

## Original Article

# Relationship between Worry, and Anger Rumination with Cardiovascular Disease Severity: Social Loneliness as a Moderator

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**Introduction**

Cardiovascular disease (CVD) is one of the three leading causes of mortality and disability in the world and is becoming the main cause of disability in most countries. It is estimated that mortality resulting from CVD will rise from 16.7 million in 2002 to 23.3 million in 2030.<sup>1</sup> Different biological and psychosocial factors play a role in the development of CVD and its progression. These psychological risk factors include anxiety and depression and their symptoms such as anger rumination and worry.<sup>2,3</sup> For example, a relationship has been identified between anger and increased risk of heart disease<sup>4</sup> and it has been shown that anger and stress increase the risk of coronary heart disease and high blood pressure among healthy people and also lead to worse prognosis among heart patients.<sup>5</sup> However, one of the uncertainties in studies is to identify the nature of stress and to investigate the specific effects of chronic stress on CV events.

Rumination is a feature that makes people susceptible

to relatively stable patterns of thinking and behavior in different situations and times.<sup>6</sup> Rumination is often associated with negative thoughts that cause discomfort, depression, increasing aggression, and reducing psychological well-being.<sup>7</sup> Anger rumination is repeated thoughts about the causes and outcomes of anger,<sup>8</sup> and it is associated with maladaptive consequences such as increased anger, physiological arousal, and aggressive behavior.<sup>9</sup> Harmful worry and rumination have the same context, and both involve repetitive thoughts about negative subjects. Worry is thoughts about uncertainty about a possible future threat, while typically rumination involves repetitive thoughts about past negative events.<sup>10</sup> Worry,<sup>11</sup> and anger rumination<sup>12</sup> are associated with symptoms of anxiety and depression disorders. A number of studies have demonstrated that poor cardiac health has been associated with high levels of anxiety and depression.<sup>13,14</sup> On the other hand, repetitive negative thinking (worry and anger rumination) is a major component of chronic stress which

raises the risk for many serious health problems.<sup>6,7,15-18</sup> For example, it has been shown that repetitive negative thinking induction is associated with a significant increase in cortisol stress response.<sup>16,17</sup> Moreover, it has been observed that severe worry is associated with a significant decrease in heart rate variability.<sup>18</sup>

Existing studies on the specific effects of worry and anger rumination on the CV system are limited, and most studies focus on the effects of anxiety and depression disorders on this system, while only rumination and worry, without the diagnosis of a mental disorder, may affect the CV system. On the other hand, evidence on the effects of repetitive thoughts on cardiovascular symptoms is contradictory. For example, some studies have indicated that rumination is associated with increased cortisol stress response,<sup>16,17</sup> and some findings suggest a lack of correlation.<sup>19</sup> Also, results from studies of cardiovascular health effects caused by anxiety are controversial; some studies suggest an association between anxiety and increased risk of CVD,<sup>20</sup> and some suggest a lack of association between anxiety and mortality in cardiac patients.<sup>4</sup> Therefore, part of the goals of this study is to investigate the role of worry and anger rumination in predicting CVD severity.

Social isolation is known as another chronic stressor associated with CVD. It seems that social isolation can moderate the relationship between worry and anger rumination and CVD severity. Social connections and interactions can be predictors of physical and mental health.<sup>21,22</sup> The existing studies indicate that loneliness is associated with impaired biological processes, including high blood pressure and high blood lipids, and poor immune function.<sup>23</sup> Loneliness is associated with an increase in systolic blood pressure,<sup>24</sup> a decrease in CV contraction, heart rate, and cardiac output.<sup>24,25</sup> Findings from many studies indicate a relationship between social isolation and the progression of CVD and death due to this disease or any other cause<sup>26</sup>; however, the findings of some studies show opposite results.<sup>27</sup> Considering the role of psychosocial factors in CVD and lack of research on the relationship between worry, anger rumination and loneliness, and CVD severity and the contribution of each of these variables to CVD severity, as well as contradictory findings yielded in this regard, it is clear that further studies are essential in this field. Among CV patients, depression<sup>28</sup> and anxiety<sup>3</sup> and their symptoms such as worry, anger rumination, and social loneliness are common and lead to exacerbation of the disease, and vice versa,<sup>29</sup> necessitating further investigations. Accordingly, the present study aimed to assess the moderator role of social loneliness in the relationship between worry, anger rumination, and CVD severity.

