



## Review Article

## Role of personality in cardiovascular diseases: An issue that needs to be focused too!

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## ARTICLE INFO

## Article history:

Received 4 September 2018

Accepted 2 November 2018

Available online 8 November 2018

## Keywords:

Personality

Type A

Type D

Cardiovascular diseases

## ABSTRACT

This review provides a broad overview of the relationship of personality with cardiovascular diseases (CVDs). There has been a sustained interest over the last half a century on the issue of relationship between personality traits and CVDs. Type A behavior was the initial focus of inquiry as it was observed that individuals who were competitive, hostile, and excessively driven were overrepresented among patients seeking treatment for CVDs and also were prone to develop coronary artery disease/syndrome. However, the research gradually expanded to assess the relationship of cardiac morbidity with various other personality facets. Furthermore, studies found out that negative effects (including anger and hostility) were also associated with adverse cardiovascular outcomes. Subsequently, a new personality entity named as the type D 'distressed' personality, which combined negative affectivity and social inhibition. type D personality then became the area of research and was demonstrated to be related with poorer cardiac outcomes. Interestingly, the results of various research studies are not equivocal, and hence, there are several critiques related to the current understanding of the link between personality construct and the risk of development as well as the outcome of CVDs. Furthermore, few personality traits such as optimism, conscientiousness, openness to experience, and curiosity have been found to be protective factors against development of CVDs and therefore are called 'cardioprotective' personality traits. A detailed discussion on the various aspects of personality in relation to CVDs along with a critical appraisal has been presented in this review.

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## 1. Introduction

Cardiovascular diseases (CVDs) are currently the leading causes of death worldwide.<sup>1</sup> Among the various risk factors enumerated and evaluated for CVDs, psychosocial factors have been found to play a significant role in the expression and outcome of cardiac illness.<sup>2,3</sup> Furthermore, among the several psychological and social factors, personality characteristics or personality traits of an individual have been explored as an important factor influencing the morbidity of CVDs. Personality in relation to cardiac illness, more

particularly coronary artery disease (CAD), has been studied across a number of studies since last 40–50 years.<sup>4</sup> Previous studies had focused on the specific typology of personality and have found a specific type of personality, i.e., type A personality (characterized by hostility, impatience, and competitiveness dominance) to be adversely related with incidence of CVDs.<sup>4,5</sup> However, subsequent research has explored other traits such as negative emotional states or negative affect, anxiety, anger, and hostility in the genesis of CVDs. However, as the findings have been inconsistent across studies yet, the conceptual debate about the role and relevance of personality traits in the causation of CVDs continues.<sup>6,7</sup>

There is no universal consensus on the definition of personality. It generally refers to the dynamic and organized set of characteristics possessed by a person which uniquely influences his or her cognitions, emotions, motivations, and behaviors in various situations.<sup>8</sup> Personality is determined by a range of factors including

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heredity, environment, and situational factors.<sup>9</sup> Personality traits have been found to be associated with happiness, physical and psychological health, spirituality, quality of relationship with peers and family, occupational choices, community involvement, criminal activity, political ideology, etc.<sup>10</sup> Hence, personality is a multidimensional construct that can have a wide range of consequential outcomes. Psychologists have postulated many theories of personality (dispositional theories, psychodynamic theories, social behavior theories, experiential or humanistic theories, biological theories, and cognitive theories); however, all of these theories tend to describe overall patterns of behavior.<sup>8</sup>

Personality shapes the outlook of an individual in different ways to react to a psychological or emotional distress. It has a stable effect on one's behavior and hence may be implicated in the genesis of disorders in which patterns of behaviors may play a role. Because CVDs are often associated with specific adverse behaviors, it seems intuitive that personality traits may be associated with development and prognosis of CVDs. In this review, we had tried to look at the possible association and explanation of the relationship of personality with CVDs.

## 2. Evolution of the concept

The possible effect or role of personality in CVDs was first identified by Friedman and Rosenman (1959) in a group of subjects with CAD.<sup>11</sup> They found that individuals with type A personality behaviors (such as more aggressive, competitive, hostile, short tempered, more time conscious, constant preoccupation with deadlines, unable to relax, cynical, etc.) were prone to excessive stress and were also prone to CAD. In addition, they found a strong association of type A behaviors with blood cholesterol level, blood-clotting time, incidence of arcus senilis, and clinical CAD.<sup>11</sup> Later, it was also proposed that individuals with features of type A personality were at an increased risk (sevenfold) of having CAD and all other causes of premature death, even after controlling for other risk factors.<sup>12</sup> Furthermore, the same group of authors found that those with type B personality features (easy going, do not get angry easily, and less competitive) have decreased risk of CAD and suggested that altering type A behavior pattern after myocardial infarction can decrease subsequent rate of reinfarction.<sup>13,14</sup>

### 2.1. Type A personality patterns and its association with CVDs

Despite several studies suggesting a strong link between type A personality patterns and CVDs, the possible role of type A personality patterns in relation to cardiac illness has been questioned again. Further studies evaluating this possible link had found no significant relationship or association between the two.<sup>15–17</sup> A meta-analysis of prospective studies until 1998 ( $n = 25$  studies) on CAD and type A personality failed to find any significant association between the two ( $r = 0.003$ ;  $n = 574,326$ ;  $p = 0.213$ ), whereas a significant association was found between hostility and risk of CAD ( $r = 0.022$ ;  $n = 15,038$ ,  $p = 0.003$ ), suggesting a possible and robust role of anger and hostility with CAD/CVDs.<sup>7</sup> Therefore, the later studies shifted their focus of research from specific type A behavior pattern to hostility as a cause for development of CVDs.

