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Relationship Between Coronary Artery Stenosis and Transdiagnostic Dysfunctional Metacognitive Beliefs: A Structural Equation Modeling Approach

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ABSTRACT

Dysfunctional metacognitive beliefs are increasingly recognized as transdiagnostic processes associated with emotional distress; however, their relationship with objective cardiovascular phenotypes remains insufficiently explored. This study examined the associations among dysfunctional metacognitive beliefs, emotional distress, and coronary artery stenosis (CAS) within a biopsychosocial framework. In total, 159 patients scheduled for elective coronary angiography completed self-report measures of anxiety, depression, and metacognitive beliefs before the procedure. CAS was defined as ≥50% luminal narrowing in at least one major coronary vessel based on angiographic evaluation. In structural equation modeling analyses, dysfunctional metacognitive beliefs—particularly negative beliefs about worry and maladaptive thought-control strategies—were strongly associated with emotional distress and also showed a significant direct association with the presence of CAS, whereas emotional distress did not statistically mediate this relationship. Together, these findings suggest that threat-focused dysfunctional metacognitive beliefs may be associated with CAS beyond concurrent emotional symptom severity; however, the cross-sectional design prevents causal inferences. Incorporating metacognitive processes into psychocardiological models may contribute to a more refined understanding of cognitive vulnerability in coronary artery disease.

Keywords: Coronary artery disease, coronary artery stenosis, emotional distress, metacognitive beliefs, structural equation modeling.

ÖZ

Koroner Arter Darlığı ile Tanı Ötesi İşlevsiz Metabilişsel İnançlar Arasındaki İlişki: Yapısal Eşitlik Modeli Yaklaşımı

Üstbilişsel inançlar, duygusal sıkıntı ile ilişkili transdiyagnostik süreçler olarak giderek daha fazla önem kazanmakla birlikte, bu bilişsel süreçlerin nesnel kardiyovasküler göstergelerle ilişkisi sınırlı düzeyde incelendi. Bu çalışmada, biyopsikososyal bir çerçeve içerisinde üstbilişsel işlevsiz inançlar, duygusal sıkıntı ve koroner arter darlığı arasındaki ilişkiler değerlendirildi. Elektif koroner anjiyografi planlanan toplam 159 hasta, işlem öncesinde anksiyete, depresyon ve üstbilişsel inançları değerlendiren öz bildirim ölçeklerini doldurdu. Koroner arter darlığı, klinik anjiyografik değerlendirmeye dayalı olarak herhangi bir majör koroner damarda %50 ve üzeri lümen daralması varlığı şeklinde tanımlandı. Yapısal eşitlik modellemesi analizlerinde, özellikle endişeye ilişkin olumsuz üstbilişsel inançlar ve uyumsuz düşünce kontrol stratejileri olmak üzere üstbilişsel işlevsiz inançların, duygusal sıkıntı ile güçlü biçimde ilişkili olduğu ve aynı zamanda koroner arter darlığı varlığıyla doğrudan ilişkili bulunduğu görüldü. Buna karşılık, duygusal sıkıntının bu ilişkiyi istatistiksel olarak aracılık yoluyla açıklamadığı saptandı. Bu bulgular, tehdit odaklı üstbilişsel işlevsiz inançların, eş zamanlı duygusal belirti düzeylerinden bağımsız olarak koroner arter darlığı ile ilişkili olabileceğine işaret etmektedir; ancak çalışmanın kesitsel tasarımı nedeniyle nedensel çıkarımlar yapılamaz. Kardiyovasküler risk değerlendirmelerinde üstbilişsel süreçlerin dikkate alınması, koroner arter hastalığında bilişsel kırılganlığın daha bütüncül biçimde anlaşılmasına katkı sağlayabilir.

Anahtar Kelimeler: Koroner arter hastalığı, koroner arter darlığı, duygusal sıkıntı, üstbilişsel inançlar, yapısal eşitlik modellemesi.

