and socio-demographic factors. Many studies (Mendlowicz et al., 2000) found higher levels of HA and RD in women than in men, although it should be noted that most of these studies were done before separating P from RD and are thus not directly comparable with our study. Occupational status was positively related to RD in Mendlowicz's study as

Table 2. Unadjusted and adjusted β-coefficients for temperament dimension scores per 10 units (p-values) from regression analyses between temperament dimensions and metabolic syndrome markers in 1997 in the Northern Finland Birth Cohort born in 1966, unadjusted and adjusted for SES in 1966

	Unadjusted					Adjusted for SES in 1966				
	SBP (mmHg)	Waist (cm)	Glucose (mmol/L)	Triglyceride (mmol/L)[a]	HDL (mmol/L)	SBP (mmHg)	Waist (cm)	Glucose (mmol/L)	Triglyceride (mmol/L)[a]	HDL (mmol/L)
NS Men	−0.27 (0.58)	1.13 (0.0024)	−0.04 (0.12)	0.91 (<0.0001)	−0.01 (0.43)	−0.10 (0.85)	1.18 (0.0015)	−0.03 (0.23)	0.91 (<0.0001)	−0.01 (0.46)
NS Women	−0.24 (0.57)	0.90 (0.031)	0.01 (0.56)	0.18 (0.25)	0.00 (0.83)	−0.13 (0.76)	0.99 (0.019)	0.01 (0.46)	0.19 (0.24)	0.00 (0.81)
HA Men	1.53 (0.0012)	−0.28 (0.44)	0.02 (0.33)	0.33 (0.081)	−0.01 (0.55)	1.37 (0.0037)	−0.27 (0.45)	0.02 (0.47)	0.35 (0.068)	−0.01 (0.48)
HA Women	0.40 (0.33)	0.19 (0.65)	0.03 (0.036)	0.02 (0.91)	0.03 (0.036)	0.28 (0.50)	0.08 (0.84)	0.03 (0.054)	−0.03 (0.86)	0.03 (0.030)
RD Men	−1.21 (0.12)	−0.24 (0.69)	−0.07 (0.066)	0.32 (0.31)	0.01[b] (0.51), −0.10 (0.015)	−0.99 (0.21)	−0.27 (0.66)	−0.06 (0.11)	0.29 (0.36)	0.01[b] (0.46), −0.10 (0.014)
RD Women	−2.21 (0.0025)	−0.99 (0.17)	0.02[b] (0.45), 0.14 (0.016)	−0.45 (0.11)	0.03 (0.20)	−2.09 (0.0044)	−0.92 (0.21)	0.02[b] (0.43), 0.14 (0.018)	−0.45 (0.11)	0.03 (0.19)
P Men	−6.13[b] (0.0002), 17.79 (0.032)	−1.87 (0.14)	−0.09 (0.25)	−1.49 (0.023)	0.04 (0.38)	−5.83[b] (0.0004), 18.73 (0.023)	−1.92 (0.12)	−0.07 (0.34)	−1.52 (0.020)	0.04 (0.35)
P Women	−3.90 (0.0068)	−7.69[b] (<0.0001), 15.20 (0.027)	−0.13 (0.019)	−1.00 (0.068)	0.09[b] (0.042), −0.55 (0.012)	−3.91 (0.0066)	−7.69[b] (<0.0001), 15.07 (0.028)	−0.13 (0.018)	−0.97 (0.075)	0.09[b] (0.051), −0.55 (0.012)

Note: NS = novelty seeking, HA = harm avoidance, RD = reward dependence, P = persistence, SBP = systolic blood pressure, Waist = waist circumference, HDL = high density lipoprotein cholesterol

[a] β-coefficient from the analysis with log-transformed outcome × 10

[b] For non-linear associations, linear coefficient followed by quadratic coefficient is presented

377

Table 3. β-coefficients for temperament dimension scores per 10 units (p-values) from regression analyses between temperament dimensions and metabolic syndrome markers in 1997 in the Northern Finland Birth Cohort born in 1966, adjusted for SES in 1997 and fully adjusted