### 2.2. Anger-hostility dimension and its association with CVDs

Anger and hostility are two important dimensions in the context of personality attributes and have been associated with several personality traits or types. Many studies have found that the hostility and anger components of the type A behavior pattern are more sensitive predictors of CVDs.<sup>6,7,18</sup> Furthermore, a meta-analysis of 25 studies and 19 studies separately which

investigated the coronary heart disease (CHD) outcome in healthy populations and those with preexisting CHD revealed that both anger and hostility were significantly associated with increased CHD events both in healthy population studies (hazard ratio [HR]  $-1.19$ ;  $p = 0.008$ ) and those with previous CHD population studies (HR,  $-1.24$ ;  $p = 0.002$ ).<sup>6</sup> Hostility has also been conceptualized as a chronic negative affect, and it increases one's tendency to experience distress.<sup>19</sup> Chronic negative affect has also been found to be associated with the risk of developing serious illness and premature mortality and affect the quality of life in those individuals with chronic medical illness.<sup>13,20,21</sup>

The anger dimension has also been evaluated separately for its association with CVDs. It has been postulated that anger can trigger ischemia in coronary tissues and may be an independent risk factor for CAD/CVDs/CHD.<sup>22–24</sup> Anger can lead to excess catecholamine release and subsequent increased cardiovascular reactivity, leading to acute sinus tachycardia, hypertension, decreased coronary perfusion, and cardiac instability.<sup>24–26</sup> A prospective study on 1055 young men followed up from 32 to 48 years of age evaluated the association between anger responses to stress during early adult life and risk of premature and total CVD and revealed excessive anger in response to stress in young men to be strongly associated with an increased risk of premature CVD, more particularly myocardial infarction (adjusted relative risk,  $-6.4$ ), thus justifying the role of anger in the development of CVD.<sup>27</sup> Another population-based observational prospective study ( $n = 785$ ) from Canada (Nova Scotia Health Survey) studied three types of anger expression, namely, constructive anger (discussing anger for resolution of the problem), destructive anger justification (blaming others for one's anger), and destructive anger rumination (brooding over an anger-inducing incident), and its possible association with incident CHD events.<sup>28</sup> It was revealed that in the observational period of 10 years, there were 115 CHD events (14.6% incidence), and a definite association was found between constructive anger expression and CHD ( $p = 0.02$ ) with significant differences between the gender (Higher levels of constructive anger expression in males were associated with lower risk of CHD event; HR  $-0.58$ ,  $p < 0.001$ ). Furthermore, higher levels of destructive anger justification were found to be associated with a 31% increased risk of CHD in both the genders (HR,  $-1.31$ ,  $p = 0.03$ ).<sup>28</sup> Therefore, it is quite evident that not only anger but also the nature of expression of anger also affects the risk of CVDs. Some studies have also stressed on the finding that anger was more significantly associated with the presence of CAD rather than hostility.<sup>29</sup> Furthermore, anger has also been found to be the main personality factor that is strongly associated with coronary stenosis in individuals with CAD.<sup>30</sup>

Furthermore, a typical coronary-prone behavior pattern has been suggested, which includes these two components, i.e., anger and hostility together known as the anger-hostility dimension.<sup>31</sup> The first component includes "potential for hostility," which is the tendency to react to unpleasant situations with responses that reflect anger, frustration, irritation, and disgust. The second component includes "anger-in" which is the lack of ability or desire to express the anger directly toward the object.<sup>32</sup> While hostility refers to combination of irritation, annoyance, and resentment, "anger-in" is the tendency to hold back the expressions of anger against others, even if such expressions might be appropriate.<sup>33</sup> The dimensions of anger-hostility have been found to have significant positive correlation with systolic and diastolic blood pressure, platelet reactivity,<sup>34</sup> and subsequent progression of atherosclerosis, as well as with the development of hypertension,<sup>6</sup> stroke,<sup>6</sup> and adverse cardiac events in those with suspected CVDs<sup>35</sup> and those with recurrent CVDs.<sup>36</sup> In addition, hostile behaviors and low anger control have been found to predict CVD events and CVD-related mortality among CVD individuals suspected with a high risk.<sup>37,38</sup>

### 2.3. The type D or the 'distressed' personality and its association with CVDs

A new personality construct known as the type D personality or the 'distressed' personality was proposed by Denollet in 2000.<sup>39,40</sup> It was observed that subjects with CAD/CVDs have an increased propensity to experience emotional and interpersonal difficulties. The type D personality comprised of two stable personality constructs of negative affectivity and social inhibition, which were closely related with neuroticism and introversion, respectively.<sup>39</sup> Negative affectivity is the tendency to experience negative emotions over time and in diverse life situations, and social inhibition is the tendency to inhibit self-expression in social interactions.<sup>40</sup> Studies have reported that those with type D personality with CVDs experience more cardiac symptoms but are less likely to report cardiac symptoms (such as swollen legs, shortness of breath, etc.) to the medical professionals or tend to seek health care late resulting in severe symptoms due to their social inhibition tendency.<sup>41</sup> In addition, it has also been reported that those with type D personality tend to have increased disease severity,<sup>42</sup> increased cardiac mortality,<sup>43</sup> impaired health status, and more depressive symptoms.<sup>44</sup> Type D personality has been linked with both fatal<sup>45</sup> and nonfatal (noncardiac chest pain) events<sup>46,47</sup> and have more work-related problems (such as higher absenteeism, more somatization, and report more work-related burnout and stress).<sup>48</sup>

Few important biological mechanisms have been implicated to underpin the relationship between type D personality and CVDs. These were based on some biological findings: (1) Among patients with heart failure, presence of type D personality emerged as a significant predictor of increased circulating levels of proinflammatory cytokine tumor necrosis factor, a marker associated with pathogenesis of heart failure.<sup>49,50</sup> (2) Subjects with type D personality were also found to have higher cortisol-awakening responses, independent of demographic and clinical factors and depression, suggesting that type D personality may be associated with disruption of hypothalamic–pituitary–adrenal axis which may play a role in the etiopathogenesis of CAD.<sup>51–53</sup> (3) Those with type D personality have been found to have exaggerated blood pressure and heart responses in relation to any stressful event which may consequently increase risk for the development of CVDs or CAD.<sup>54–56</sup> Furthermore, it has been found that individuals with CVD with type D personality have decreased cognitive functioning, which is independent of depression and anxiety.<sup>57</sup>