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INTRODUCTION

Coronary artery disease (CAD) remains a major priority on the global health agenda as a complex disease burden shaped by biological, psychological, and social factors. Despite substantial reductions in age-standardized mortality rates, CAD continues to pose a significant public health challenge, with increasing absolute cases and deaths continiuing to rise—particularly in low- and middle-income countries. Between 1990 and 2019, the global incidence of cardiovascular diseases increased by 77% and mortality by 54%. While CAD-related mortality declined by more than 50% in high-income countries, the reduction remained below 15% in low- and middle-income regions, underscoring pronounced global health inequities (Li et al., 2023; Timmis et al., 2023). In Europe, the downward trend observed between 2000 and 2015 has recently plateaued, a pattern partly attributed to behavioral risk factors such as obesity and smoking (Sterpetti et al., 2024). In Türkiye, CAD mortality demonstrates both an upward trajectory and marked regional disparities, with environmental stressors and behavioral factors—including tobacco and alcohol use—playing a substantial role (Tutar et al., 2024; Yalim et al., 2022). Collectively, these findings underscore that CAD cannot be conceptualized solely as a biological condition but rather as a multidimensional disorder influenced by socioeconomic, environmental, and behavioral determinants.

Psychological determinants have gained increasing attention within this broader framework. The prevalence of depression among patients with CAD has been reported to range between 20% and 40%, whereas that of anxiety exceeds 50% (Jupe et al., 2023). Depression has been consistently associated with adverse cardiovascular outcomes, with mechanisms including inflammatory activation, autonomic dysregulation, and endothelial dysfunction (Xu et al., 2024). Several longitudinal studies have linked anxiety to cardiovascular prognosis, although the magnitude and specificity of these associations vary across populations and measurement approaches (Peter et al., 2020). From a biological perspective, emotional stress is associated with heightened sympathetic activation, hypothalamic–pituitary–adrenal (HPA) axis stimulation, and enhanced proinflammatory responses, providing plausible mechanistic pathways rather than definitive causal explanations (Henein et al., 2022). A meta-analysis by Song et al. (2020) demonstrated that depression significantly predicts adverse cardiac outcomes following percutaneous coronary intervention. These findings indicate that psychological distress should not be considered a secondary correlate of CAD but rather a clinically relevant factor in disease management. (Clarification of the Song et al., 2020 statement and conceptual linkage).

In this context, "mental stress" refers not only to subjective distress but also to sustained cognitive–emotional activation involving perseverative thinking, heightened threat appraisal, and self-focused attention. Experimental and observational studies indicate that such patterns are associated with impaired endothelial reactivity, reduced flow-mediated dilation, and prolonged sympathetic activation independent of overt psychiatric diagnoses (Henein et al., 2022; Li et al., 2025). These findings suggest a plausible pathway through which repetitive negative thinking influences vascular function. (Clarification of the term "mental stress" and its vascular mechanisms)

However, emotional distress may represent only the observable surface of deeper cognitive processes. In particular, dysfunctional metacognitive beliefs may shape how individuals interpret and respond to internal and external cardiac threat cues, potentially influencing both psychological and physiological stress regulation. Metacognitive beliefs have been identified as proximal cognitive processes underlying both the development of emotional symptoms and individuals' responses to health-related threats. According to Wells' metacognitive model, negative beliefs about worry—particularly the perception that worry is uncontrollable and dangerous—play a central role in the maintenance of anxiety and depression rather than the initiation of anxiety and depression (Capobianco et al., 2020). These beliefs shape stress appraisal and emotional reactivity and have been implicated in, rather than conclusively shown to determine, health-related risk behaviors and threat evaluations (Laferton et al., 2023; Nadeem et al., 2022).

While substantial evidence links metacognitive beliefs to emotional distress, few studies have examined their relevance in cardiac populations. However, accumulating data indicate that components of the CAS—particularly rumination and anxiety—are meaningfully associated with coronary heart disease (CHD).

Faija et al. (2020) validated the CAS-1R in 440 patients undergoing cardiac rehabilitation, demonstrating the applicability of CAS assessment in cardiac settings. In a cohort of 426 cardiac patients, Guan et al. (2021) found that brooding and intrusive rumination uniquely predicted anxiety and depression 24 months after acute coronary events or bypass surgery. Tunheim et al. (2022) reported that rumination showed the strongest association with depressive symptoms and negative affectivity in 1,042 CHD outpatients. Similarly, Solg and Yaseminejad (2018) identified rumination as a robust predictor of anxiety and depression in 130 patients with CHD. Collectively, these studies—encompassing nearly 1,800 cardiac patients—provide consistent evidence that these perseverative cognitive processes are highly relevant in cardiac populations. (Expansion of CAS-related literature in cardiac populations).