	Adjusted for SES in 1997					Fully adjusted[a]				
	SBP (mmHg)	Waist (cm)	Glucose (mmol/L)	Triglyceride (mmol/L)[b]	HDL (mmol/L)	SBP (mmHg)	Waist (cm)	Glucose (mmol/L)	Triglyceride (mmol/L)[b]	HDL (mmol/L)
NS Men	-0.16 (0.75)	1.20 (0.0013)	-0.03 (0.17)	0.95 (<0.0001)	-0.01 (0.45)	0.00 (0.99)	1.04 (0.010)	-0.04 (0.15)	0.77 (0.0002)	-0.01 (0.48)
NS Women	-0.13 (0.76)	1.08 (0.010)	0.01 (0.37)	0.24 (0.13)	0.00 (0.94)	0.07 (0.88)	1.00 (0.026)	0.01 (0.57)	0.13 (0.47)	0.00 (0.74)
HA Men	1.39 (0.0044)	-0.18 (0.63)	0.01 (0.66)	0.25 (0.20)	-0.01 (0.32)	0.91 (0.069)	-0.23 (0.54)	0.01 (0.62)	0.29 (0.15)	-0.02 (0.11)
HA Women	0.18 (0.67)	-0.17 (0.68)	0.02 (0.15)	-0.11 (0.50)	0.03 (0.014)	-0.13 (0.76)	-0.24 (0.58)	0.02 (0.13)	-0.06 (0.70)	0.03 (0.058)
RD Men	-1.07 (0.18)	-0.23 (0.71)	-0.06 (0.12)	0.37 (0.24)	0.01c (0.63), -0.09 (0.034)	-0.74 (0.36)	-0.26 (0.68)	-0.05 (0.20)	0.34 (0.29)	0.00c (0.86), -0.08 (0.053)
RD Women	-2.11 (0.0042)	-0.66 (0.37)	0.03c (0.36), 0.15 (0.012)	-0.39 (0.16)	0.03 (0.25)	-1.90 (0.013)	-0.65 (0.39)	0.02c (0.58), 0.11 (0.065)	-0.40 (0.17)	0.03 (0.23)
P Men	-5.53c (0.0011), 17.62 (0.034)	-2.36 (0.065)	-0.04 (0.62)	-1.24 (0.065)	0.05 (0.27)	-5.17c (0.0032), 17.74 (0.039)	-2.64 (0.049)	-0.01 (0.93)	-1.10 (0.11)	0.07 (0.12)
P Women	-3.16 (0.030)	-6.79c (<0.0001), 14.60 (0.034)	-0.10 (0.084)	-0.79 (0.15)	0.08c (0.072), -0.55 (0.014)	-2.78 (0.066)	-6.03 (< 0.0001)	-0.09 (0.097)	-0.97 (0.088)	0.07c (0.11), -0.63 (0.0050)

Note: NS = novelty seeking, HA = harm avoidance, RD = reward dependence, P = persistence, SBP = systolic blood pressure, Waist = waist circumference, HDL = high density lipoprotein cholesterol

a Adjusted for father's SES in 1966 and own SES, smoking and drinking habits in 1997

b β-coefficient from the analysis with log-transformed outcome × 10

c For non-linear associations, linear coefficient followed by quadratic coefficient is presented

