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Research paper

Association between affective temperaments and the severity and the extent of coronary artery disease as obtained by coronary CT angiography

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ABSTRACT

Background: Affective temperaments are documented predictors of psychopathology, but cumulating data suggest their relationship with coronary artery disease (CAD). We aimed to evaluate their role in relation to surrogate semiquantitative markers of coronary plaque burden, as assessed by coronary CT angiography (CCTA).
Methods: We included 351 patients who were referred for CCTA due to suspected CAD. All patients completed the Temperament Evaluation of Memphis, Pisa, Paris and San Diego Autoquestionnaire (TEMPS-A). The severity and extent of CAD was evaluated by CCTA, applying semiquantitative plaque burden scores, notably Segment Involvement Score (SIS) and Segment Stenosis Score (SSS). Logistic regression analyses were performed to define the predictors of CAD severity and extent.
Results: Regarding the scores evaluated by TEMPS-A that consists of 110 questions, in men, significant inverse association was found between hyperthymic temperament score and SSS ($\beta = -0.143$, (95%CI: -0.091 to -0.004), $p = 0.034$). Compared to the TEMPS-A form, applying the abbreviated version – containing 40 questions – significant relationship between affective temperaments and SSS or SIS was found in case of both sexes. Concerning men, hyperthymic temperament was demonstrated to be independent predictor of both SSS ($\beta = -0.193$, (95%CI: -0.224 to -0.048), $p = 0.004$) and SIS ($\beta = -0.194$, (95%CI: -0.202 to -0.038), $p = 0.004$). Additionally, we proved, that significant positive association between irritable temperament and SSS ($\beta = 0.152$, (95%CI: 0.002 to 0.269), $p = 0.047$) and SIS ($\beta = 0.155$, (95%CI: 0.004 to 0.221), $p = 0.042$) exists among women.
Limitations: Cross-sectional analysis of a single center study with self-reported questionnaires.
Conclusions: Assessment of affective temperaments could offer added value in stratifying cardiovascular risk for patients beyond traditional risk factors.

1. Introduction

Cardiovascular disease (CVD) remains the leading cause of morbidity, disability and mortality worldwide, imposing substantial economic and healthcare costs globally (Roth et al., 2020). Timely identification of traditional risk factors can mitigate the occurrence and development of CVD through early prevention and intervention measures (Tsao et al., 2022). There is also growing awareness of the role of

Abbreviations: CVD, Cardiovascular disease; TEMPS-A, Temperament Evaluation of Memphis, Pisa, Paris and San Diego Autoquestionnaire; CAD, Coronary artery disease; CCTA, Coronary CT angiography; AMI, Acute myocardial infarction; PCI, Percutaneous coronary intervention; SIS, Segment involvement score; SSS, Segment stenosis score; SD, Standard deviation; CV, Cardiovascular.

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mental health in the development and progression of CVD, with psychopathological aspects encompassing a range of contributing factors (Lu et al., 2021; Hu et al., 2022). Personality traits and temperaments have a consistent influence on an individual's behaviours and biological processes from birth due to their genetic foundation, unlike psychiatric disorders which typically have a delayed onset and episodic course (Zwir et al., 2020). Affective temperaments have been increasingly recognized as potential nontraditional risk factors that constitute a stable core of personality. Understanding their predisposing role towards psychological challenges can help us extend our knowledge in developing more personalized therapies.

Affective temperaments are composed of five distinct dimensions (depressive, irritable, anxious, hyperthymic, cyclothymic), which can be assessed using The Temperament Evaluation of Memphis, Pisa, Paris and San Diego Autoquestionnaire (TEMPS-A) (Rihmer et al., 2010; Akiskal et al., 2005a). Several previous studies have addressed the role of affective temperaments in CV pathology (Nemcsik et al., 2017; Vecsey-Nagy et al., 2021a,b, 2022). Although the relationship between affective temperaments and the presence of coronary artery disease (CAD) or severe stenosis on coronary CT angiography (CCTA) has been documented before (Nemcsik et al., 2017; Vecsey-Nagy et al., 2021b), metrics of overall CAD extent and severity has not been studied in this context. Our study aims to evaluate the role of affective temperaments in relation to surrogate semiquantitative markers of coronary plaque burden, as assessed by CCTA. Our previous studies supported the protective role of hyperthymic temperament and identified the irritable temperament as a non-traditional risk factor in relation to various aspects of CV disorders (László et al., 2016; Vecsey-Nagy et al., 2021b; Nemcsik et al., 2015). Therefore, we hypothesized a positive correlation in case of irritable and an inverse association in case of hyperthymic temperament. Considering that significant gender-specific differences have been previously documented (Vázquez et al., 2012), we aimed to examine these potential associations separately in female and male patient cohorts.