In the context of cardiovascular disease, emerging evidence suggests that dysfunctional metacognitive beliefs (DMB) are closely associated with psychological distress and that brief metacognitive interventions may improve psychological well-being (Gebhardt et al., 2022; Anderson et al., 2019). Nevertheless, theoretical models explaining how DMB appraisals might relate to objective coronary pathology indicators, such as coronary artery stenosis (CAS), remain insufficiently developed.

Although the existing literature robustly supports the association between metacognitive beliefs and psychological symptoms, substantial gaps persist regarding how these beliefs interact with coronary stenosis defined angiographically. While uncontrollability and danger beliefs are known to disrupt emotional regulation, mental stress exerts direct effects on vascular function and endothelial reactivity, independent of overt emotional symptom severity (Li et al., 2025). Integrative models that jointly examine metacognitive beliefs, emotional distress, and CAS remain scarce. (Clarification regarding independence from cardiovascular risk factors) Moreover, whether emotional distress serves as a potential intermediary mechanism rather than a definitive pathway linking cognitive processes to cardiovascular outcomes remains unclear. This gap highlights the need for studies that simultaneously examine metacognitive beliefs, emotional distress, and CAS within a unified analytical framework.

Accordingly, the present study aimed to examine, rather than establish causal pathways among, DMB, emotional distress, and CAS from a holistic perspective. Specifically, we hypothesized that (1) negative metacognitive beliefs would be significantly associated with emotional distress, (2) DMB components would be directly associated with, rather than predictive of, CAS, and (3) emotional distress would serve as a potential mediator, acknowledging the exploratory nature of this pathway.

METHODS

Study Design

This cross-sectional, analytical investigation aimed to examine the associative relationships between psychological and metacognitive characteristics in patients scheduled for elective coronary angiography. Given the cross-sectional design, all findings are interpreted in terms of statistical associations rather than causal effects.

Study Setting and Study Period

The study was conducted at the Cardiology Clinic of Tokat State Hospital between January 2, 2023, and December 1, 2023. Data were collected in a standard clinical setting after the decision for coronary angiography (CAG) had been made during outpatient cardiology evaluations but before the angiographic procedure itself, thereby minimizing the potential confounding effects of procedural outcomes on psychological assessments.

Participants

Inclusion Criteria

- Age ≥ 18 years,
- Scheduled for elective CAG by a cardiology specialist,
- Adequate cognitive capacity to independently complete self-report questionnaires,
- Provision of written informed consent.

Exclusion Criteria

- Acute coronary syndrome or emergency angiography requirement,
- Hemodynamic instability,
- Illiteracy,
- Incomplete questionnaire data,
- Inability to complete assessments due to severe neurological or psychiatric conditions that could compromise the validity of self-report measures.

Sample Formation

A total of 177 patients were initially assessed. Twelve participants were excluded due to incomplete questionnaire responses, and six were excluded due to illiteracy. The final study sample consisted of 159 participants.

Power Analysis

The sample size adequacy was evaluated using an a priori power estimation conducted with G*Power 3.1. The analysis was based on the detection of a medium standardized effect size (β≈0.30) with 80% power at a 95% confidence level. Although G*Power does not directly estimate power for complex structural equation models (SEMs), the obtained sample size exceeds the commonly recommended minimum thresholds for SEM analyses with a limited number of latent variables and indicators. Accordingly, the final sample size of 159 participants was sufficient to support the planned SEM analyses.

Coronary Angiography and Stenosis Classification

Selective right and left coronary angiography was performed using the Judkins technique in all patients. Procedures were conducted by experienced interventional cardiologists who performed more than 75 procedures annually. Vascular access was obtained via radial or femoral approaches, as preferred

by the operator. The attending interventional cardiologists evaluated the angiographic findings in routine clinical practice.

Patients with ≥50% luminal narrowing in at least one major coronary artery were classified as the stenosis group, whereas those with <50% stenosis were classified as the non-stenosis group, consistent with widely used clinical and research definitions.

Data Collection Procedure

Data were collected through face-to-face interviews after the decision for coronary angiography and before the procedure. This timing was intentionally chosen to minimize the potential influence of procedural stress on psychological assessments.

The Following Data Were Collected:

Demographic variables: Age and sex.

Hospital Anxiety and Depression Scale (HADS): Used to assess anxiety and depressive symptoms.

Metacognition Questionnaire-30 (MCQ-30): Used to assess metacognitive beliefs.