378

SBP **1a HARM AVOIDANCE AND SBP IN MEN**

SBP **1b REWARD DEPENDENCE AND SBP IN WOMEN**

SBP **1c PERSISTENCE AND SBP IN MEN**
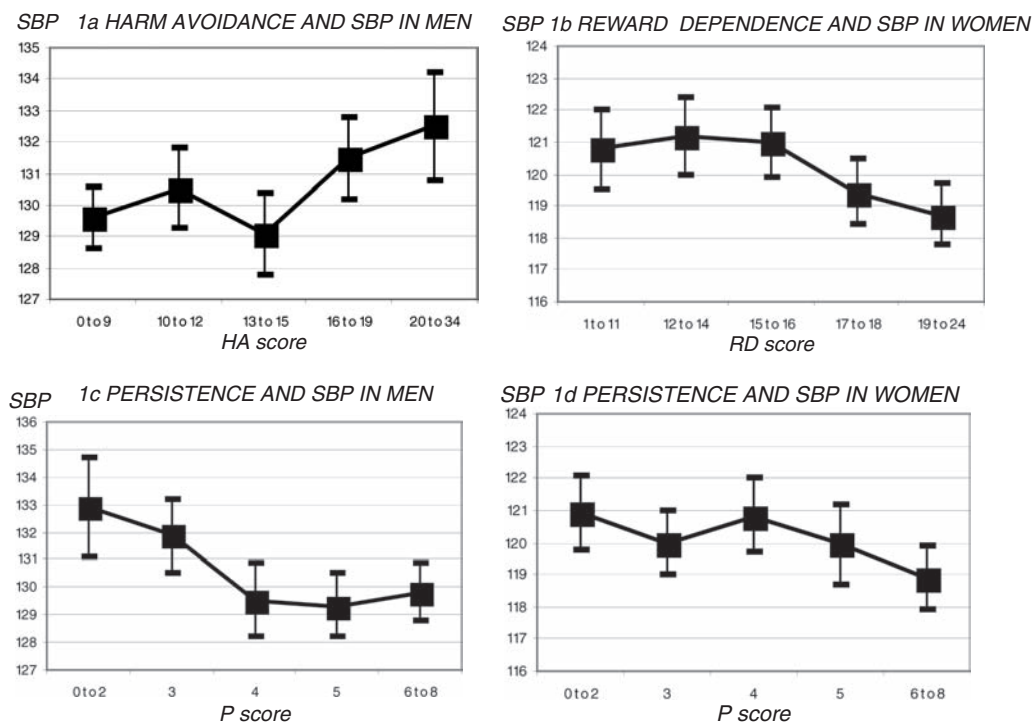
SBP **1d PERSISTENCE AND SBP IN WOMEN**

Figure 1a-1d. Temperament dimension score (quintiles) and systolic blood pressure (SBP, mmHg), mean and its 95 per cent confidence interval in 1997 in the Northern Finland Birth Cohort born in 1966.

well as in our study. Smoking and alcohol consumption showed similar associations with temperament as reported in earlier studies (Cloninger et al., 1988; Masse & Tremblay, 1997).

The results of our study are, however, in contradiction with the only other study published on temperament dimensions and metabolic syndrome markers, the CRYF study (Keltikangas-Järvinen et al., 1999). This study and our own both included a cohort of young Finnish men who filled in the TCI questionnaire in 1997 and are comparable in this respect. There are, however, differences in the study design, dropout, selection bias and sample size, as well as the statistical methods used.

We chose to look at each of the temperament dimensions (exposure) in relation to each metabolic syndrome marker (outcome) using regression models. This gave an idea of how much a change in temperament score affects the level of the outcome assuming a causal relationship. Large sample size and treating the variables as continuous in the analyses guaranteed a good statistical power. Grouping temperament dimension scores and comparing the

levels of metabolic outcomes between different combinations was considered but did not give essential additional information and reduced the power considerably. Furthermore, using a summary variable for metabolic syndrome would have been problematic because few people satisfy the metabolic syndrome criteria (Expert Panel on Detection, 2001) in young adulthood. However, it is important to search for risk groups and start prevention at an earlier age, and therefore it is helpful to look at continuous, single markers at this stage.

In the CRYF study four temperament profiles were formed by cluster analysis and differences in metabolic syndrome markers and a summary variable IRS (Insulin Resistance Syndrome) factor, formed by principal components analysis, were compared between these temperament profiles. In the CRYF study only unadjusted comparisons were made.

The CRYF study found that a temperament profile characterized by a high level of P and RD, an average level of NS and a low level of HA was related to IRS factor, whereas in NFBC 1966 men NS was related to increased waist circumference and triglyceride, HA to

379

increased SBP, and P to lower SBP, waist circumference and triglyceride levels. In NFBC 1966 men, high levels of RD and P seem to protect from developing cardiovascular risk factors whereas high levels of NS and HA increased their likelihood. Despite the differences in the design and methods used, it is fair to say that these results are contradictory.

In NFBC 1966 men, NS was related to increased waist circumference and triglyceride levels, as well as higher alcohol consumption, smoking and SES. The diet of smokers is documented to be unhealthier than of non-smokers (Morabia, Curtin, & Bernstein, 1999; Nuttens et al., 1992), and together with alcohol consumption, this may contribute to the association between NS and higher waist circumference (Laitinen et al., 2004). Abdominal obesity is a marker of insulin resistance, which is often accompanied by high triglyceride levels. Alcohol consumption also raises triglyceride levels.