2. Methods

2.1. Study population

In this cross-sectional, single center study patients with stable anginal symptoms were screened, all of whom were clinically recommended to undergo CCTA. The study cohort consisted of patients over 18 years of age who also completed the TEMPS-A autoquestionnaire, and granted written consent for the collection and examination of data prior to imaging. Patients with known CAD, previous acute myocardial infarction (AMI), percutaneous coronary intervention (PCI), coronary bypass operation, or with non-diagnostic image quality were excluded from the study. Additionally, those with ongoing psychiatric disorder or dementia were not eligible. Prior to the examination, demographic data, anthropometric measurements and medical history were documented and participants completed the self-report temperament questionnaire. Risk factors were recorded at the time of CCTA.

The study was approved by the Scientific and Research Ethics Committee of the Medical Research Council, the Hungarian Ministry of Health (ETT TUKEB 570/2014) and was carried out in accordance with the tenets of the Declaration of Helsinki.

2.2. Evaluation of affective temperaments

The TEMPS-A form – a comprehensive 110-item autoquestionnaire – was used to assess affective temperaments across multiple subscales, where participants responded with 'yes' (score 1) or 'no' (score 0) answers. In addition, a newly developed 40-item abbreviated version of the Hungarian version was also applied, which has been demonstrated to be a robust indicator of affective temperaments (Lang et al., 2018). Both versions were devised to evaluate the relative excess of five affective temperaments (depressive, cyclothymic, hyperthymic, irritable and anxious), by employing true/false questions across the five subscales. A fellow researcher in Semmelweis University Heart and Vascular Center was responsible for enrolling participants and introducing the autoquestionnaires which were administered prior to the scheduled coronary CT examination, allowing patients to complete them by themselves. The questions of the different temperament types are grouped together in the following way:

1. depressive temperament: questions 1 to 21 (21 points, in short version 12 points)
2. cyclothymic temperament: questions 22 to 42 (21points, in short version 9 points)
3. hyperthymic temperament: questions 23 to 63 (21 points, in short version 7 points)
4. irritable temperament: questions 64 to 84 (21 points in women, 20 in the men's version, in short version 9 points)
5. anxious temperament: questions 85 to 110 (26 points, in short version 3 points)

TEMPS-A is a comprehensive instrument, that has been translated into over 25 languages and validated in various linguistic contexts. Similarities and also characteristic differences of affective temperaments have been observed in national samples, suggesting that the distribution of affective temperaments has both universal and culturally specific features (Vázquez et al., 2012; Rózsa et al., 2008).

2.3. Coronary computed tomography angiography

CCTA examinations were performed on each patient, using a 256-slice CT scanner (Phillips Brilliance iCT, Best, The Netherlands) with a 270 millisecond rotation time and 128 × 0.625 mm collimation in ECG-triggered axial sequential mode. According to appropriate scanning protocols, a tube potential of 100–120 kVp and a tube current of 200–300 mAs were applied and tailored to the patient's body habitus (EACVI, 2022). Brachial blood pressure and heart rate were measured once on the left arm in a seated position and were recorded 1 h prior to the examination. The patient was administered a maximum of 100 mg of per os, and up to 20 mg of, intravenous metoprolol, heart rate exceeded 65 beats per minute. To ensure appropriate vasodilatation during CCTA, patients were administered sublingual nitroglycerin (0.8 mg), unless contraindicated. Patients received Iomeprol contrast media (Iomeron 400, Bracco Ltd., Milan, Italy) using four-phasic injection protocol (Karády et al., 2017). Between 85 and 95 ml of contrast material was injected via antecubital venous access at a flow rate ranging from 4.5 to 5.5 ml/s.

