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Gelotophobia and indicators of subclinical cardiovascular symptoms amongst healthy subjects

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Abstract

The high morbidity and mortality associated with cardiovascular diseases (CVD) have led to an increasing extent of research into its aetiology. The main focus was initially on biological risk factors. Whilst these factors do account for half of the variances in cardiovascular disease risk, researchers have begun to focus on identifying the psychological and behavioural risk factors. Feeling socially excluded or rejected threatens people's mental and physical well-being. Arterial stiffening may underlie the association between social rejection and cardiovascular disease. This study aims to investigate the associations between fear of being laughed at (gelotophobia) as a sign of social rejection and indicators of subclinical cardiovascular symptoms—central arterial stiffness and to determine whether this association is independent of or mediated by anxiety. Methods: The demographic data (age, gender, education, marital status and occupation), smoking status and body weight were collected, and all the individuals were subjected to instrumental measurement of the condition of the arterial walls using applanation tonometry, EKG and blood pressure (BP) measurement. Data collection tools: A self-assessment questionnaire, measuring anxiety and gelotophobia, was used. Conclusions: In this study, individuals with a specific fear of being laughed at and ridiculed, who always perceive other persons' laughter as a threat, showed the higher pulse wave velocity. This is a confirmation of the idea that social rejection is a significant factor for CVD and confirmation of the usefulness of the assessment of gelotophobia in the process of clarifying social rejection. Recommendation: The study results support the idea that the fear of being laughed at (gelotophobia) can be used as a sign and predictor of social rejection and social isolation. On this point, the future research can be addressed to the creation of interventions for social rejection relief and early detection and reduction of subclinical cardiovascular symptoms, before cardiovascular health problems develop.

Keywords: Arterial stiffening, gelotophobia, pulse wave velocity, social rejection.

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1. Introduction

Cardiovascular diseases (CVD) are the main cause of morbidity and mortality in most of the countries worldwide. A linear relationship between elevated BP and cardiovascular events is well established. Atherosclerosis and arterial stiffening are the primary processes leading to cardiovascular disease (Bots, Dijk, Oren & Grobbee, 2002, Laurent et al., 2006; Lorenz, Markus, Bots, Rosvall & Sitzer, 2007). In addition, arterial stiffening—integrating the damage of risk factors on the aortic wall—is recognised as a marker and mediator of CVD. With this connection, carotid-femoral pulse wave velocity (PWV), which is an accepted non-invasive measure of arterial stiffness, is recommended for cardiovascular risk prediction amongst hypertensive patients in the European Guidelines.

The next group of factors connected to CVD is psychological, especially depression (Lane, Carrol, Ring, Beevers & Lip, 2000), anxiety (Nekouei, Yousefy, Manshaee & Nikneshan, 2011) and stress (Steptoe & Kivimäki, 2012). There are a lot of evidence which suggest that psychological factors, as independent risk factors, have an important role in physical chronic diseases, particularly coronary heart disease (Rafia & Naumana, 2012). On the other hand, biological and genetic factors and physical diseases are well known as important determinants of psychological disorders including depression. Noradrenalin, serotonin and dopamine neurotransmitters are accepted to be influential on depression (Aarabi, Abdi & Heydari, 2018). In addition, there are personality traits and emotions, which have been associated with the development of subclinical CVD, measured as carotid atherosclerosis or arterial stiffness. Some of the most investigated and discussed traits are hostility and fear of social rejection.

Cardiovascular reactivity connects to emotional stressors such as anxiety and social rejection. Psychosocial factors can affect the development of coronary artery disease and manifestations of coronary heart disease. According to many recent studies, stress and negative emotions alter several physiological processes relevant to this complex path physiology (Rozanski, Blumenthal & Kaplan, 1999). Psychosocial risk factors (hostility, depression and social isolation) might also contribute to coronary artery disease and coronary heart disease through behavioural pathways (Smith, Gallo, Shivpuri & Brewer, 2001), such as health habits (smoking and inactivity), and behavioural components of standard care (e.g. adherence to medication regimens and diet restrictions). Cardiovascular reactivity can be discussed as a mechanism linking psychosocial risk factors and coronary artery disease (Manuck, 1994). The significant and prolonged increases in BP and heart rate, as well as related cardiovascular changes, are hypothesised to initiate the development of coronary artery disease. One of the most common hypotheses regarding cardiovascular reactivity (Smith & Gerin, 1998) is that it is a mediating mechanism, by which psychosocial risk factors (social isolation, anger and trait hostility) affect coronary artery disease.