Compared to general population, those with CAD have increased tendency to self-blame themselves, seek avoidance, and socially isolate themselves from the community.<sup>58</sup> Three types of coping strategies have been evaluated in relation to chronic medial diseases, i.e., confrontational coping, avoidance coping, and acceptance-resignation coping.<sup>59</sup> Furthermore, it has been found that those with type D personality more frequently use maladaptive coping, i.e., less confrontational coping and more acceptance-resignation coping in response to CVD. In addition, confrontation coping was found to mediate the association between type D personality and perceived severity of disease, and acceptance-resignation coping mediated the relationship between type D personality and morale, suggesting that coping modification strategies should be an important aspect of psychological intervention in subjects with CVDs and type D personality.<sup>60</sup>

Studies have also reported that in subjects with CVDs before implantable cardioverter defibrillator (ICD) implantation, presence of type D personality pattern was associated with poor physical and mental health status.<sup>61</sup> Furthermore, it has also been found that patients with ICD with a type D personality report more depressive symptoms if they have a partner with type D personality.<sup>62</sup> Similarly, studies have also found that patients treated with

percutaneous coronary interventions (PCIs) with type D personality have nearly 3.69-fold increased risk for depression and 2.72-fold increased risk for anxiety at 10 years of follow-up.<sup>63</sup> Therefore, studies have also tried to focus on the impact of psychological profile of caregiver/partner of patients with CVDs.

### 2.4. Emotional dysregulation and risk of CVDs

Cardiomyopathies, more particularly Takotsubo cardiomyopathy (commonly known as stress cardiomyopathy), has been found to be significantly associated with emotional triggers such as death of a close relative, failure in relationship, or unpredicted separation from one's partner.<sup>64</sup> Furthermore, studies have found strong association between Type D personality and stress cardiomyopathy after acute emotional stressful triggers leading to acute cardiac events.<sup>64,65</sup> Emotional competence that is the integration of one's emotional intelligence (ability to be aware of and control one's own emotions), metacognitive beliefs (ability to be aware of and regulate one's own thinking), and emotional processing deficits has been found to be quite dysfunctional (after adjusting for depression) in patients with Takotsubo cardiomyopathy who experience frequent emotional triggers.<sup>29,66</sup> Therefore, it is further proved that certain psychological factors play significant role in the development of specific cardiomyopathies too.

### 2.5. Cardioprotective personality traits

Few personality traits such as optimism, conscientiousness, openness, and curiosity have been found to be associated with positive health outcomes in subjects with CVDs and hence can be regarded as cardioprotective personality traits. *Optimism*, is a positive personality trait, which is defined as the tendency to expect good experiences in the future, has been found to be a protective factor against the risk of CAD in elderly,<sup>67</sup> has predicted better physical health and emotional health (lower depressive symptoms) after an acute coronary syndrome event,<sup>68</sup> and has been associated with reduced pain intensity and physical symptom reporting after coronary artery by-pass graft surgery.<sup>69</sup> In contrast, pessimism (opposite of optimism) has been found to be a substantial risk factor for cardiovascular mortality.<sup>70</sup>

Another personality trait of *conscientiousness* (which encompasses personality dispositions like self-efficacy, orderliness, dutifulness, achievement-striving, self-discipline and cautiousness)<sup>71</sup> has been found to predict longevity among apparently healthy persons.<sup>72</sup> In subjects with CVDs, low conscientiousness has been evaluated as a risk factor for all-cause mortality due to CVDs, stroke, and malignancies in prospective cohort studies conducted over a period of 3–17 years.<sup>73,74</sup> *Openness to experience*, a personality trait from the five-factor personality model that involves active imagination, artistic sensitivity, attentiveness to inner feelings, and intellectual curiosity,<sup>75</sup> has also been found to be an independent protective factor for incident CHD/CVDs in the community after adjusting for all putative confounding factors including depression.<sup>76</sup> Furthermore, *curiosity*, yet another personality characteristic probably related to the five-factor model trait of openness to experience, has been found to be associated with longevity, independent of medical risk factors and health behavior.<sup>77</sup>

## 3. Link/association between personality and CVDs

Various models have been put forth to explain the relationship between personality and the risk of developing CVDs (summarized in Fig. 1). These are as listed in the following subsections:

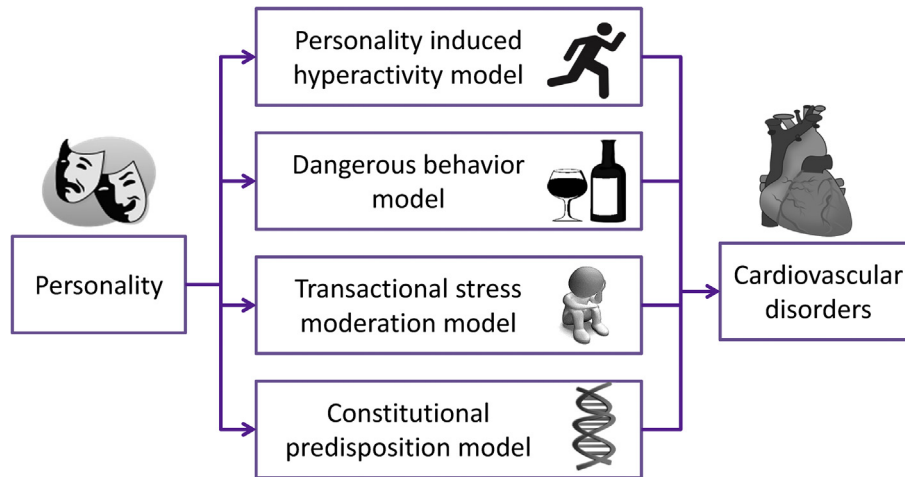


Fig. 1. Theories to explain relationship between personality and cardiovascular disorders.