2.4. Plaque burden assessment with CCTA

Image interpretation was carried out by readers with 5–10 years of experience in cardiac CT. Scoring systems, proposed by Min et al., were implemented to characterize the extent and severity of CAD (Min et al., 2007). For semiquantitative plaque assessment, all segments were analysed for the presence of plaque and the degree of stenosis (rated as: 0, none; 1, minimal (<25 %); mild (25–49 %); 3, moderate (50–69 %); 4, severe (70–99 %); 5, occlusion (100 %)). The segment involvement score (SIS) can then be calculated by adding up the number of coronary artery segments where plaque is present, irrespective of severity. Thus, we recorded a score within the range of 0 to 18 using the 18-segment coronary model (Leipsic et al., 2014; Kim et al., 2024). Segment stenosis score (SSS), on the other hand, can be acquired by summing the stenosis scores of each segment, leading to a score ranging between 0 and 90. While SSS reflects the severity of CAD adjusting for the traditional grading of stenosis during clinical read, SIS only represents its extent. Both metrics can be utilized for quantifying coronary plaque burden and are adequate predictors of plaque progression (Szilveszter

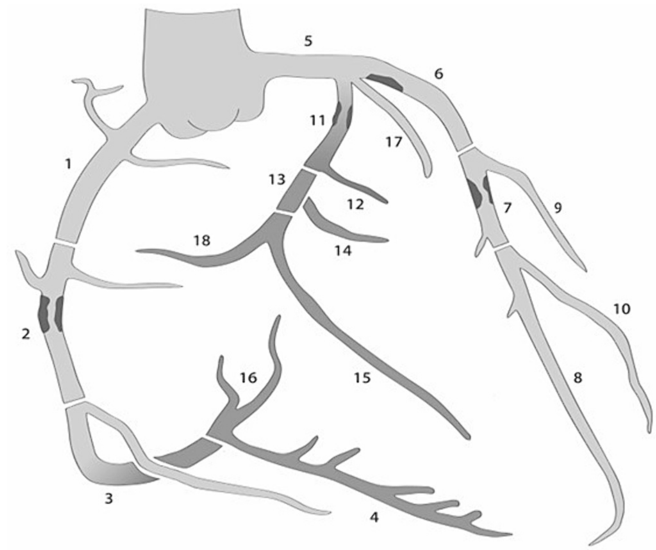

Fig. 1. Schematic illustration of 18-segment coronary tree model with mild to moderate lesions.

et al., 2021). With these qualities resulting improved risk assessment, SIS and SSS were chosen for the characterization and description of CAD in this current study. In Fig. 1, changes in the coronary system can be seen through a schematic illustration of the 18-segment coronary model. Fig. 2 demonstrates representative images of a patient with severe and extended CAD.

2.5. Statistical analysis

Continuous variables are expressed as mean ± standard deviation (SD) or median with 25th–75th percentiles, while categorical variables appear as numbers and percentages. Normality of continuous parameters was tested with the Kolmogorov-Smirnov test. Univariable linear regression analysis was used to assess determinants of semiquantitative CCTA scores (SSS, SIS). All traditional risk factors and temperament scores with a p-value < 0.10 in univariable linear regression were entered into a multivariable linear model. Since, SSS and SIS values were non-normally distributed, we log-transformed (log2 of 1 + variable) the parameters in the regression models. A two-sided $p < 0.05$ was considered significant in all analyses. SPSS (Armonk, NY, USA version 25.0) was used for all calculation.

3. Results

3.1. Descriptive data

In total, 351 patients met the inclusion criteria, and were enrolled in our study. The mean age of our cohort was 60.8 ± 10.5 years, approximately half of them (159/351; 45.3 %) were female and had dyslipidemia (172/351; 49 %). Demographic and clinical data, scores assessed by TEMPS-A on each subscale, and CTA-derived parameters are demonstrated in Table 1. Fig. 3 depicts the distribution of affective temperaments assessed based on mean ± SD applying the original, 110-item and the abbreviated, 40-item TEMPS-A autoquestionnaires.

3.2. Predictors of CAD extent

According to the results received by using the 110-item autoquestionnaire, in men, traditional risk factors, notably hypertension and dyslipidemia proved to be independent predictors of SIS (β = −0.158, (95%CI: −1.089 to −0.076), p = 0.024; β = 0.154, (95%CI: 0.038 to 0.624), 0.027). While positive association between age and SIS was observed in both female and male population, there was no effect of affective temperaments on the extent of CAD in this case. However, applying the 40-item TEMPS-A in male population, besides conventional risk factors, hyperthymic temperament proved to be independent predictor for SIS (β = −0.194, (95%CI: −0.202 to −0.038), p = 0.004) as well. In addition, regarding women, significant positive relationship was also found between irritable temperament and SIS (β = 0.155, (95%CI: 0.004 to 0.221), p = 0.042).