The explanation behind the observed inverse relationship between P and various metabolic syndrome markers may lie partly in psychophysiological reactivity (Lovallo & Gerin, 2003). People with low P have a low tolerance of frustration and may react more strongly to stressful situations and expectations from others. They are less optimistic and thus more prone to depression, which in turn is related to increased cardiovascular disease risk (Joynt, Whellan, & O'Connor, 2003). The positive relationship between HA and higher metabolic outcome levels in males may also be partly explained by expectations from society. The components of HA (worry/pessimism, fear of uncertainty, shyness and fatigability) are not generally perceived as masculine. Boys are expected to be tough and strong (Courtenay, 2000), and those who fail to behave like this may face extra pressure from peers and authorities. This in turn may raise the level of stress, and via hormonal changes affect metabolic outcomes, like SBP and cholesterol levels (Chrousos, 2000; Wallerius, Rosmond, Ljung, Holm, & Bjorntorp, 2003). On the other hand, high levels of RD (sentimentality, social attachment and dependence), especially in women, appear to have a protective effect against metabolic syndrome. This might be due to the ability to share emotions and problems before they become a burden causing stress. Presumably those who respond intensively to reward also tend to be rewarded more. High RD is more common in women (Mendlowicz et al., 2000) probably because RD-related behaviour, like interpersonal dependency, is more accepted in women (Courtenay, 2000). For this reason there may

be a close link between RD and social norms regulating health-related lifestyle through the formation and maintenance of internalized psychological control. Those who do not respond to reward and do not form social attachments may be prone to more stress, and thereby have a higher risk of adverse metabolic outcomes (Rosmond, Dallman, & Björntorp, 1998; Shively, Adams, Kaplan, & Williams, 2000). In our study those who consumed the most alcohol had the lowest RD. Low RD is also associated with high noradrenaline levels, which is correlated with increased blood pressure (Hofman, Boomsma, Schalekamp, & Valkenburg, 1979).

The strength of our study was the design: prospective follow-up of a large birth cohort, which eliminates recall bias and makes it possible to control for confounding. However, in the preliminary analyses childhood SES emerged as the only potentially important confounder from the past and therefore the main focus was on cross-sectional associations. Due to the observational setting and having to restrict to the background variables collected in 1966 there is still a possibility of residual confounding but we assume this to be small. There was some selection bias due to attrition towards highly educated women but overall the sample studied is fairly representative of the whole cohort. The TCI questionnaire was completed at home and family members may have influenced how the subject answered the questions. This may have introduced some bias if the influence varied according to temperament traits, but in our study this kind of bias was impossible to measure or control.

More research is needed to confirm the associations between temperament dimensions and metabolic syndrome markers we observed. When genomewide data become available in the near future, it will be possible to assess better the contribution of genetic factors to temperament traits and examine to what extent genetic factors explain the relationship between temperament and metabolic syndrome markers.

In conclusion, our results suggest that temperament is associated with several metabolic syndrome markers and this association is partly mediated by lifestyle factors and SES. In our study low P was found to be related to elevated SBP, waist circumference, fasting glucose and triglyceride levels and low HDL cholesterol level, especially in women. NS was positively associated with waist circumference in both genders, HA showed positive association with SBP in men and RD inverse association with SBP in women. These results may help in understanding the

380

underlying mechanisms behind the psychosocial and biobehavioural risk factors of cardiovascular disease.

References

Alestalo, M., & Uusitalo, H. (1978). *Occupational prestige and its determinants: The case of Finland. Research group for comparative sociology*. Helsinki: University of Helsinki Research Reports.

Caspi, A., Harrington, H. L., Milne, B., Amell, J. W., Theodore, R. F., & Moffitt, T. E. (2003). Children's behavioural styles at age 3 are linked to their adult personality traits at age 26. *Journal of Personality*, *71*, 495.

Chrousos, G. P. (2000). The role of stress and the hypothalamic-pituitary-adrenal axis in the pathogenesis of the metabolic syndrome: Neuro-endocrine and target tissue-related causes. *International Journal of Obesity and Related Metabolic Disorders*, *24*(Supp. 2), S50–S55.

Cloninger, C. R., Przybeck, T. R., Svrakic, D. M., & Wetzel, R. D. (1994). *The Temperament and Character Inventory (TCI): A guide to its development and use*. St Louis: Washington University, Center for Psychobiology of Personality.

Cloninger, C. R., Sigvardsson, S., & Bohman, M. (1988). Childhood personality predicts alcohol abuse in young adults. *Alcoholism, Clinical and Experimental Research*, *12*, 494–505.

Courtenay, W. H. (2000). Constructions of masculinity and their influence on men's well-being: A theory of gender and health. *Social Science & Medicine*, *50*, 1385–1401.