### 3.1. The personality-induced hyperactivity model<sup>78</sup>

This model suggests that some individuals may have a style of functioning characterized by exaggerated neuroendocrine and sympathetic responses toward perceived stressors. Such individuals appraise demanding situations as more threatening than others and have more intense physiological responses. Congruent to this hypothesis, individuals having type A personality have been found to have physiological characteristics that include higher noradrenaline levels, faster blood-clotting times, higher cholesterol levels, and higher plasma lipid (triglycerides and low-density lipoprotein cholesterol) levels.<sup>79–81</sup>

### 3.2. The dangerous behaviors model

This model suggests that personality affects health indirectly through excess health-degrading behaviors and lack of health-promoting behaviors. For example, it has been reported that type A individuals often seek challenging and competitive situations and tend to smoke more and consume more alcohol than type B individuals.<sup>82</sup> This predisposes them to have a greater risk of CVDs. They also have a tendency to underreport the severity of their physical symptoms, which may place them at risk for untreated progression of disease. Type A behavior has been regarded as a general risk factor for physical disorder. They are more likely to have accidents, to die from accidents/violence, and to incur CVDs.<sup>83</sup> Similarly, certain personality characteristics such as conscientiousness and openness to experience have been associated with health-promoting behaviors which reduce the risk of developing medical health problems.<sup>84</sup>

### 3.3. The transactional stress moderation model

This model suggests that individuals with certain personality dispositions may have tendencies toward using particular coping strategies when stressed. Maladaptive coping styles may lead to adverse physiological and behavioral consequences. Type A behavior pattern has been found to be associated with emotion-focused and avoidance-focused coping,<sup>85</sup> whereas type D personality pattern has been associated with confrontational coping and acceptance-resignation coping in subjects with CVDs.<sup>60</sup>

### 3.4. The constitutional predisposition model

It is also known as the biological interaction model. It suggests a noncausal association between personality and health, whereby an underlying genetic or other constitutional factor produces both a physiologic vulnerability to disease and the behavioral, emotional, and cognitive phenotype of personality.<sup>86</sup> It has been well established across a number of studies that chronic anger, hostility, and negative affect are independent risk factors for poor physical health outcomes, more particularly CVDs.<sup>22,37,87</sup>

## 4. Critical appraisal of the personality construct in relation to cardiac illness

As per the current body of research, the relationship of type A personality pattern and CVDs is not equivocally acceptable due to lack of consistent findings.<sup>7,88</sup> The new entity of type D personality in relation to cardiac illness has been in the focus of research since 2000. Two separate meta-analyses of 10 prospective studies and 15 studies, respectively, examining the relationship between type D personality and health status in patients with CVDs had suggested type D personality to be regarded as an independent correlate of impaired patient-reported physical and mental health status.<sup>89,90</sup> Furthermore, cross-cultural validity of the type D construct and its relation with CVDs has been carried out across 22 countries in about 6222 patients and has revealed a pan cultural relationship between type D personality and some cardiovascular risk factors, supporting the role of type D personality across different cultures and countries.<sup>91</sup> However, despite much research in this area, the question of whether type D personality is additionally helpful in explaining the relationship between behavior and cardiovascular disorders has been critiqued by some authors, and several questions have been raised on the meta-analyses on type D personality studies.<sup>92</sup>

Experts have asserted that type D personality is another form of neuroticism and question what additional psychological risk factor is gained by exploring into type D personality.<sup>93</sup> In addition, concerns have been raised regarding the focus on sole personality characteristic such as type D, undermining the role of mood states such as depression, anxiety, and vital exhaustion in the development of CVDs which have also been evaluated as independent risk factors for the same.<sup>94,95</sup>

Furthermore, type D personality has also been found to be a vulnerability marker/factor, which affects people not only with



CVDs but also with many other medical disorders (such as chronic pain, asthma, tinnitus, sleep apnea, vulvovaginal candidiasis, mild traumatic brain injury, vertigo, melanoma, and diabetic foot).<sup>96</sup> In general, it has now been regarded as a vulnerability factor for any kind of psychological distress and is associated with disease-promoting mechanisms in healthy individuals.<sup>48</sup> Therefore, linking type D personality patterns solely to CVDs is not justified.

If one carefully examines the nature of literature related to type D personality and its association with CVDs, it becomes quite evident that most of the research had emerged from a single center and single group of investigators.<sup>97,98</sup> Moreover, type D personality has been explained for a significant number of deaths in their observations, and it has been remarked that a few deaths in the other group would have substantially changed the findings. In this regard, recent data from outside the original investigator group have failed to find a prognostic value for type D,<sup>99</sup> and researchers have suggested that early studies on type D personality had overestimated its prognostic relevance.<sup>100</sup> Furthermore, it has been concluded from these studies that more methodologically sound studies are required to draw any definite conclusions between the personality construct and its prognostic significance for CVDs.<sup>100</sup> To counteract these propositions, the main proponents of type D personality construct had conducted a study to explain the large heterogeneity in type D studies and have reported the same previous finding, i.e., Type D personality was associated with an increased risk of cardiac events, but additionally in this study, they have reported that type D personality was not associated with noncardiac death or with events in subjects aged above 70 years.<sup>101</sup> Although few recent studies have also questioned the assumptions of type D personality as it has been now found that conscientiousness and the Big Five personality variables predict health-related variables and behavior better than type D personality,<sup>102</sup> others have supported the predictive value of type D personality for impaired endothelial function in subjects with CAD and have found that those with type D personality have an increased risk of endothelial dysfunction (flow-mediated dilation less than 5.5%).<sup>103</sup> More recently, a combined personality construct of type A and type D typology has been identified in a group of subjects with essential hypertension and acute coronary syndrome. The six combined personality profiles identified after cluster analysis were type D, type A negatively affected, not type A negatively affected, Socially inhibited-positively affected, Not socially inhibited, and neither type A nor type D. Of all these types, the type A negatively affected cluster displayed the worst cardiovascular profile, thus suggesting that a new approach to identify combined personality profiles should be now thought of.<sup>104</sup>

Negative affectivity as a component of type D personality strongly overlaps with the construct of depression. The question whether type D is a really stable personality rather than a response to illness requires further clarity as most studies have assessed such a personality construct in patients who have already been diagnosed with CVDs. It could also be argued that the knowledge of the

illness may lead to negative mood state and inhibitions in social interactions.