3.3. Predictors of CAD severity

Regarding the scores evaluated by TEMPS-A that consists of 110 questions, in case of male participants, after the adjustment of traditional risk factors, significant inverse association was found between hyperthymic temperament score and SSS (β = −0.143, (95%CI: −0.091 to −0.004), p = 0.034). Hypertension and dyslipidemia remained to be independent predictors of SSS among men, in multivariate analysis (β = −0.154, (95%CI: −1.297 to −0.089), p = 0.025; β = 0.191, (95%CI: 0.152 to 0.851), p = 0.005). Compared to the TEMPS-A form that encompasses 110 questions, applying the abbreviated 40-question version,

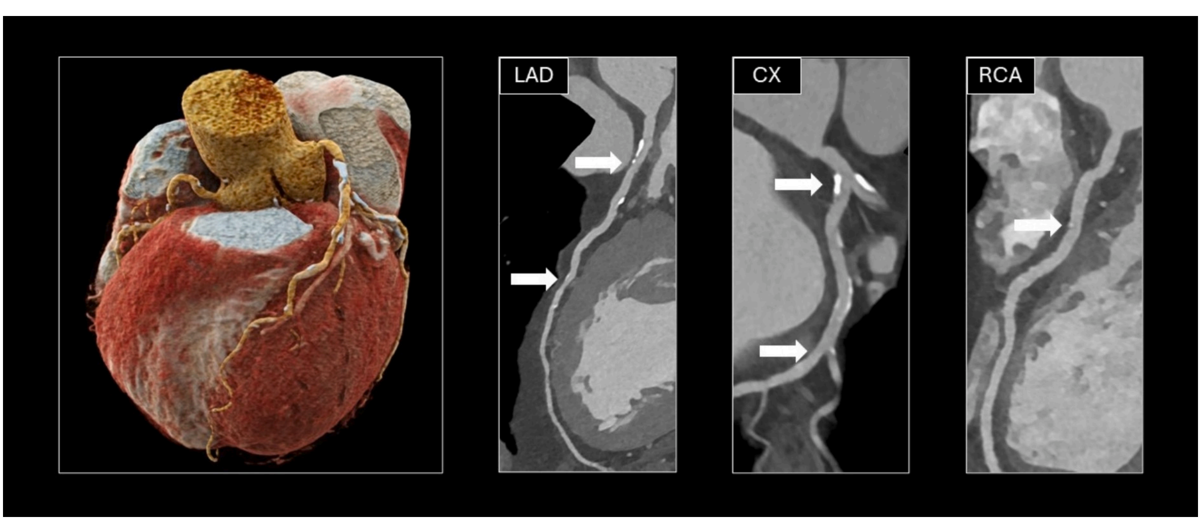

Fig. 2. A representative 3D volumetric image and curved multiplanar reformats of a male patient's coronary arteries demonstrating a severe and extensive coronary artery disease with an SIS score of 5, SSS score of 11 and an irritable temperament score of 17.
LAD: Left Anterior Descending Artery; LCX: Left Circumflex Artery; RCA: Right Coronary Artery; SIS: Segment Involvement Score; SSS: Segment Stenosis Score.

Table 1
Demographic parameters, clinical data, cardiovascular risk factors, TEMPS-A and semiquantitative plaque scores in the total study cohort.