Expert Panel on Detection, E. a. T. o. H. B. C. i. A. (2001). Executive summary of the third report of the National Cholesterol Education Program (NCEP) expert panel on detection, evaluation, and treatment of high blood cholesterol in adults (Adult Treatment Panel III). *Journal of the American Medical Association*, *285*, 2486–2496.

Gallacher, J. E. J., Sweetnam, P. M., Yarnell, J. W. G., Elwood, P. C., & Stansfeld, S. A. (2003). Is type A behaviour really a trigger for coronary heart disease? *Psychosomatic Medicine*, *65*, 339–346.

Heath, A. C., Cloninger, C. R., & Martin, N. G. (1994). Testing a model for the genetic structure of personality: A comparison of the personality systems of Cloninger and Eysenck. *Journal of Personality and Social Psychology*, *66*, 762–775.

Hemingway, H., & Marmot, M. (1999). Psychosocial factors in the aetiology and prognosis of coronary heart disease: Systematic review of prospective cohort studies. *British Medical Journal*, *318*, 1460–1467.

Hofman, A., Boomsma, F., Schalekamp, M. A., & Valkenburg, H. A. (1979). Raised blood pressure and plasma noradrenaline concentrations in teenagers and young adults selected from an open population. *British Medical Journal*, *1*, 1536–1538.

Jorgensen, R. S., Johnson, B., Kolodziej, M. E., & Schreer, G. E. (1996). Elevated blood pressure and personality: A meta-analytic review. *Psychological Bulletin*, *120*, 293–320.

Joynt, K. E., Whellan, D. J., & O'Connor, C. M. (2003). Depression and cardiovascular disease: Mechanisms of interaction. *Biological Psychiatry*, *54*, 248–261.

Keltikangas-Järvinen, L., Ravaja, N., & Viikari, J. (1999). Identifying Cloninger's temperament profiles as related to the early development of the metabolic cardiovascular syndrome in young men. *Arteriosclerosis, Thrombosis, and Vascular Biology*, *19*, 1998–2006.

Ketola, E., Sipilä, R., & Mäkelä, M. (2000). Effectiveness of individual lifestyle interventions in reducing cardiovascular disease and risk factors. *Annals of Medicine*, *32*, 239–251.

Laitinen, J., Pietiläinen, K., Wadsworth, M., Sovio, U., & Järvelin, M.-R. (2004). Predictors of abdominal obesity among 31-year-old men and women born in northern Finland in 1966. *European Journal of Clinical Nutrition*, *58*, 180–190.

Lovallo, W. R., & Gerin, W. (2003). Psychophysiological reactivity: Mechanisms and pathways to cardiovascular disease. *Psychosomatic Medicine*, *65*, 36–45.

Mäkikyrö, T., Isohanni, M., Moring, J., Oja, H., Hakko, H., & Jones, P. (1997). Is a child's risk of early onset schizophrenia increased in the highest social class? *Schizophrenia Research*, *23*, 245–252.

Marmot, M. G., & Bartley, M. (2002). Social class and coronary heart disease. In S. A. Stansfeld & M. G. Marmot (Eds.), *Stress and the heart: Psychosocial pathways to coronary heart disease* (pp. 5–19). London: BMJ Books.

Masse, L. C., & Tremblay, R. E. (1997). Behaviour of boys in kindergarten and the onset of substance use during adolescence. *Archives of General Psychiatry*, *54*, 62–68.

Mendlowicz, M. V., Jean-Louis, G., Gillin, J. C., Akiskal, H. S., Furlanetto, L. M., Rapaport, M. H. et al. (2000). Sociodemographic predictors of temperament and character. *Journal of Psychiatric Research*, *34*, 221–226.

Miettunen, J., Kantojärvi, L., Ekelund, J., Veijola, J., Karvonen, J. T., Peltonen, L. et al. (2004). A large population cohort provides normative data for investigation of temperament. *Acta Psychiatrica Scandinavica*, *110*, 150–157.

Morabia, A., Curtin, F., & Bernstein, M. S. (1999). Effects of smoking and smoking cessation on dietary habits of a Swiss urban population. *European Journal of Clinical Nutrition*, *53*, 239–243.

Myrtek, M. (2001). Meta-analyses of prospective studies on coronary heart disease, type A personality, and hostility. *International Journal of Cardiology*, *79*, 245–251.