## 5. Clinical implications of identifying personality types in patients with CVDs

The hypothesis of personality affecting the development of CVDs/CAD and the outcome of CVDs translates into attempts at finding whether modification of personality characteristics and behavior patterns can result in attenuation of the risk and delay of/reduce negative outcome of CVDs, respectively.<sup>105</sup> Previous studies on altering type A behavior pattern in the Recurrent Coronary Prevention Project ( $n = 1035$ ) specifically focused on modifying type A behavior and negative affect by using group therapy, and counseling groups focused on behavioral modification showed that those who received group counseling sessions showed significant reduction in the rate of cardiovascular system mortality and nonfatal myocardial infarction.<sup>14</sup>

Very few studies are available which have attempted behavioral modification on subjects with CVDs and comorbid type D personality. A randomized controlled trial attempting at type D behavior modification divided patients ( $n = 224$ ) into expanded cardiac rehabilitation (stress management, increased physical training, stay at patient hotel after discharge, and cooking sessions) and routine rehabilitation.<sup>106</sup> The additional interventions were associated with improved quality of life and nonsignificant improvement in type D scores, depression, and anxiety. Studies have also supported the beneficial effect of cardiac rehabilitation program when combined with relaxation and meditation strategies on depressive and anxiety symptoms in patients with CVDs.<sup>107</sup> Hence, these studies suggest some promise of interventions to change coronary-prone behaviors, but further work is required before definite inferences and conclusions are drawn.

## 6. Conclusions and future directions

To conclude, present literature suggests that some personality characteristics may be associated with the development of CVDs. Some plausible mechanisms have been suggested to explain the relationship of CVDs and health-related outcomes. Ascertainment of personality characteristics is likely to provide a more comprehensive and integrative view of the risk factors for CVDs and potentially provide interventions to reduce the impact of such risk factors. However, one should also note some important aspects of personality measurement and its dimensions as mentioned in Table 1. Future research should pursue the possibility that health consequences of personality characteristics vary across the context in which they occur. Research also needs to acknowledge the age, gender, ethnicity, and developmental process in the relationship of personality and CVDs. Moreover, future research also needs to take into account the fact that personality traits are not static and may show changes with time. Hence, interventions may be customized

**Table 1**  
Important points to note on the association of personality and CVDs.

- Type A and type B personality constructs are behavioral constructs and are mostly self-reported.
- Most of the studies that have evaluated for type A and type D personality constructs have used self-assessment questionnaires in which there is every possibility that the subjects could have concealed hostility aspect.
- Another major limitation of these studies is the use of different scales for assessment of personality which makes comparison across these studies difficult. Furthermore, there is no consensus over which scale is the best scale to measure personality dimensions.
- The anger dimension of personality, if self-reported, can be inaccurate as the same anger can be considered as constructive by perpetrator and destructive by others.
- Psychological risk factors do not occur in isolation but cluster together within patients, complicating risk assessment.
- Comorbid depression has been found to be a confounder in the risk assessment of personality dimensions in subjects with CVDs.
- There is a possible chance of significant publication bias in the earlier studies (70s) in reporting the association between personality and CVDs. However, recent studies have now well identified these associations with the use of methodologically sound strategies.

to target individuals at risk to reduce the probability of developing adverse cardiovascular outcomes. Although primary prevention is difficult, increasing general public awareness about the role personality traits and its impact on cardiac illness could be beneficial. Secondary prevention needs to be strengthened which can be made possible by identifying maladaptive personality traits in those suffering from CVDs and taking psychotherapy sessions (counseling) to modify these aspects so as to reduce risk of adverse cardiac events/outcomes.

### Author contributions

All the authors equally contributed to this article with the conception and design of the article, literature review, drafting, and final approval of the manuscript.

### Conflict of interest

All authors have none to declare.