## Material and Methods

### Study Design and Participants

Totally, 327 (138 women and 189 men,  $M = 52.39$  years

$\pm SD = 6.23$ ) CV patients who were hospitalized in Afshar Hospital in Yazd, Iran, enrolled in this cross-sectional study. The sampling method was purposive (non-random), involving all patients that fulfilled the inclusion criteria. The inclusion criteria were: suffering from CVD, age 20 to 70, not suffering from serious medical illnesses other than CVD, and willingness to participate in the study. The exclusion criteria were: suffering from a major psychiatric disorder and having substance dependence. The sampling duration of the study was six months. All subjects provided written informed consent prior to their inclusion in the study. In total, we collected data from 378 patients, but eventually the data of 327 questionnaires were analyzed and the rest of the questionnaires were excluded because they were not completed. In order to handle missing data, we contacted the participants and asked them to provide the missing values, when possible. To handle the rest of the missing data, we used the mean of the non-missing observations.

For the purpose of quality assurance in this study, we explained to the participants how to answer the questions on the questionnaire. To obtain the most accurate information, the subjects were assured of the confidentiality of their information. Required explanations were provided to clarify questions of the questionnaire that were unclear for the participants. In order to increase the validity of the answers, the questionnaires were arranged randomly in each copy. The researcher randomly controlled the answers of some questionnaires with the participants. Incomplete questionnaires or questionnaires that were probably not completed correctly were followed up and the subjects were asked to complete them again carefully. Someone other than the researcher randomly reviewed some data entered into the SPSS. Statistical analysis of data was performed twice.

### Assessments

Basic demographic data and the presence of traditional major cardiovascular risk factors were collected including age, sex, hypertension, dyslipidemia, diabetes mellitus, family history of premature CVD, body mass index (BMI), and current smoking status. Patients were considered to have type II diabetes mellitus if they were previously diagnosed and treated for diabetes and/or if they had a fasting blood glucose level of  $\geq 126$  mg/dL. Patients were considered to have hypertension if they had previously known hypertension, or if they were on antihypertensive therapy, or if they had a systolic blood pressure of  $\geq 140$  mm Hg and diastolic blood pressure of  $\geq 90$  mm Hg. BMI greater than or equal to 25, triglyceride level of greater than 200 mg/dL (2.8 mmol/L), and LDL greater than or equal to 130 mg/dL (3.4 mmol/L) were considered as abnormal indicators.

CVD severity in each patient was scored using the modified Gensini method.<sup>30</sup> In this scoring system, a

cumulative numeric score is determined by the degree of luminal narrowing and the anatomical location of each stenosis. The modified Gensini score has been described and validated previously.<sup>31</sup> The most severe stenosis in each of the eight coronary segments was graded from 1 to 4 (1 = 1% to 49% lumen diameter reduction; 2 = 50% to 74% stenosis; 3 = 75% to 99% stenosis; 4 = 100% occlusion) to give a total score ranging from 0 to 32. This score, therefore, gives a measure that combines both the severity and extent of coronary atherosclerosis.<sup>30</sup>

### Anger Rumination Scale

The 19-item Anger Rumination Scale (ARS) assesses tendencies to engage in repeated thoughts about anger-related experiences.<sup>8</sup> For all items, respondents indicated their agreement on a 4-point Likert scale. Higher summed scores indicate greater anger rumination. ARS has four subscales: angry afterthoughts, thoughts of revenge, angry memories, and understanding of causes. The psychometric properties of the ARS have approved in several studies.<sup>8,32</sup> In a sample of 833, the scale showed good internal consistency ( $\alpha = 0.95$ ) and test-retest reliability ( $r = 0.77$ ) for total score. Also, convergent and discriminant validity of the ARS was supported by significant correlations with measures of psychological symptoms and dysregulated behavior.<sup>32</sup>

### Penn State Worry Questionnaire

Worry was measured with the Penn State Worry Questionnaire (PSWQ), a 16-item self-report measure in which worry is rated on a 5-point Likert scale. The PSWQ has good internal consistencies (alphas of 0.88 or higher) and test-retest reliability ( $r = 0.74$ – $0.93$ ).<sup>33,34</sup>

### Multidimensional Scale of Perceived Social Support

The 12-item Multidimensional Scale of Perceived Social Support (MSPSS) assesses perceived social support with three subscales, each addressing a different source of support; (a) Family, (b) Friends, and (c) Significant Other.<sup>35</sup> Each item ranges from 1–7. The MSPSS was found to have good internal reliability across subject groups.<sup>35</sup>