	Total ($N = 351$)	Male ($N = 192$)	Female ($N = 159$)	p-Value
Demographics				
Age (years)	60.8 ± 10.5	58.3 ± 10.1	63.8 ± 10.2	***<0.001***
BMI (kg/m^2)	29.3 ± 5	29.8 ± 4.6	28.7 ± 5.4	
Cardiovascular risk factors, %				
Hypertension, n (%)	302 (86.0)	170 (89.5)	132 (83.0)	0.150
Diabetes n (%)	55 (15.7)	38 (19.8)	17 (10.7)	***0.026***
Dyslipidemia, n (%)	172 (49.0)	89 (46.4)	83 (52.2)	0.285
Current smoker, n (%)	47 (13.4)	32 (16.7)	15 (9.4)	0.058
Affective temperaments				
Depressive	6.4 ± 3.4	5.7 ± 2.8	7.2 ± 3.4	***<0.001***
Cyclothymic	4.4 ± 4.2	4.0 ± 3.8	4.8 ± 4.6	0.080
Hyperthymic	12.1 ± 4.3	4.6 ± 13.0	11.1 ± 4.6	***<0.001***
Irritable	4.5 ± 3.3	5.0 ± 3.9	3.9 ± 3.1	***0.001***
Anxious	6.2 ± 5.5	4.6 ± 4.6	8.2 ± 6.0	***<0.001***
Semiquantitative plaque scores				
SIS	3.6 ± 3.0	4.1 ± 3.1	3.0 ± 2.7	***0.001***
SSS	3.9 ± 3.6	6.1 ± 5.9	3.3 ± 3.2	***0.014***
Log$_2$ SIS	1.8 ± 1.1	2.3 ± 1.3	1.6 ± 1.1	***0.002***
Log$_2$ SSS	2.1 ± 1.3	2.0 ± 1.1	1.9 ± 1.3	***0.008***

BMI, Body mass index; SIS, Segment Involvement Score; SSS, Segment Stenosis Score.
Bold italic indicates significance ($p < 0.05$). Continuous variables are presented as mean ± standard deviation (SD), while categorical variables are expressed as numbers and percentages.

significant relationship between affective temperament and SSS was found in case of both female and male population. Concerning men, hyperthymic temperament was demonstrated to be independent predictor of SSS (β = −0.193, (95%CI: −0.244 to −0.048), p = 0.004). Additionally, we proved, that significant positive association between irritable temperament and SSS (β = 0.152, (95%CI: 0.002 to 0.269), p = 0.047) exists among women. Tables 2 and 3 summarize the results of multivariate logistic regression analysis on the determinants of SSS and SIS in case of applying both version of TEMPS-A.

4. Discussion

Our study revealed that beyond traditional risk factors, affective temperaments are independent predictors of the severity and the extent of CAD. We demonstrated a significant, inverse association between hyperthymic temperament and clinical plaque burden scores (SIS, SSS) for men. For the female population, irritable temperament independently predicted the severity and extent of CAD.

The contribution of episodic affective disorders to the development of physical illnesses is rooted in their recurring nature, which stems from affective temperament. This line of reasoning has led to the further expansion of studies on the relationship between somatic diseases and affective temperaments. In a previous study, patients with HIV infection and poor health-related quality of life had higher depressive temperament scores (Pompili et al., 2013), while in another study in patients with open-angle glaucoma depressive and hyperthymic temperament differed from healthy controls (Scuderi et al., 2011). These findings support the assumption that patients may respond differently to their illness based on their specific temperaments. Additionally, the associations of affective temperaments and somatic diseases can also be dependent on mediation pathways as in a recently published study Szabo G et al. clarified that infertility treatment outcomes can be associated with different temperaments directly (in case of anxious and depressive), indirectly (through diet adherence in case of irritable) or both directly and indirectly (in case of cyclothymic) (Szabo et al., 2024). The importance of psychosocial factors in the development and manifestation of CVD has been widely studied and well-documented (Visseren et al., 2021). A bidirectional relationship exists between major depression and CV morbidity and mortality (Rozanski et al., 1999). Furthermore, bipolar disorder is an independent risk factor, associated with an increased prevalence of hypertension and CVD (Goldstein et al., 2009). It is noteworthy that psychometric instruments assessing affective disorders can only determine the currents psychiatric status of a subject and scoring on these scales can change for psychotherapy or medical interventions (Guy et al., 2024). Consequently, in terms of prevention, their effectiveness might be limited compared to TEMPS-A, which is considered to be stable in adulthood except for depressive temperament in women which seems to be more pronounced with ageing (Vázquez et al., 2012).

The correlation between affective temperaments and psychopathological dimensions has been established. According to the model of Akiskal, affective temperaments are perceived as the subclinical manifestations and precursors of major mood disorders (Rihmer et al., 2010). Therefore, it seems plausible that certain affective temperaments, traits play a more central role in CAD development. Cumulating evidence supports the positive association between cyclothymic temperament and cardiovascular (CV) pathology and the protective effect of hyperthymic temperament on CAD (Vecsey-Nagy et al., 2021a,b, 2022; Körösi et al., 2019; Nemcsik et al., 2016, 2017).