### References

1. *Cardiovascular Diseases (CVDs) [Internet]*. World Health Organization; 2017 [cited 2018 Aug 7]. Available from: [http://www.who.int/news-room/factsheets/detail/cardiovascular-diseases-\(cvds\)](http://www.who.int/news-room/factsheets/detail/cardiovascular-diseases-(cvds)).
2. Everson-Rose SA, Lewis TT. Psychosocial factors and cardiovascular diseases. *Annu Rev Public Health*. 2005;26:469–500.
3. Khayyam-Nekouei Z, Neshatdoost H, Yousefi A, Sadeghi M, Manshaee G. Psychological factors and coronary heart disease. *ARYA Atherosclerosis*. 2013;9:102–111.
4. Bishop GD. Personality and cardiovascular disease: overview. In: *Handbook of Psychocardiology*. Singapore: Springer; 2015:1–14 [Internet].
5. Eysenck HJ. Personality as a risk factor in coronary heart disease. *Eur J Pers*. 1991;5:81–92.
6. Chida Y, Steptoe A. The association of anger and hostility with future coronary heart disease: a meta-analytic review of prospective evidence. *J Am Coll Cardiol*. 2009;53:936–946.
7. Myrtek M. Meta-analyses of prospective studies on coronary heart disease, type A personality, and hostility. *Int J Cardiol*. 2001;79:245–251.
8. Ryckman R. *Theories of Personality*. 8th ed. Belmont CA: Thomson/Wadsworth; 2004.
9. Loehlin JC, Nichols RC. *Heredity, Environment, & Personality: A Study of 850 Sets of Twins*. Texas: University of Texas Press; 1976.
10. Ozer DJ, Benet-Martínez V. Personality and the prediction of consequential outcomes. *Annu Rev Psychol*. 2006;57:401–421.
11. Friedman M, Rosenman RH. Association of specific overt behavior pattern with blood and cardiovascular findings; blood cholesterol level, blood clotting time, incidence of arcus senilis, and clinical coronary artery disease. *J Am Med Assoc*. 1959;169:1286–1296.
12. Friedman M. Type A behavior pattern: some of its pathophysiological components. *Bull N Y Acad Med*. 1977;53:593–604.
13. Friedman HS, Booth-Kewley S. Personality, type A behavior, and coronary heart disease: the role of emotional expression. *J Pers Soc Psychol*. 1987;53:783–792.
14. Friedman M, Thoresen CE, Gill JJ, et al. Feasibility of altering type A behavior pattern after myocardial infarction. Recurrent coronary prevention project study: methods, baseline results and preliminary findings. *Circulation*. 1982;66:83–92.
15. Case R, Heller S, Case N, Moss A, Multicenter post-infarction research group. Type A behavior and survival after acute myocardial infarction. *N Engl J Med*. 1985;312:737–741.
16. Coronary-prone behavior and coronary heart disease: a critical review. The review panel on coronary-prone behavior and coronary heart disease. *Circulation*. 1981;63:1199–1215.
17. Petticrew MP, Lee K, McKee M. Type A behavior pattern and coronary heart disease: Philip Morris's "Crown Jewel". *Am J Public Health*. 2012;102:2018–2025.
18. Delunas LR. Beyond Type A: hostility and coronary heart disease—implications for research and practice. *Rehabil Nurs*. 1996;21:196–201.
19. McCrae RR, John OP. An introduction to the five-factor model and its applications. *J Pers*. 1992;60:175–215.
20. Hu J, Gruber KJ. Positive and negative affect and health functioning indicators among older adults with chronic illnesses. *Issues Ment Health Nurs*. 2008;29:895–911.
21. Mayne TJ. Negative affect and health: the importance of being earnest. *Cognit Emot*. 1999;13:601–635.
22. Siegman AW. Cardiovascular consequences of expressing, experiencing, and repressing anger. *J Behav Med*. 1993;16:539–569.
23. Verrier RL, Mittelman MA. Cardiovascular consequences of anger and other stress states. *Bailliere Clin Neurol*. 1997;6:245–259.
24. Verrier RL, Mittleman MA. Life-threatening cardiovascular consequences of anger in patients with coronary heart disease. *Cardiol Clin*. 1996;14:289–307.
25. Gullette EC, Blumenthal JA, Babyak M, et al. Effects of mental stress on myocardial ischemia during daily life. *J Am Med Assoc*. 1997;277:1521–1526.
26. Mittleman MA, Maclure M. Mental stress during daily life triggers myocardial ischemia. *J Am Med Assoc*. 1997;277:1558–1559.
27. Chang PP, Ford DE, Meoni LA, Wang N-Y, Klag MJ. Anger in young men and subsequent premature cardiovascular disease: the precursors study. *Arch Intern Med*. 2002;162:901–906.
28. Davidson KW, Mostofsky E. Anger expression and risk of coronary heart disease: evidence from the Nova Scotia health Survey. *Am Heart J*. 2010;159:199–206.
29. Compare A, Mommersteeg PMC, Faletta F, et al. Personality traits, cardiac risk factors, and their association with presence and severity of coronary artery plaque in people with no history of cardiovascular disease. *J Cardiovasc Med (Hagerstown)*. 2014;15:423–430.
30. Compare A, Grossi E, Buscema M, et al. Combining personality traits with traditional risk factors for coronary stenosis: an artificial neural networks solution in patients with computed tomography detected coronary artery disease. *Cardiovasc Psychiatry Neurol*. 2013;2013:814967.
31. Lachar BL. Coronary-prone behavior. Type A behavior revisited. *Tex Heart Inst J*. 1993;20:143–151.
32. Musante L, MacDougall JM, Dembroski TM, Costa PT. Potential for hostility and dimensions of anger. *Health Psychol*. 1989;8:343–354.
33. Dembroski TM, MacDougall JM, Williams RB, Haney TL, Blumenthal JA. Components of Type A, hostility, and anger-in: relationship to angiographic findings. *Psychosom Med*. 1985;47:219–233.
34. Shimbo D, Chaplin W, Wasson LT, Burg MM. Hostility and platelet reactivity in individuals without a history of cardiovascular disease events. *Psychosom Med*. 2009;71:741–747.
35. Olson MB, Krantz DS, Kelsey SF, et al. Hostility scores are associated with increased risk of cardiovascular events in women undergoing coronary angiography: a report from the NHLBI-Sponsored WISE Study. *Psychosom Med*. 2005;67:546–552.
36. Wong JM, Na B, Regan MC, Whooley MA. Hostility, health behaviors, and risk of recurrent events in patients with stable coronary heart disease: findings from the heart and soul study. *J Am Heart Assoc*. 2013;2. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3835215/>.
37. Haukkala A, Kontinen H, Laatikainen T, Kawachi I, Uutela A. Hostility, anger control, and anger expression as predictors of cardiovascular disease. *Psychosom Med*. 2010;72:556–562.
38. Matthews KA, Gump BB, Harris KF, Haney TL, Barefoot JC. Hostile behaviors predict cardiovascular mortality among men enrolled in the multiple risk factor Intervention Trial. *Circulation*. 2004;109:66–70.
39. Denollet J. DS14: standard assessment of negative affectivity, social inhibition, and Type D personality. *Psychosom Med*. 2005;67:89–97.
40. Denollet J. Type D personality: a potential risk factor refined. *J Psychosom Res*. 2000;49:255–266.
41. Schiffer AA, Denollet J, Widdershoven JW, Hendriks EH, Smith ORF. Failure to consult for symptoms of heart failure in patients with a type-D personality. *Heart*. 2007;93:814–818.
42. Svansdottir E, Karlsson HD, Gudnason T, et al. Validity of Type D personality in Iceland: association with disease severity and risk markers in cardiac patients. *J Behav Med*. 2012;35:155–166.
43. Schiffer AA, Smith ORF, Pedersen SS, Widdershoven JW, Denollet J. Type D personality and cardiac mortality in patients with chronic heart failure. *Int J Cardiol*. 2010;142:230–235.
44. Schiffer AA, Pedersen SS, Widdershoven JW, Hendriks EH, Winter JB, Denollet J. The distressed (type D) personality is independently associated with impaired health status and increased depressive symptoms in chronic heart failure. *Eur J Cardiovasc Prev Rehabil*. 2005;12:341–346.
45. Pedersen SS, Denollet J. Type D personality, cardiac events, and impaired quality of life: a review. *Eur J Cardiovasc Prev Rehabil*. 2003;10:241–248.
46. Campbell KA, Madva EN, Villegas AC, et al. Non-cardiac chest pain: a review for the consultation-Liaison psychiatrist. *Psychosomatics*. 2017;58:252–265.
47. Kuijpers PMJC, Denollet J, Wellens HJJ, Crijns HM, Honig A. Noncardiac chest pain in the emergency department: the role of cardiac history, anxiety or depression and Type D personality. *Eur J Cardiovasc Prev Rehabil*. 2007;14:273–279.
48. Mols F, Denollet J. Type D personality in the general population: a systematic review of health status, mechanisms of disease, and work-related problems. *Health Qual Life Outcome*. 2010;8:9.
49. Conraads VM, Denollet J, De Clerck LS, Stevens WJ, Bridts C, Vrints CJ. Type D personality is associated with increased levels of tumour necrosis factor (TNF)-alpha and TNF-alpha receptors in chronic heart failure. *Int J Cardiol*. 2006;113:34–38.
50. Denollet J, Conraads VM, Brutsaert DL, De Clerck LS, Stevens WJ, Vrints CJ. Cytokines and immune activation in systolic heart failure: the role of Type D personality. *Brain Behav Immun*. 2003;17:304–309.
51. Girod JP, Brotman DJ. Does altered glucocorticoid homeostasis increase cardiovascular risk? *Cardiovasc Res*. 2004;64:217–226.