### Statistical Analysis

Statistical analysis was conducted using SPSS (version 23). Means were given together with standard errors, and frequencies were expressed as percentages. The association between CVD severity, which was assessed by the Gensini score, and other variables was analyzed by correlation analysis. Regression analysis was also used to control demographic and clinical variables. The Hayes' Conditional Process Procedure,<sup>36</sup> which is a macro for SPSS, was employed to determine moderator effects. Hayes provides different types of model templates that show the moderating effect of a variable M on the relationship between an independent variable X and

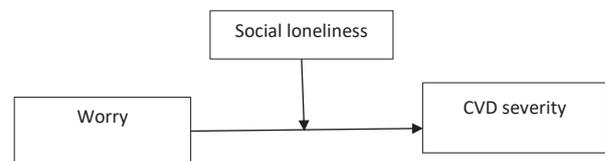
a dependent variable Y. In this paper, "Model 1" of the PROCESS Macro was selected to examine whether the correlation between worry and anger rumination and CVD severity is moderated by social loneliness. These moderating effects are visualized in Figures 1 and 2. Using Hayes' Process Macro in SPSS, the coefficients, standard errors and a 95% confidence interval (CI) were calculated. A moderator variable and its interaction with independent variables were entered into two models. Both models were estimated for 5000 bootstrapped samples.

### Results

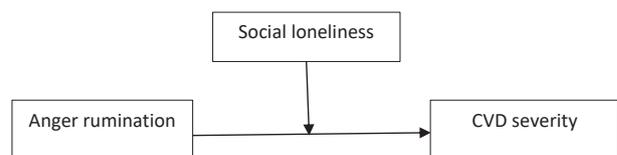
Table 1 provides a description of the demographic, medical factors, and variables of the study including worry, anger rumination, social support, and Gensini score for the participants.

Bivariate correlation coefficients between variables are shown in Table 2. The results showed a significant correlation between worry, anger rumination and social support with CVD severity ( $P < 0.01$ ).

Initially, using regression analysis, the effects of demographic and clinical variables were controlled and the residual variance of the CVD severity adjusted for age, sex, BMI, family history of the disease, diabetes, high cholesterol, high triglycerides, smoking, and pressure high blood pressure was used. The regression analysis showed a significant moderating effect of social loneliness on the correlation between worry and CVD severity, ( $\Delta R^2 = 0.007$ ,  $F(1,323) = 4.2870$ ,  $P < 0.05$ ). Therefore, we investigated whether the main effects or moderating effects were present. There was a statistically significant main effect for worry on the dependent variable ( $\beta = 0.32$ ,  $SE = 0.04$ ,  $95\% \text{ CI} = [0.2289, 0.4222]$ ,  $P < 0.001$ ), denoting that a positive value of worry is associated with an increase in CVD severity. Also, a main effect could be found for social loneliness on CVD severity ( $\beta = 0.46$ ,  $SE = 0.04$ ,  $95\% \text{ CI} = [0.3649, 0.5572]$ ,  $P < 0.001$ ). This implies that social



**Figure 1.** Moderating Effect of Social Loneliness on the Correlation between Worry and CVD Severity.



**Figure 2.** Moderating Effect of Social Loneliness on the Correlation between Anger Rumination and CVD Severity.

**Table 1.** Descriptive Characteristics of Participants

Characteristic	M	SD	Number	Percent
Age	52.39	6.23	–	–
Sex	–	–	–	–
Male	–	–	189	58
Female	–	–	138	42
Smoking	–	–	72	22
Family history of CVD	–	–	98	30
BMI	28.09	7.63	–	–
Abnormal BMI	–	–	122	37
LDL (mg/dL)	157.05	9.11	–	–
High LDL	–	–	94	29
Triglycerides (mg/dL)	278.67	9.43	–	–
High triglycerides	–	–	100	31
Glucose (mg/dL)	132.49	8.16	–	–
Type 2 diabetes	–	–	93	28
Diastolic BP (mm Hg)	111.04	5.47	–	–
Systolic BP (mm Hg)	161.12	7.18	–	–
Hypertension	–	–	217	66
Worry	54.44	12.31	–	–
Anger rumination	46.54	12.47	–	–
Social support	28.22	9.13	–	–
Gensini score	15.07	5.13	–	–

M, mean; SD, standard deviation; CVD, cardiovascular disease; BMI, body mass index; LDL, low-density lipoprotein; BP, blood pressure.