Cyclothymic affective temperament can be described by depression and hyperthymia presenting in an alternating cyclic pattern (Rihmer et al., 2011). Aiming to further clarify the generally accepted link of cyclothymia and bipolar disorder (Akiskal et al., 1977), a specific subtype of soft bipolarity (BP-II spectrum) was proved to be distinguished by the presence of cyclothymic temperament (Akiskal et al., 2003).

Anxious and depressive temperaments share many similarities; however, it is essential to highlight some of their distinctive features. One of the fundamental aspects of depressive temperament is the sensitivity to suffering, and it often embodies a shy and reclusive personality. This temperament can be considered as the clinical sub-

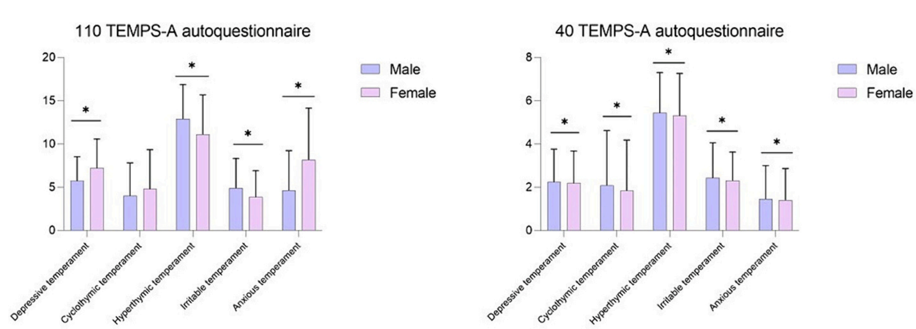

Fig. 3. Bar charts representing the distribution of affective temperaments based on mean and standard deviation (SD) applying both the 110-item and the 40-item TEMPS-A autoquestionnaire.
* Represents a $p < 0.05$ (independent samples t-test).

Table 2
Results of the multiple linear regression analyses applying the 110 TEMPS-A autoquestionnaire.

Dependent variables	Female population								Male population							
					Log2 SIS				Log2 SSS				Log2 SIS			
	St. β	95 % CI, lower-upper		p	St. β	95 % CI, lower-upper		p	St. β	95 % CI, lower-upper		p	St. β	95 % CI, lower-upper		p
Age	***0.340***	***0.023***	***0.064***	***<0.001***	***0.355***	***0.020***	***0.053***	***<0.001***	***0.445***	***0.040***	***0.076***	***<0.001***	***0.416***	***0.029***	***0.059***	***<0.001***
Hypertension	−0.130	−0.1026	0.107	0.111	−0.127	−0.823	0.095	0.119	***−0.154***	***−1.297***	***−0.089***	***0.025***	***−0.158***	***−1.089***	***−0.076***	***0.024***
Diabetes	0.136	−0.071	1.207	0.081	0.107	−0.157	0.879	0.171	0.102	−0.118	−0.787	0.147	0.109	−0.088	0.672	0.131
Dyslipidaemia	0.107	−0.112	0.673	0.160	0.080	−0.149	0.488	0.295	***0.191***	***0.152***	***0.851***	***0.005***	***0.154***	***0.038***	***0.624***	***0.027***
Smoking	−0.056	−0.949	0.437	0.466	−0.059	−0.781	0.343	0.442	0.081	−0.190	0.759	0.238	0.078	−0.174	0.622	0.268
BMI (kg/m^2)	−0.014	−0.04	0.035	0.862	0.000	−0.031	0.031	0.999	0.051	−0.024	0.052	0.464	0.047	−0.021	0.042	0.510
Depressive																
Cyclothymic																
Hyperthymic									***−0.143***	***−0.091***	***−0.004***	***0.034***	−0.133	−0.072	0.001	0.054
Irritable	0.120	−0.013	−0.116	0.118	0.140	−0.004	0.101	0.069								
Anxious																

Bold italic indicates statistical significance ($p < 0.05$). BMI: Body mass index.

Table 3
Results of the multiple linear regression analyses applying the 40 TEMPS-A autoquestionnaire.