All questionnaires were completed in full under standardized conditions and under the supervision of the researcher.

Missing Data Management

The proportion of missing data was below 5%. Little's MCAR test indicated that the missing data were completely random. Given the low proportion and random nature of missing information, we applied listwise deletion without substantial loss of statistical power.

Variables

Dependent variable: Coronary artery stenosis (CAS): 0=<50% stenosis; 1=≥50% stenosis.

Independent variables: Dysfunctional metacognitive beliefs (DMB): Negative beliefs about worry (NBW), need to control thoughts (NCT), and cognitive self-consciousness (CSC) subscales.

Emotional distress: HADS-Anxiety and HADS-Depression.

Covariates: Age and sex.

Bias Reduction

Scale administration order was standardized across all participants. To minimize observer effects, the assessments were conducted in a controlled, distraction-free environment. To prevent missing data and response errors, all forms were reviewed immediately after completion.

Measurement Instruments

Hospital Anxiety and Depression Scale

The HADS was developed by Zigmond and Snaith (1983) as a screening instrument specifically designed for individuals with medical conditions by excluding somatic symptom items. It consists of two subscales—anxiety (HADS-A) and depression (HADS-D)—each comprising seven items, yielding scores ranging from 0 to 21. For the HADS, we reported item-level mean scores (range 0–3) rather than subscale total scores to facilitate comparability across measures and interpretation of symptom intensity. (clarification regarding HADS scoring, we have specified that item-level mean scores (0–3) rather than subscale total scores (0–21) were reported to prevent misinterpretation of the scale range.)The Turkish version has been validated (Aydemir et al., 1997). In the present study, internal consistency was acceptable to good, with Cronbach's alpha values of 0.75 for HADS-A and 0.80 for HADS-D.

Metacognition Questionnaire-30

The MCQ-30 is a 30-item, four-point Likert-type scale that assesses DMB. Higher scores indicate more maladaptive metacognitive beliefs. The questionnaire comprises five subscales: PBW, NBW, cognitive confidence (CC), NCT, and CSC. Cronbach's alpha coefficients ranged from 0.74 to 0.86, indicating satisfactory internal consistency. Selected MCQ-30 subscales (NBW, NCT, and CSC) were specified as observed indicators of the latent DMB construct in the SEM analyses.

Statistical Analysis

All statistical analyses were conducted using IBM SPSS Statistics for Windows, Version 29.0, and the lavaan package (version 0.6-17) implemented in R. We assessed distributional assumptions using skewness, kurtosis, Shapiro–Wilk tests, histograms, and Q–Q plots. Although some normality tests were significant, the robustness of parametric procedures was supported by graphical inspections and sample size considerations.

Group comparisons were conducted using independent samples t-tests, with effect sizes reported as Cohen's d. Pearson correlation coefficients were calculated to examine the bivariate associations. Sex differences in CAS were evaluated using the chi-square test.

A structural equation model was constructed to examine the relationships among DMB, emotional distress, and CAS within an integrated framework. Given the binary nature of the CAS variable, the robust WLSMV estimator was employed, which is appropriate for categorical outcomes and provides reliable parameter estimates and fit indices.

The direct, indirect, and total effects were estimated. The model fit was evaluated using CFI, TLI, SRMR, and RMSEA.

Table 1. Comparison of psychological and metacognitive variables in patients with vs. without coronary artery stenosis

Variable	No CAS (n=80) M (SD)	CAS (n=79) M (SD)	t	df	p	Cohen's d
Age	58.68 (10.42)	61.30 (7.87)	-1.79	157	0.075	0.29
HADS- ANXIETY	1.21 (0.36)	1.33 (0.43)	-2.03	157	0.045	0.30
HADS- DEPRESSION	1.18 (0.36)	1.25 (0.34)	-1.51	157	0.133	0.19
PBW	2.12 (0.48)	2.23 (0.49)	-1.59	157	0.112	0.23
NBW	2.24 (0.61)	2.61 (0.56)	-3.88	157	<0.001	0.63
NCT	1.93 (0.54)	2.24 (0.42)	-4.19	157	<0.001	0.66
CSC	2.37 (0.52)	2.55 (0.39)	-2.45	157	0.016	0.38
CC	2.09 (0.70)	2.44 (0.61)	-3.39	157	0.001	0.52

M: Mean; SD: Standard deviation; CAS: No coronary artery stenosis; HADS: Hospital anxiety and depression scale; PBW: Positive beliefs about worry; NBW: Negative beliefs about worry; NCT: Need for control over thoughts; CSC: Cognitive self-consciousness; CC: Cognitive confidence.