**Table 2.** Correlation Coefficient between Variables

Variables	Worry	Anger Rumination	Social Support	Gensini Score
Age	-0.13*	-0.08	0.08	0.11
Gender	0.06	0.19**	0.02	0.08
Smoking	0.12*	0.18**	-0.41**	0.53**
Family history of CVD	0.09	0.16**	0.07	0.14*
BMI	0.03	0.04	0.06	0.22**
High LDL	0.10	0.06	0.07	0.20*
High triglycerides	0.11	0.09	-0.05	0.24**
Diabetes	0.13*	0.34**	0.04	0.21**
Hypertension	0.21**	0.19**	-0.09	0.48**
Worry	1	0.37**	0.54**	0.59**
Anger rumination	–	1	0.42**	0.36**
Social Support	–	–	1	-0.65**
Gensini Score	–	–	–	1

BMI, body mass index; LDL, low-density lipoprotein.

\* $P < 0.05$ ; \*\* $P < 0.01$ .

**Table 3.** Moderation Analysis for the Moderator Role of Social Loneliness in the Relationship between Worry and CVD Severity

Predictors	R <sup>2</sup>	R <sup>2</sup> Change	β	SE	t	P	LLCI	ULCI
Worry (A)	–	–	0.325	0.049	6.62	0.00	0.2289	0.4222
Social loneliness (B)	–	–	0.461	0.048	9.43	0.00	0.3649	0.5572
Worry × Social loneliness (A × B interaction)	0.4972	0.0073	0.079	0.036	2.16	0.03	0.0074	0.1522

SE, standard error; LLCI, lower limit confidence interval; ULCI, upper limit confidence interval.

**Table 4.** Moderation Analyses for the Moderator role of Social Loneliness in the Relationship between Anger Rumination and CVD Severity

Predictors	R <sup>2</sup>	R <sup>2</sup> Change	β	SE	t	P	LLCI	ULCI
Anger rumination × social loneliness	0.3746	0.0060	0.068	0.038	1.76	0.07	-0.0080	0.1449

SE, standard error; LLCI, lower limit confidence interval; ULCI, upper limit confidence interval.

loneliness influences CVD severity positively. Further, the results of the analysis indicate the moderating effects of this variable on the relationship between worry and CVD severity ( $\beta = 0.07$ ,  $SE = 0.03$ ,  $95\% \text{ CI} = [0.0074, 0.1522]$ ,  $P < 0.001$ ), such that the worry-CVD severity relationship is stronger for individuals with a high level of social loneliness compared to individuals with a low level of social loneliness. The detailed results are shown in Table 3.

Table 4 displays moderation analyses for the moderator role of social loneliness in the relationship between anger rumination and CVD severity. As can be seen in Table 4, regression analysis did not show there a significant moderating effect for social loneliness, ( $\Delta R^2 = 0.006$ ,  $F(1,323) = 3.10$ ,  $P > 0.05$ ). Therefore, social loneliness did not have a moderator role in the relationship between anger rumination and CVD severity (Table 4).

### Discussion

The results of this study showed that there is a significant positive correlation between anger rumination and CVD severity. The results are consistent with earlier research.<sup>7,14,17,20</sup> It was also shown that there is a significant positive correlation between worry and CVD severity. This finding is consistent with the results of the studies conducted in this area.<sup>3,5,6,18</sup> Social loneliness had a moderator role in the relationship between worry and CVD severity.

Evidence suggests that repetitive thoughts are effective on the pathways of the CV system, the autonomic and endocrine system that are pathogenic pathways with long-term consequences. In particular, repetitive thoughts increase heart rate, blood pressure, and cortisol activity, and decrease heart rate variability.<sup>5</sup> Rumination and repetitive thoughts focus on problematic events and related emotions and the possible consequences of these events.<sup>6</sup> In explaining the mechanism of rumination effect on the CV system, some researchers suggest that rumination tends to create negative emotions (i.e. anger, sadness or anxiety) and these feelings increase the activity of the autonomic system (such as increased blood pressure).<sup>15</sup> Hyperactivity of the sympathetic nervous system may prolong negative emotions, which in turn leads to an increase in rumination.