Nuttens, M. C., Romon, M., Ruidavets, J. B., Arveiler, D., Ducimetiere, P., Lecerf, J. M. et al. (1992). Relationship between smoking and diet: The MONICA-France project. *Journal of Internal Medicine*, *231*, 349–356.

Poikolainen, K., & Vartiainen, E. (1997). Determinants of gamma-glutamyltransferase: Positive interaction with alcohol and body mass index, negative association with

coffee. *American Journal of Epidemiology*, *146*, 1019–1024.

Räikkönen, K., Matthews, K. A., & Salomon, K. (2003). Hostility predicts metabolic syndrome risk factors in children and adolescents. *Health Psychology*, *22*, 279–286.

Rantakallio, P. (1979). Social background of mothers who smoke during pregnancy and influence of these factors on the offspring. *Social Science & Medicine*, *13A*, 423–429.

Rantakallio, P. (1988). The longitudinal study of the northern Finland birth cohort of 1966. *Paediatric and Perinatal Epidemiology*, *2*, 59–88.

Ravaja, N., Keltikangas-Järvinen, L., & Viikari, J. (1996). Type A behaviour and metabolic syndrome precursors in young adults. *Journal of Clinical Epidemiology*, *49*, 335–343.

Rosmond, R., Dallman, M. F., & Björntorp, P. (1998). Stress-related cortisol secretion in men: Relationships with abdominal obesity and endocrine, metabolic and hemodynamic abnormalities. *Journal of Clinical Endocrinology and Metabolism*, *83*, 1853–1859.

Schum, J. L., Jorgensen, R. S., Verhaeghen, P., Sauro, M., & Thibodeau, R. (2003). Trait anger, anger expression, and ambulatory blood pressure: A meta-analytic review. *Journal of Behavioral Medicine*, *26*, 395–415.

Shively, C. A., Adams, M. R., Kaplan, J. R., & Williams, J. K. (2000). Social stress, gender, and coronary heart disease risk in monkeys. In P. M. McCabe, N. Schneiderman, T. Field, & A. R. Wellens (Eds.), *Stress, coping, and cardiovascular disease* (pp. 71–84). New Jersey: Lawrence Erlbaum Associates, Publishers.

Spies, C. D., Sander, M., Stangl, K., Fernandez-Sola, J., Preedy, V. R., Rubin, E. et al. (2001). Effects of alcohol on the heart. *Current Opinion in Critical Care*, *7*, 337–343.

Vartiainen, E., Jousilahti, P., Alfthan, G., Sundvall, J., Pietinen, P., & Puska, P. (2000). Cardiovascular risk factor changes in Finland, 1972–1997. *International Journal of Epidemiology*, *29*, 49–56.

Wallerius, S., Rosmond, R., Ljung, T., Holm, G., & Bjorntorp, P. (2003). Rise in morning saliva cortisol is associated with abdominal obesity in men: A preliminary report. *Journal of Endocrinological Investigation*, *26*, 616–619.

Williams, R. (2002). Hostility, psychosocial risk factors, changes in brain serotonergic function, and heart disease. In S. A. Stansfeld & M. G. Marmot (Eds.), *Stress and the heart: Psychosocial pathways to coronary heart disease* (pp. 86–100). London: BMJ Books.

Yan, L. L., Liu, K., Matthews, K. A., Daviglus, M. L., Ferguson, T. F., & Kiefe, C. I. (2003). Psychosocial factors and risk of hypertension. *Journal of the American Medical Association*, *290*, 2138–2148.

Author biographies

ULLA SOVIO is a statistician and epidemiologist specializing in statistical methods of genetic and life-course epidemiology.

VANESSA KING worked as a research co-ordinator in the project, studying risk factors of cardiovascular disease.

JOUKO MIETTUNEN is a statistician and epidemiologist specializing in statistical methods in psychiatric research.

ELLEN EK is a health psychologist specialized in young adults' work entrance and well-being.

JAANA LAITINEN, specialized research scientist, is specialized in nutrition and health promotion.

MATTI JOUKAMAA is a professor of social psychiatry, interested especially in the fields of psychiatric epidemiology and psychosomatics.

JUHA VEIJOLA is a psychiatrist. His main interests are in the field of psychiatric epidemiology, especially in preventing psychiatric disorders in adulthood.

MARJO-RIITTA JÄRVELIN is a professor of life-course epidemiology with a special interest in large-scale population studies.