Exceptionally high fit indices (CFI=1.000; TLI=1.035; RMSEA=0.000) were interpreted cautiously because they likely reflect the parsimonious model structure and limited number of indicators rather than a perfect model fit. Statistical significance was set at $p<0.05$.

Ethical Approval

The Clinical Research Ethics Committee of Tokat Gaziosmanpaşa University Faculty of Medicine reviewed and approved this study (Approval No: 22-KAEK-252; Meeting No: 2022/20; Decision Date: November 24, 2022). The study was ethically and scientifically appropriate in accordance with national regulations governing clinical research.

This study was conducted following the principles of the Declaration of Helsinki.

RESULTS

Descriptive Characteristics of Participants and Sex Differences in Patients with Coronary Artery Stenosis

A total of 159 patients were included in this study. Of these, 80 (50.3%) patients had no CAS, whereas 79 (49.7%) patients had stenosis. The prevalence of CAS was comparable between sexes. Among women, 42 (51.2%) had no stenosis, and 40 (48.8%) had stenosis; among men, 38 (49.4%) had no stenosis, and 39 (50.6%) had stenosis. The Pearson's chi-square test did not indicate a significant association between sex and stenosis status, $\chi^2(1)=0.055$, $p=0.814$; Fisher's exact test similarly yielded a non-significant result ($p=0.874$). Accordingly, sex was not retained as a differentiating factor for CAS in subsequent analyses.

Psychological and Metacognitive Differences Between Patients with and Without Coronary Artery Stenosis

Group differences in psychological and metacognitive variables were examined using independent samples t-tests (Table 1). Patients with CAS exhibited modestly higher HADS-Anxiety scores than those without stenosis ($t(157)=2.03$, $p=0.045$, Cohen's $d=0.30$). In contrast, the HADS-Depression scores did not significantly differ between the groups ($p=0.133$).

Patients with stenosis demonstrated a consistently more maladaptive metacognitive profile. NBW, NCT, and CSC were significantly higher in the stenosis group ($p<0.001$, $p<0.001$, and $p=0.016$, respectively). CC scores were significantly elevated in the stenosis group ($p=0.001$), indicating lower perceived CC. The observed effect sizes fell within the small-to-moderate range, suggesting that the detected differences, while statistically significant, reflect modest clinical magnitude.

Comparison of Psychological and Metacognitive Variables

Pearson Correlations Among the Study Variables

The Pearson correlation coefficients among the psychological and metacognitive variables are presented in Table 2. Anxiety and depression were strongly and positively correlated ($r=0.581$, $p<0.01$). Dysfunctional metacognitive belief components, including NBW, NCT, and CSC, showed moderate-to-strong positive correlations with anxiety and depression ($r\approx0.35–0.70$). This pattern supports the conceptualization of these variables as related but non-redundant components of a shared cognitive–emotional distress domain.

Measurement Model (Factor Structure)

Two latent variables were specified within the structural equation modeling framework. DMB were defined by NBW, NCT, and CSC indicators, whereas the HADS-Anxiety and HADS-Depression subscales represented emotional distress (DISTRESS).

Table 3 presents the factor loadings for the measurement model, with all loadings achieving statistical significance ($\beta=0.627–0.905$). The overall fit of the measurement model was very high, as indicated by the fit indices reported in Table

Table 2. Pearson correlations among the study variables

Variable	1	2	3	4	5	6	7
1. HADS-Anxiety	–						
2. HADS-Depression	0.581*	–					
3. NCT	0.531*	0.451*	–				
4. PBW	0.344*	0.317*	0.650*	–			
5. CC	0.518*	0.353*	0.619*	0.454*	–		
6. NBW	0.575*	0.482*	0.701*	0.535*	0.657*	–	
7. CSC	0.392*	0.285*	0.512*	0.492*	0.489*	0.616*	–

*: p<0.01. HADS: Hospital anxiety and depression scale; PBW: Positive beliefs about worry; NBW: Negative beliefs about worry; NCT: Need for control over thoughts; CSC: Cognitive self-consciousness; CC: Cognitive confidence.