Repetitive thoughts and worry may lead to illness and exacerbate it by prolonging the stress-related physiological activity, enhancing short-term response to stress, delaying recovery or re-activating the response to a stressor.<sup>7</sup> It is argued that repetitive thoughts mediate the relationship between stress and physical illness; when stressors persist in thought, physiological activation associated with stress is prolonged, resulting in vulnerability to stress-related illness.

In addition, evidence suggests that there is a relationship between rumination and eating unhealthy food such as cakes, chips, and sweets.<sup>37</sup> Also, rumination may be associated with insomnia,<sup>38</sup> poor interpersonal relationships, poor perceived health, and perceived stress.<sup>39</sup> It should be noted that worry is a risk factor in adjustment with an injury or loss and CV patients may be more likely to experience worry after developing this chronic illness and losing their physical health, due to their uncertainty about their future physical condition.<sup>40</sup> Worry and anger rumination are associated with anxiety and depression which affect the CV system. Anxiety can cause the activation of the hypothalamic-pituitary-adrenal axis and the sympathetic nervous system, which leads to increased release of catecholamine and endothelial cell damage, and ultimately atherosclerosis, coronary artery disease, and acute coronary events.<sup>28</sup> Depression is also associated with inflammatory processes, malfunctioning of the autonomic nervous system and damaged arterial flow that increase the risk of myocardial ischemia.<sup>14</sup> On the other hand, anxiety and depression are associated with an unhealthy lifestyle and poor adherence to health-related behaviors such as healthy diet, exercise, and smoking cessation.<sup>13,14</sup>

The results of this study showed that there is a significant positive correlation between social loneliness and CVD severity. It has also been shown that social loneliness has a moderating role in the relationship between worry and CVD severity, such that the worry-CVD severity relationship is stronger for individuals with high level of social loneliness than for individuals with low level of social loneliness. This finding is consistent with previous studies.<sup>23-27</sup> Loneliness can have harmful effects on health through behavioral, psychological and physiological mechanisms.<sup>24</sup> Studies recognize social support as a moderator between stress and later mental health.<sup>24</sup> The benefit of a network of social support includes receiving emotional attention, increasing the level of individual information, obtaining guidance, getting feedback from others, and improving the quality of life.<sup>22-25</sup> From a biological point of view, the sympathetic and hypothalamic-pituitary-adrenal nervous systems have a direct role in physical response to stress and the function of these systems depends on the social systems, especially the feeling of closeness and intimacy with others.<sup>27</sup> On the other hand, loneliness is associated with risk factors of CVD such as poor sleep quality,<sup>23</sup> depression symptoms,<sup>25</sup> and alcoholism.<sup>26</sup> For example, symptoms of depression

are associated with inflammation factors<sup>22</sup> and CVD, and in fact, this is a two-way relationship.<sup>25</sup> Loneliness is associated with high blood pressure<sup>23,25</sup> and reduction of CV contraction, heart rate variability and cardiac output.<sup>25</sup> Also, isolated individuals report more risk factors of CVD including the immune system, obesity, and unhealthy habits such as smoking, physical inactivity, and lack of sleep.<sup>21-23</sup>

#### Authors' Contribution

MAB: Study design, managing the entire study, and major revisions; SR: Data gathering and statistical analysis; HN: Monitoring medical aspects of study.

#### Conflict of Interest Disclosures

The authors have no conflicts of interest.

#### Ethical Statement

All subjects provided written informed consent prior to their inclusion in the study. The participants were briefly explained about the study process and its goals and also assured of the confidentiality of their personal information.