Dependent variables	Female population								Male population							
	Log2 SSS				Log2 SIS				Log2 SSS				Log2 SIS			
	St. β	95 % CI, lower-upper		p	St. β	95 % CI, lower-upper		p	St. β	95 % CI, lower-upper		p	St. β	95 % CI, lower-upper		p
Age	***0.334***	***0.023***	***0.063***	***<0.001***	***0.347***	***0.020***	***0.745***	***<0.001***	***0.448***	***0.041***	***0.076***	***<0.001***	***0.420***	***0.030***	***0.060***	***<0.001***
Hypertension	−0.136	−0.1046	0.083	0.094	−0.132	−0.839	0.078	0.103	***−0.162***	***−1.332***	***−0.136***	***0.016***	***−0.167***	***−1.118***	***−0.117***	***0.016***
Diabetes	0.137	−0.065	1.206	0.078	0.108	−0.150	0.883	0.163	0.095	−0.134	−0.762	0.169	0.102	−0.101	0.649	0.152
Dyslipidaemia	0.107	−0.111	0.670	0.160	0.080	−0.149	0.486	0.295	***0.190***	***0.169***	***0.847***	***0.005***	***0.155***	***0.043***	***0.621***	***0.025***
Smoking	−0.057	−0.946	0.432	0.463	−0.060	−0.783	0.338	0.434	0.075	−0.201	0.729	0.264	0.074	−0.177	0.602	0.283
BMI (kg/m^2)	−0.015	−0.042	0.035	0.852	0.001	−0.032	0.031	0.986	0.034	−0.028	0.047	0.615	0.031	−0.024	0.038	0.658
Depressive																
Cyclothymic																
Hyperthymic									***−0.193***	***−0.244***	***−0.048***	***0.004***	***−0.194***	***−0.202***	***−0.038***	***0.004***
Irritable	***0.152***	***0.002***	***0.269***	***0.047***	***0.155***	***0.004***	***0.221***	***0.042***								
Anxious																

Bold italic indicates statistical significance ($p < 0.05$). BMI: Body mass index.

manifestation of major depression (Akiskal and Akiskal, 2005). Anxious temperament encompasses general worrying towards ordinary issues, it can be regarded as the predisposition of generalized anxiety disorder, and major depression as well (Akiskal, 1998). While a relationship between irritable, anxious and cyclothymic temperament and resistant hypertension were shown (Kőrösi et al., 2021), recent study demonstrated that besides these temperaments, depressive temperament also has an adverse effect on CV system (Cicero et al., 2017).

Irritable affective temperament shares commonalities with traits typically associated with anger and hostility. Stress-induced CV and neuroendocrine hyperreactivity, that is manifested with an enhanced secretion of cortisol and catecholamine, is associated with negative affects (Suarez et al., 1998). Various findings supported the inverse relationship between the psychological trait of hostility and cardiac autonomic responses notably heart rate variability (Sloan et al., 2001). The role of affective temperament among primary care patients was also investigated concerning tobacco dependence. In females, the irritable temperament emerged as an indicator of smoking initiation, thus underlining its relevance as a CV risk factor (Eory et al., 2015). Moreover, our previous study proved that irritable affective temperament can be regarded as an independent predictor of pulse wave velocity (Nemcsik et al., 2015), arterial stiffness index (Gyöngyösi et al., 2022) and in hypertensive men, it is also associated with nighttime brachial and central blood pressure (Kőrösi et al., 2019). Experiencing multiple stressful interpersonal transactions each day is associated with the overactivation of the sympathetic nervous system, a situation that occurs more frequently in subjects with irritable affective temperament. Our study implies that besides the aforementioned documented factors, irritable affective temperament is an additional independent predictor of CAD extent and severity.

Hyperthymic affective temperament is characterized by exuberant, upbeat, overenergetic and overconfident lifelong traits (Akiskal and Akiskal, 2005). In contrast to irritable affective temperament, hyperthymic temperament encompasses super-adaptability and low level of interpersonal conflict, which enables facing psychosocial stressors easily (Sakai et al., 2005). This temperament's psychopathological significance is well-known and supported by several findings. Hyperthymic temperament is considered a protective factor against not just for major depressive disorders, but suicide as well (Pompili et al., 2008; Rihmer et al., 2009; Vázquez et al., 2010). Positive impacts of hyperthymic temperament on CV pathology were proposed where it proved to be independent determinant of serum brain-derived neurotrophic factor level (Nemcsik et al., 2016). Our previous researches demonstrated an inverse relationship between hyperthymic temperament and the presence of CAD (Nemcsik et al., 2017). The current research extended these previous results by not only confirming the protective role of hyperthymic temperament on CAD severity, but also on its extent.