Table 3. Measurement model factor loadings

Latent variable	Observed indicator	β	SE	z	p
DMB	NBW	0.905	—	—	<0.001
	NCT	0.825	0.073	10.02	<0.001
	CSC	0.627	0.062	8.52	<0.001
DISTRESS	HADS-Anxiety	0.845	—	—	<0.001
	HADS-Depression	0.688	0.111	7.26	<0.001

The standardized factor loadings (β) are presented. SE: Standard error; DMB: Dysfunctional metacognitive beliefs; DISTRESS: Emotional distress; HADS: Hospital anxiety and depression scale. NBW: Negative beliefs about worry; NCT: Need for control over thoughts; CSC: Cognitive self-consciousness.

Table 4. Indirect, direct, and total effects

Effect type	Path	B	SE	β	z	p
Indirect effect	DMB→DISTRESS→CAS	-0.272	0.287	-0.150	-0.95	0.344
Direct effect	DMB→CAS	1.035	0.329	0.574	3.15	0.002
Total effect	DMB→CAS	0.764	0.167	0.423	4.57	<0.001

Coronary artery stenosis (0=no stenosis, 1=stenosis). SE: Standard error; DMB: Dysfunctional metacognitive beliefs; CAS: No coronary artery stenosis.
Model Fit Indices $\chi^2(7)=1.11$, p=0.993; CFI=1.000; TLI=1.035; SRMR=0.021; RMSEA=0.000, 90% CI (0.000, 0.075), p=0.998.

Table 5. Results of the structural model

Dependent variable	Predictor	B	SE	β	z	p
DISTRESS	DMB	0.450	0.058	0.752	7.81	<0.001
CAS (0/1)	DISTRESS	-0.604	0.631	-0.200	-0.96	0.339
	DMB	1.035	0.329	0.574	3.15	0.002

Standardized (β) and unstandardized (B) coefficients are presented. Coronary artery stenosis (0=no stenosis, 1=stenosis). SE: Standard error; DMB: Dysfunctional metacognitive beliefs; CAS: No coronary artery stenosis.

4: $\chi^2(7)=1.11$, p=0.993; CFI=1.000; TLI=1.035; SRMR=0.021; RMSEA=0.000 (90% CI [0.000–0.075], p=0.998). Given the parsimonious structure of the model and the limited number of indicators per latent construct, these indices were interpreted with caution.

Results of the Structural Model

The relationships among DMB, emotional distress, and CAS were examined using structural path coefficients, which are presented in Table 5. DMB was strongly associated with

emotional distress (DMB→DISTRESS: β=0.752, p<0.001). Moreover, DMB remained significantly associated with coronary artery stenosis after accounting for emotional distress (DMB→CAS: β=0.574, p=0.002). Emotional distress was not significantly associated with coronary artery stenosis (DISTRESS→CAS: p=0.339). These findings indicate that concurrent emotional distress did not explain the association between DMB and CAS.

Direct, Indirect, and Total Effects

Table 4 presents the direct, indirect, and total effects, along with overall model fit indices. The indirect effect of DMB on CAS via emotional distress was not statistically significant (β=–0.150, p=0.344). In contrast, the direct effect of DMB on stenosis was significant (β=0.574, p=0.002), as was the total effect (β=0.423, p<0.001). Model fit indices—$\chi^2(7)=1.11$, p=0.993; CFI=1.000; TLI=1.035; SRMR=0.021; RMSEA=0.000—were again interpreted conservatively, as exceptionally high values may reflect model simplicity rather than a perfect model fit.

DISCUSSION

This study aimed to address a significant gap in the literature by examining how psychological and metacognitive processes are jointly associated with angiographically defined CAS within the broader context of CAD. Our findings demonstrate that DMB, operationalized through NBW, NCT, and CSC, were significantly associated with emotional distress and CAS. These findings suggest that CAD may not be fully understood solely in terms of biological alterations within the vascular system; rather, they point to a multilayered process in which cognitive appraisals, threat perception, and the regulation of internal experiences may play a contributory role. Although the contribution of psychological factors to cardiovascular risk has long been recognized, empirical studies focusing specifically on the role of metacognitive beliefs within this relationship remain limited. In this context, our results extend the existing literature by highlighting metacognition not only as a mechanism sustaining emotional symptoms but also as a cognitive domain potentially linked to objective markers of cardiovascular pathology.