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#### References

1. Correll CU, Solmi M, Veronese N, Bortolato B, Rosson S, Santonastaso P, et al. Prevalence, incidence and mortality from cardiovascular disease in patients with pooled and specific severe mental illness: a large-scale meta-analysis of 3,211,768 patients and 113,383,368 controls. *World Psychiatry*. 2017;16(2):163-80. doi:10.1002/wps.20458
2. 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(11):936-46. doi: 10.1016/j.jacc.2008.11.044.
3. Roest AM, Martens EJ, de Jonge P, Denollet J. Anxiety and risk of incident coronary heart disease: a meta-analysis. *J Am Coll Cardiol*. 2010;56(1):38-46. doi: 10.1016/j.jacc.2010.03.034.
4. Suls J. Toxic affect: Are anger, anxiety, and depression independent risk factors for cardiovascular disease? *EMR*. 2018;10(1):6-17. doi:10.1176/ajp.150.4.
5. Emdin CA, Oduyayo A, Wong CX, Tran J, Hsiao AJ, Hunn BH. Meta-analysis of anxiety as a risk factor for cardiovascular disease. *Am J Cardiol*. 2016;118(4):511-9. doi: 10.1016/j.amjcard.2016.05.041.
6. Ottaviani C, Shapiro D, Davydov DM, Goldstein IB, Mills PJ. The autonomic phenotype of rumination. *Int J Psychophysiol*. 2009;72(3):267-75. doi: 10.1016/j.ijpsycho.2008.12.014.
7. Brosschot JF. Markers of chronic stress: Prolonged physiological activation and (un) conscious perseverative cognition. *Neurosci Biobehav Rev*. 2010;35(1):46-50. doi: 10.1016/j.neubiorev.2010.01.004.
8. Sukhodolsky DG, Golub A, Cromwell EN. Development and validation of the anger rumination scale. *Pers Individ Differ*. 2001;31(5):689-700. doi: 10.1016/S0191-8869(00)00171-9.
9. Besharat MA, Nia ME, Farahani H. Anger and major depressive disorder: The mediating role of emotion regulation and anger rumination. *Asian J Psychiatr*. 2013;6(1):35-41. doi: 10.1016/j.ajp.2012.07.013.
10. Watkins ER. Constructive and unconstructive repetitive thought. *Psychol Bull*. 2008;134(2):163. doi: 10.1037/0033-2909.134.2.163.