Both the 110-item and the shorter, 40-item version of TEMPS-A are consistent and accurate measures for the assessment of temperamental variations. The Hungarian adaptation of 110-item TEMPS-A was one of the first validated autoquestionnaires among 25 languages (Rózsa et al., 2008) and served as a basis for quantifying affective temperaments in several studies (Nemcsik et al., 2017; Vecsey-Nagy et al., 2021a,b, 2022). Nevertheless, due to the original version's time-consuming nature, the shortened 40-item TEMPS-A has been developed and validated in various languages involving Hungarian (Lang et al., 2018; Akiskal et al., 2005b). With its good to excellent internal consistency, and strong correlation with the 110-item version, the shortened TEMPS-A questionnaire may be a dependable and time-efficient instrument for the evaluation of affective temperaments (Lang et al., 2018). We found differences applying the 110-item autoquestionnaire and the 40-item abbreviated version regarding female population. When comparing the two approaches that might be due to that the shortened version captures CV implications more efficiently and hold more relevance in CV prevention, however further clinical studies are warranted to confirm its accuracy.

Regular assessment of coronary arteries on CTA primarily concentrates on determining stenosis severity and plaque composition by qualitative evaluation. However, CCTA also enables quantitative, and semi-quantitative assessment of CAD (Szilveszter et al., 2022). Clinical coronary artery plaque scores, notably SSS or SIS, by assessing the severity and overall extent of coronary artery plaque burden, are prognostically valuable indices for predicting adverse CV outcomes (Min et al., 2007). Besides the degree of luminal stenosis, the extent of CAD proved to carry added incremental value to the long-term prediction of major adverse cardiac events according to previous studies (Min et al., 2007; Bittencourt et al., 2014). The concept of these semi-quantitative plaque burden scores appears to hold validity in risk stratification in patients with extended CAD (Kolossváry et al., 2017), providing us information regarding the severity and the extent of the lesion.

We acknowledge the limitations of our study. Although standardized autoquestionnaires were used and patients with dementia and ongoing affective disorder were excluded, the complete exclusion of misinterpretations by patients or mistakes was not feasible. Furthermore, one of the main limitations originates from the cross-sectional design of the study which precludes causal inference. Prospective studies should target the evaluation of the effects of affective temperaments on CV pathology to determine the measure of its long-term prognostic value. Another limitation stems from the lack of the analysis of laboratory parameters and the potential confounding effect of medications.

In conclusion, among patients referred for CCTA, irritable affective temperament was found to be significantly associated with the severity and the extent of CAD in women. Whereas, in the male population, an inverse correlation was observed between hyperthymic affective temperament and clinical plaque burden scores (SIS, SSS), beyond traditional CV risk factors. These findings suggest that the assessment of affective temperaments may provide additional value in stratifying CV risk for patients beyond conventional risk factors. The implementation of the TEMPS-A autoquestionnaire in everyday clinical practice could provide an improved and comprehensive approach to primary prevention of CV events in an easy, time-efficient and cost-effective way.

CRediT authorship contribution statement

Barbara Sipos: Writing – review & editing, Writing – original draft, Visualization, Project administration, Methodology, Investigation, Formal analysis, Data curation. **Milán Vecsey-Nagy:** Writing – review & editing, Writing – original draft, Visualization, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Borbála Vattay:** Visualization, Software, Project administration. **Melinda Boussoussou:** Visualization, Software. **Zsófia Jokkel:** Visualization. **Sarolta Borzsák:** Software, Project administration. **Ádám Jermendy:** Visualization, Software, Methodology. **Alexisz Panajotu:** Visualization, Software, Methodology. **Xenia Gonda:** Validation, Supervision, Methodology. **Zoltán Rihmer:** Methodology, Investigation, Conceptualization. **Béla Merkely:** Supervision, Project administration, Conceptualization. **Bálint Szilveszter:** Writing – review & editing, Writing – original draft, Visualization, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **János Nemcsik:** Writing – review & editing, Writing – original draft, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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