The association of DMB with CAS independent of emotional distress suggests that cognitive threat-related processes may impose a more persistent stress burden on cardiovascular physiology. The results of the structural model indicated that emotional distress did not statistically mediate the relationship between DMB and CAS; instead, DMB was significantly associated directly with stenosis. In contrast to our third hypothesis, emotional distress did not function as a mediator within the structural model, indicating that concurrent affective symptom severity did not explain the association between DMB and stenosis. (The reviewer's request for clarification explicitly stated that emotional distress did not mediate the association between DMB and CAS, thereby preventing the overinterpretation of indirect effects.) This pattern should be interpreted as indicative of statistical independence rather than evidence of a causal pathway. This finding is consistent with previous studies demonstrating that metacognitive beliefs are strongly related to anxiety and depression (Capobianco et al., 2020; Anderson et al., 2019). Moreover, such beliefs have been shown to amplify perseverative thinking patterns, thereby being associated with biological stress responses such as hypothalamic–pituitary–adrenal (HPA) axis activation and cortisol dysregulation (Sladek et al., 2020). Parallel findings from cardiovascular research indicate that mental stress is associated with endothelial dysfunction, microvascular vasoconstriction, and heightened inflammatory activation (Henein et al., 2022; Peter et al., 2020). Taken together, these converging lines of evidence support the plausibility of an association between threat-focused metacognitive beliefs and coronary physiology, potentially mediated by chronic stress-related mechanisms.

While prior research has primarily emphasized emotional stress-related vascular reactivity, the broader literature indicates that the relationship between psychological symptoms and structural coronary pathology is more heterogeneous than initially assumed. Rozanski et al. (2011) reported minimal association between psychological risk factors and coronary artery calcium, and Whooley (2006) suggested that psychological distress may be more closely related to incident cardiovascular events than cumulative plaque burden. These findings indicate that psychological and cognitive processes, including vascular reactivity or stress-related physiological modulation, may influence cardiovascular outcomes through pathways other than progressive atherosclerosis. (Reviewer Comment: Emotional intensity does not linearly translate into cardiovascular risk).

Longitudinal evidence further highlights the heterogeneity of the association between emotional symptoms and cardiovascular outcomes. Peter et al. (2020) identified distinct anxiety and depression trajectories in a 15-year follow-up study of patients with stable CHD and demonstrated that persistently high or high-decreasing anxiety and stable high depression were associated with elevated cardiovascular risk, whereas increasing anxiety did not reach statistical significance after covariate adjustment. These findings suggest that emotional symptom intensity alone does not uniformly predict cardiovascular risk; however, chronicity and trajectory patterns are critical. (Reviewer Comment – Peter et al. 2020 research).

The independence of the association between DMB and coronary stenosis from emotional distress further suggests that metacognitive processes may represent a higher-order cognitive vulnerability domain, which is partially distinct from affective symptom severity. Emerging evidence indicates that metacognitive beliefs account for incremental variance in psychological symptom severity beyond that explained by traditional affect-focused measures (Kołodziejczyk et al., 2024; Capobianco et al., 2020). Furthermore, these beliefs predict treatment response, symptom trajectory, and long-term stress exposure more consistently than emotional symptoms alone (Nordahl et al., 2017; Salguero & Ramos-Cejudo, 2023). Our findings do not challenge the established links between depression, anxiety, and cardiovascular risk; rather, they suggest that DMB may constitute a more proximal cognitive context within which these emotional processes operate. The absence of a mediating effect of emotional distress implies that DMB may be related to cardiovascular risk through mechanisms not fully captured by transient mood states, potentially involving tonic sympathetic activation or low-grade inflammation. DMB may contribute to a sustained physiological stress milieu even in individuals without clinically elevated affective symptoms.

Studies demonstrating that illness perceptions predict cardiovascular outcomes (Lotfi-Tokaldany et al., 2022) further underscore the importance of cognitive appraisals in shaping clinical trajectories, with DMB potentially functioning as an overarching cognitive framework through which such appraisals are constructed. Within this theoretical context, the inclusion of only three MCQ-30 subscales—NBW, NCT, and cognitive self-consciousness—reflects a theoretically driven and conceptually parsimonious decision. These subscales represent the core components of DMB, as defined in Wells' model, and capture perceptions of cognitive threat, beliefs about uncontrollability, tendencies toward thought suppression, and heightened self-focused attention. Therefore, they may be regarded as particularly relevant indicators of metacognitive vulnerability in medical populations. Evidence that metacognitive interventions facilitate clinical improvement in cardiac rehabilitation settings (Wells et al., 2021; Wells et al., 2023) further supports the modifiable and clinically actionable nature of these threat-focused metacognitive processes.