11. American Psychiatric Association. Diagnostic and statistical manual of mental disorders (DSM-5®). 5th ed. American Psychiatric Pub; 2013.
12. Kala P, Hudakova N, Jurajda M, Kasperek T, Ustohal L, Parenica J, et al. Depression and anxiety after acute myocardial infarction treated by primary PCI. *PLoS One*. 2016;11(4):e0152367. doi: 10.1371/journal.pone.0152367.
13. Bonnet F, Irving K, Terra JL, Nony P, Berthezène F, Moulin P. Anxiety and depression are associated with unhealthy lifestyle in patients at risk of cardiovascular disease. *Atherosclerosis*. 2005;178(2):339-44. doi: 10.1016/j.atherosclerosis.2004.08.035.
14. Gustad LT, Laugsand LE, Janszky I, Dalen H, Bjerkeset O. Symptoms of anxiety and depression and risk of acute myocardial infarction: the HUNT 2 study. *Eur Heart J*. 2013;35(21):1394-403. doi: 10.1093/eurheartj/eh387.
15. Kocsel N, Köteles F, Szemenyei E, Szabó E, Galambos A, Kökönyei G. The association between perseverative cognition and resting heart rate variability: A focus on state ruminative thoughts. *Biol Psychol*. 2019;145:124-33. doi: 10.1016/j.biopsycho.2019.04.004.
16. Byrd-Craven J, Granger DA, Auer BJ. Stress reactivity to co-rumination in young women's friendships: Cortisol, alpha-amylase, and negative affect focus. *JSPR*. 2011;28(4):469-87. doi: 10.1177/0265407510382319.
17. Vrshek-Schallhorn S, Velkoff EA, Zinbarg RE. Trait rumination and response to negative evaluative lab-induced stress: neuroendocrine, affective, and cognitive outcomes. *Cogn Emot*. 2019;33(3):466-79. doi: 10.1080/02699931.2018.1459486.
18. Chalmers JA, Heathers JA, Abbott MJ, Kemp AH, Quintana DS. Worry is associated with robust reductions in heart rate variability: a transdiagnostic study of anxiety psychopathology. *BMC Psychol*. 2016;4(1):32. doi: 10.1186/s40359-016-0138-z.
19. Ottaviani C, Thayer JF, Verkuil B, Lonigro A, Medea B, Couyoumdjian A, et al. Physiological concomitants of perseverative cognition: A systematic review and meta-analysis. *Psychol Bull*. 2016;142(3):231. doi: 10.1037/bul0000036.
20. Young EA, Nolen-Hoeksema S. Effect of ruminations on the saliva cortisol response to a social stressor. *Psychoneuroendocrinology*. 2001;26(3):319-29. doi:10.1016/s0306-4530(00)00059-7.
21. Wong ST, Wu A, Gregorich S, Pérez-Stable EJ. What type of social support influences self-reported physical and mental health among older women? *J Aging Health*. 2014;26(4):663-78. doi: 10.1177/0898264314527478
22. Taylor SE. Social support: A review. In: Friedman HS, ed. *The Oxford Handbook of Health Psychology*. Oxford University Press; 2011.
23. Holt-Lunstad J, Smith TB, Baker M, Harris T, Stephenson D. Loneliness and social isolation as risk factors for mortality: a meta-analytic review. *Perspect Psychol Sci*. 2015;10(2):227-37. doi: 10.1177/1745691614568352.
24. Grant N, Hamer M, Steptoe A. Social isolation and stress-related cardiovascular, lipid, and cortisol responses. *Ann Behav Med*. 2009;37(1):29-37. doi: 10.1007/s12160-009-9081-z.
25. Cacioppo JT, Hawkley LC, Crawford LE, Ernst JM, Bursleson MH, Kowalewski RB, et al. Loneliness and health: Potential mechanisms. *Psychosom Med*. 2002;64(3):407-17. doi: 10.1097/00006842-200205000-00005.
26. Segrin C. Indirect effects of social skills on health through stress and loneliness. *Health Commun*. 2019;34(1):118-24. doi: 10.1080/10410236.2017.1384434.
27. Birditt K, Antonucci TC. Life sustaining irritations? Relationship quality and mortality in the context of chronic illness. *Soc Sci Med*. 2008;67(8):1291-9. doi: 10.1016/j.socscimed.2008.06.029.
28. Cohen BE, Edmondson D, Kronish IM. State of the art review: depression, stress, anxiety, and cardiovascular disease. *Am J Hypertens*. 2015;28(11):1295-302. doi: 10.1093/ajh/hpv047
29. Riba M, Wulsin L, Rubenfire M, Ravindranath D. *Psychiatry and heart disease: the mind, brain, and heart*. West Sussex: John Wiley & Sons; 2012.
30. Gensini GG. A more meaningful scoring system for determining the severity of coronary heart disease. *Am J Cardiol*. 1983;51:606. doi: 10.1016/s0002-9149(83)80105-2.
31. Sullivan DR, Marwick TH, Freedman SB. A new method of scoring coronary angiograms to reflect extent of coronary atherosclerosis and improve correlation with major risk factors. *Am Heart J*. 1990;119(6):1262-7. doi: 10.1016/s0002-8703(05)80173-5.
32. Besharat MA, Hosseini S, Mohammad Mehr R, Azizi K. Reliability, validity and factor analysis of Anger Rumination Scale in Tehran University Students. *Journal of Research in Educational Systems*. 2009;5:21-9. doi: 10.22037/anm.v19i65.1338.
33. Brown TA, Antony MM, Barlow DH. Psychometric properties of the Penn State Worry Questionnaire in a clinical anxiety disorders sample. *Behav Res Ther*. 1992;30(1):33-7. doi: 10.1016/0005-7967(92)90093-v.
34. Startup HM, Erickson TM. The Penn State Worry Questionnaire (PSWQ). In: Davey GC, Wells A, eds. *Worry and its psychological disorders: Theory, assessment and treatment*. Wiley Online Library; 2006:101-19.
35. Zimet GD, Powell SS, Farley GK, Werkman S, Berkoff KA. Psychometric characteristics of the multidimensional scale of perceived social support. *J Pers Assess*. 1990;55(3-4):610-7. doi: 10.1080/00223891.1990.9674095.
36. Hayes AF. *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach*. 2nd ed. Guilford Publications; 2017.
37. Cropley M, Michalianou G, Pravettoni G, Millward LJ. The relation of post-work ruminative thinking with eating behaviour. *Stress Health*. 2012;28(1):23-30.
38. Harvey AG, Greenall E. Catastrophic worry in primary insomnia. *J Behav Ther Exp Psychiatry*. 2003;34(1):11-23. doi: 10.1016/s0005-7916(03)00003-x.
39. Kertz SJ, Woodruff-Borden J. Human and economic burden of GAD, subthreshold GAD, and worry in a primary care sample. *J Clin Psychol Med Settings*. 2011;18(3):281-90. doi: 10.1007/s10880-011-9248-1.
40. Eisma MC, Stroebe MS, Schut HA, Van Den Bout J, Boelen PA, Stroebe W. Development and psychometric evaluation of the Utrecht Grief Rumination Scale. *J Psychopathol Behav Assess*. 2014;36(1):165-76. doi: 10.1007/s10862-013-9377-y.