52. Molloy GJ, Perkins-Porras L, Strike PC, Steptoe A. Type-D personality and cortisol in survivors of acute coronary syndrome. *Psychosom Med.* 2008;70: 863–868.
53. Whitehead DL, Perkins-Porras L, Strike PC, Magid K, Steptoe A. Cortisol awakening response is elevated in acute coronary syndrome patients with type-D personality. *J Psychosom Res.* 2007;62:419–425.
54. Brotman DJ, Golden SH, Wittstein IS. The cardiovascular toll of stress. *Lancet.* 2007;370:1089–1100.
55. Denollet J, Kupper N. Stress and the heart: the role of type D personality in personalized care. *Eur Heart J.* 2015;36:1783–1785.
56. Sher L. Type D personality: the heart, stress, and cortisol. *QJM.* 2005;98: 323–329.
57. Unterrainer J, Michal M, Rahm B, et al. Association of Type D personality with cognitive functioning in individuals with and without cardiovascular disease — the Gutenberg Health Study. *Int J Cardiol.* 2016;214:256–261.
58. Pignalberi C, Patti G, Chimenti C, Pasceri V, Maseri A. Role of different determinants of psychological distress in acute coronary syndromes. *J Am Coll Cardiol.* 1998;32:613–619.
59. Feifel H, Strack S, Nagy VT. Degree of life-threat and differential use of coping modes. *J Psychosom Res.* 1987;31:91–99.
60. Yu X, Chen Z, Zhang J, Liu X. Coping mediates the association between type D personality and perceived health in Chinese patients with coronary heart disease. *Int J Behav Med.* 2011;18:277–284.
61. Starrenburg AH, Kraaier K, Pedersen SS, van Hout M, Scholten M, van der Palen J. Association of psychiatric history and type D personality with symptoms of anxiety, depression, and health status prior to ICD implantation. *Int J Behav Med.* 2013;20:425–433.
62. van den Broek KC, Versteeg H, Erdman RAM, Pedersen SS. The distressed (Type D) personality in both patients and partners enhances the risk of emotional distress in patients with an implantable cardioverter defibrillator. *J Affect Disord.* 2011;130:447–453.
63. Al-Qezweny MNA, Utens EMWJ, Dulfer K, et al. The association between type D personality, and depression and anxiety ten years after PCI. *Neth Heart J.* 2016;24:538–543.
64. Compare A, Bigi R, Orrego PS, Proietti R, Grossi E, Steptoe A. Type D personality is associated with the development of stress cardiomyopathy following emotional triggers. *Ann Behav Med.* 2013;45:299–307.
65. Compare A, Grossi E, Bigi R, et al. Stress-induced cardiomyopathy and psychological wellbeing 1 year after an acute event. *J Clin Psychol Med Settings.* 2014;21:81–91.
66. Compare A, Brugnera A, Spada MM, et al. The role of emotional competence in Takotsubo cardiomyopathy. *Psychosom Med.* 2018;80:377–384.
67. Kubzansky LD, Sparrow D, Vokonas P, Kawachi I. Is the glass half empty or half full? A prospective study of optimism and coronary heart disease in the normative aging study. *Psychosom Med.* 2001;63:910–916.
68. Ronaldson A, Molloy GJ, Wikman A, Poole L, Kaski J-C, Steptoe A. Optimism and recovery after acute coronary syndrome: a clinical cohort study. *Psychosom Med.* 2015;77:311–318.
69. Ronaldson A, Poole L, Kidd T, Leigh E, Jahangiri M, Steptoe A. Optimism measured pre-operatively is associated with reduced pain intensity and physical symptom reporting after coronary artery bypass graft surgery. *J Psychosom Res.* 2014;77:278–282.
70. Pänkäläinen M, Kerola T, Kampaan O, Kauppi M, Hintikka J. Pessimism and risk of death from coronary heart disease among middle-aged and older Finns: an eleven-year follow-up study. *BMC Publ Health.* 2016;16:1124.
71. Goldberg LR. The structure of phenotypic personality traits. *Am Psychol.* 1993;48:26–34.
72. Kern ML, Friedman HS. Do conscientious individuals live longer? A quantitative review. *Health Psychol.* 2008;27:505–512.
73. Hagger-Johnson G, Sabia S, Nabi H, et al. Low conscientiousness and risk of all-cause, cardiovascular and cancer mortality over 17 years: Whitehall II cohort study. *J Psychosom Res.* 2012;73:98–103.
74. Jokela M, Pulkki-Råback L, Elovainio M, Kivimäki M. Personality traits as risk factors for stroke and coronary heart disease mortality: pooled analysis of three cohort studies. *J Behav Med.* 2014;37:881–889.
75. Costa PT, McCrae RR. Normal personality assessment in clinical practice: the NEO personality Inventory. *Psychol Assess.* 1992;4:5–13.
76. Lee HB, Offidani E, Ziegelstein RC, et al. Five-factor model personality traits as predictors of incident coronary heart disease in the community: a 10.5-year cohort study based on the Baltimore epidemiologic catchment area follow-up study. *Psychosomatics.* 2014;55:352–361.
77. Swan GE, Carmelli D. Curiosity and mortality in aging adults: a 5-year follow-up of the Western collaborative group study. *Psychol Aging.* 1996;11: 449–453.
78. Bennett D. Eating disturbance as a manifestation of the stress process: a review of the literature. *Stress Med.* 1999;15:167–182.
79. Fredrikson M, Blumenthal JA. Serum lipids, neuroendocrine and cardiovascular responses to stress in healthy Type A men. *Biol Psychol.* 1992;34:45–58.
80. Lundberg U, Hedman M, Melin B, Frankenhaeuser M. Type A behavior in healthy males and females as related to physiological reactivity and blood lipids. *Psychosom Med.* 1989;51:113–122.