Our results suggest that assessing metacognitive beliefs may provide incremental information in cardiovascular care. Previous research indicates that DMB strongly predicts psychological distress in patients with cardiac arrest and that incorporating metacognitive measures alongside standard screening tools may enhance the identification of patients at risk for sustained psychological burden (Capobianco et al., 2020; Anderson et al., 2019). Psychometric evidence supporting the applicability of the Metacognition Questionnaire in cardiac populations (Faija et al., 2020), together with its demonstrated explanatory value across other chronic illness groups (Kołodziejczyk et al., 2024), suggests that metacognitive assessment could be feasibly integrated into routine clinical practice. Moreover, findings indicating that structured psychological assessment within cardiac rehabilitation improves outcomes reinforce the potential relevance of targeting metacognitive processes as part of comprehensive cardiovascular care (Wells et al., 2021; Wrzeciono et al., 2024). Taken together, these observations support the consideration of DMB in relation to psychological well-being and broader physiological and clinical outcomes.

One of the primary strengths of this study lies in its integrative approach, which simultaneously examined psychological and metacognitive processes alongside CAS within a single structural model. Whereas much of the existing literature has focused predominantly on emotional distress, this study directly incorporated DMB into the analytical framework, thereby extending prior models of psychological risk in CVD. Data collection before coronary angiography reduced the potential confounding effects of procedure-related stress and allowed for a more stable assessment of psychological variables. Although exceptionally high model fit indices were observed, given the model's parsimonious structure and the limited number of indicators, these were interpreted conservatively.

Several limitations should be considered when interpreting these findings. First, CAS was assessed using visual estimation during clinically indicated angiography. Although a ≥50% luminal narrowing threshold is widely accepted as clinically meaningful (Anderson & Pepine, 2013), this approach may not fully capture microvascular dysfunction or borderline lesions. Second, the cross-sectional design precludes causal inferences regarding the directionality of the observed associations. Longitudinal and experimental studies are needed to clarify whether DMB precedes or is shaped by vascular pathology. Finally, the use of a clinically referred sample limits the generalizability of the findling to broader populations.

Although the current structural model is theoretically focused on cognitive and emotional constructs, it did not incorporate established cardiometabolic risk factors—including smoking, hypertension, diabetes, dyslipidemia, obesity, and medication adherence—were not incorporated into the structural model. These established determinants account for a substantial proportion of CAD burden and directly influence endothelial injury and atherosclerotic progression; however, their absence limits the ability to disentangle cognitive vulnerability from biological and behavioral confounding.

DMB may be indirectly associated with coronary stenosis through unmeasured lifestyle or metabolic pathways. The specificity and incremental explanatory value of DMB beyond conventional cardiovascular risk markers cannot be fully determined without adjustment for these variables. Accordingly, the present findings should be interpreted as exploratory and hypothesis-generating rather than as evidence of an independent cognitive pathway to structural coronary disease (Cardiovascular risk factors inclusion).

CONCLUSION

This study contributes to the field of cardiovascular psychology by demonstrating the association of DMB with CAS independent of emotional distress. The findings suggest that metacognitive beliefs shaping threat perception and stress regulation may be linked to cardiovascular physiology in ways that extend beyond emotional symptom burden. Incorporating metacognitive processes into cardiac assessment may enhance risk stratification and support more individualized intervention approaches. Longitudinal and mechanistic studies are required to elucidate causal pathways and determine whether targeting metacognitive beliefs can influence coronary outcomes. Overall, the present findings underscore the value of an integrative perspective on the interplay between cognitive processes and cardiovascular health.

However, the results should be interpreted cautiously given the absence of traditional cardiovascular risk factors in the model and the cross-sectional design. Longitudinal studies incorporating established cardiometabolic risk markers are required to clarify the temporal and incremental contribution of these factors to coronary disease risk.(CV risk absence, Cross-sectional caution, Longitudinal call).

Ethics Committee Approval: The Tokat Gaziosmanpaşa University Faculty of Medicine Clinical Research Ethics Committee granted approval for this study (date: 24.11.2022, number: 22-KAEK-252).

Informed Consent: Written informed consent was obtained from all participants prior to data collection.

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