81. Weidner G, Sexton G, McLellarn R, Connor SL, Matarazzo JD. The role of type A behavior and hostility in an elevation of plasma lipids in adult women and men. *Psychosom Med.* 1987;49:136–145.
82. Folsom AR, Hughes JR, Buehler JF, Mittelmark MB, Jacobs DR, Grimm RH. Do type A men drink more frequently than type B men? Findings in the multiple risk factor intervention trial (MRFIT). *J Behav Med.* 1985;8:227–235.
83. Suls J, Sanders GS. Type A behavior as a general risk factor for physical disorder. *J Behav Med.* 1988;11:201–226.
84. Lodi-Smith J, Jackson J, Bogg T, et al. Mechanisms of health: education and health-related behaviours partially mediate the relationship between conscientiousness and self-reported physical health. *Psychol Health.* 2010;25: 305–319.
85. Lovallo WR, Pincomb GA, Wilson MF. Heart rate reactivity and type A behavior as modifiers of physiological response to active and passive coping. *Psychophysiology.* 1986;23:105–112.
86. Smith TW. Personality as risk and resilience in physical health. *Curr Dir Psychol Sci.* 2006;15:227–231.
87. Smith TW, MacKenzie J. Personality and risk of physical illness. *Annu Rev Clin Psychol.* 2006;2:435–467.
88. Evans PD. Type A behaviour and coronary heart disease: when will the jury return? *Br J Psychol.* 1990;81:147–157.
89. O'Dell KR, Masters KS, Spielmanns GI, Maisto SA. Does type-D personality predict outcomes among patients with cardiovascular disease? A meta-analytic review. *J Psychosom Res.* 2011;71:199–206.
90. Versteeg H, Spek V, Pedersen SS, Denollet J. Type D personality and health status in cardiovascular disease populations: a meta-analysis of prospective studies. *Eur J Prev Cardiol.* 2012;19:1373–1380.
91. Kupper N, Pedersen S, Höfer S, Saner H, Oldridge N, Denollet J. Cross-cultural analysis of Type D (distressed) personality in 6222 patients with ischemic heart disease: a study from the International HeartQoL Project. *Int J Cardiol.* 2013;166:327–333.
92. Coyne JC, de Voogd JN. Flawed meta-analysis of a flawed literature: commentary on Versteeg et al. *Eur J Prev Cardiol.* 2012;19:1381–1382.
93. Williams L, O'Connor RC, Howard S, et al. Type-D personality mechanisms of effect: the role of health-related behavior and social support. *J Psychosom Res.* 2008;64:63–69.
94. Gan Y, Gong Y, Tong X, et al. Depression and the risk of coronary heart disease: a meta-analysis of prospective cohort studies. *BMC Psychiatr.* 2014;14. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4336481/>.
95. Van der Kooy K, van Hout H, Marwijk H, Marten H, Stehouwer C, Beekman A. Depression and the risk for cardiovascular diseases: systematic review and meta analysis. *Int J Geriatr Psychiatr.* 2007;22:613–626.
96. Mols F, Denollet J. Type D personality among noncardiovascular patient populations: a systematic review. *Gen Hosp Psychiatr.* 2010;32:66–72.
97. Coyne JC, de Voogd JN. Are we witnessing the decline effect in the Type D personality literature? What can be learned? *J Psychosom Res.* 2012;73: 401–407.
98. de Voogd JN, Sanderman R, Coyne JC. A meta-analysis of spurious associations between type D personality and cardiovascular disease endpoints. *Ann Behav Med.* 2012;44:136–137.
99. Coyne JC, Jaarsma T, Luttik M-L, van Sonderen E, van Veldhuisen DJ, Sanderman R. Lack of prognostic value of type D personality for mortality in a large sample of heart failure patients. *Psychosom Med.* 2011;73:557–562.
100. Grande G, Romppel M, Barth J. Association between type D personality and prognosis in patients with cardiovascular diseases: a systematic review and meta-analysis. *Ann Behav Med.* 2012;43:299–310.
101. Kupper N, Denollet J. Explaining heterogeneity in the predictive value of Type D personality for cardiac events and mortality. *Int J Cardiol.* 2016;224: 119–124.
102. Horwood S, Anglim J. A critical analysis of the assumptions of Type D personality: comparing prediction of health-related variables with the Five Factor Model. *Pers Individ Differ.* 2017;117:172–176.
103. Denollet J, Feliuss R, Lodder P, et al. Predictive value of Type D personality for impaired endothelial function in patients with coronary artery disease. *Int J Cardiol.* 2018;259:205–210.
104. Steca P, D'Addario M, Magrin M, et al. A type A and type D combined personality typology in essential hypertension and acute coronary syndrome patients: associations with demographic, psychological, clinical, and lifestyle indicators. *PLoS One.* 2016;11. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5010181/>.
105. Kupper N, Denollet J. Type D personality as a risk factor in coronary heart disease: a review of current evidence. *Curr Cardiol Rep.* 2018;20:104.
106. Karlsson MR, Edström-Plüss C, Held C, Henriksson P, Billing E, Wallén NH. Effects of expanded cardiac rehabilitation on psychosocial status in coronary artery disease with focus on type D characteristics. *J Behav Med.* 2007;30: 253–261.
107. Delui MH, Yari M, khouyinezhad G, Amini M, Bayazi MH. Comparison of cardiac rehabilitation programs combined with relaxation and meditation techniques on reduction of depression and anxiety of cardiovascular patients. *Open Cardiovasc Med J.* 2013;7:99–103.