The social relationships are very important for the survival of mammalian species. In this connection, the social attachment system has adopted the neural computations of the anterior cingulate cortex, which is involved in pain and conflict detection. These processes support the social connectivity. According to animal research, in nonhuman primates, the magnitude of stress-induced increases in heart rate is associated with the severity of coronary atherosclerosis (Manuck, Kaplan, Adams & Clarkson, 1989). This model explains that the pharmacological blockade of sympathetically mediated cardiovascular reactivity eliminates the effects of chronic stress on initial endothelial injury and advanced lesions (Kaplan, Manuck, Adams, Weingand & Clarkson, 1987). These findings support the idea that physiological stress responses mediate the effect of psychosocial stress on coronary artery disease. The neuroimaging study (Eisenberge, Lieberman and Williams) examines the neural correlations of social exclusion. This study tests the hypothesis that the brain bases of social pain are similar to those of physical pain. The suggestions of the study are that social pain is analogous in its neurocognitive function to physical pain, alerting us when we have an injury to the social connections.

Much recent research indicated the social isolation and low levels of social support as a risk of CHD (Hazuda, 1994) and confirmed this association in a healthy population. The perception of social

isolation can be found not only in humans but also behaviour related to social isolation has been observed in animals (Cacioppo et al., 2015). Perceived social isolation has damaging effects on the physical health of both humans and animals by the activation of the hypothalamic–pituitary–adrenal axis and increased anxious and depressive behaviour. The overall rates of mortality due to loneliness and social isolation are 1.50, which is comparable to light smoking and greater than the risks due to obesity and hypertension (Holt-Lunstad, Smith & Layton, 2010). The recent studies indicate that social isolation, loneliness and living alone increase the possibility of death by 29%, 26% and 32%, respectively (Holt-Lunstad, Smith, Baker, Harris & Stephenson, 2015).

The concept of 'rejection sensitivity' refers to the individual differences in the perception of social rejection cues. It is defined as the disposition to anxiously expect and strongly react to social rejection (Downey & Feldman, 1996; Downey, Freitas, Michaelis & Khouri, 1998).

Social anxiety disorder is the most common anxiety disorder. According to the Diagnostic and Statistical Manual of Mental Disorders (Castillo et al., 2007, p. 456), social anxiety disorder is a 'marked and persistent fear of social or performance situations in which embarrassment may occur'. This fear may either be specific or generalised. The patients with social anxiety disorder withdraw from feared social situations even though they may realise that their fears are ungrounded. Anxiety-related symptoms of arousal (blushing, sweating, trembling, palpitations and nausea) are involved in the cognitive and behavioural aspects of the disorder. Similarly, to social anxiety disorder, gelotophobia includes fear of negative evaluation or confusion, a withdrawal from social interactions and anxiety-related symptoms of physiological arousal (Titze, 2009). Individuals with gelotophobia have a disposition to perceive other's laughter as a ridicule (Ruch & Proyer, 2008; Ruch, Hofmann, Platt & Proyer, 2014). Gelotophobia occurs in nonclinical populations as well as in psychiatric patients (Ruch & Proyer, 2009; Ruch, Proyer & Ventis, 2010). The concept of gelotophobia is related to the concept of social rejection and refers to the fear of being laughed at. According to Havranek et al. (2017), gelotophobia might be an overlooked symptom of social anxiety disorder and avoidant personality disorder and could be used as an additional diagnostic criterion for the two disorders. In this connection, it might be useful to investigate the relationship between gelotophobia and cardiovascular dysfunction in the context of anxiety-related symptoms of arousal and other significant correlations of anxiety with cardiovascular reactivity.

The aims of this study are to investigate the associations between fear of being laughed at (gelotophobia) as a sign of social rejection and indicators of subclinical cardiovascular symptoms—central arterial stiffness and to determine whether this association is independent of or mediated by anxiety.

2. Methods

2.1. Applanation tonometry

Arterial stiffness was evaluated with the tonometric method (PulsePen, DiaTecne, Milan, Italy) (Salvi et al., 2004). This method provides the estimates of PWV, where central systolic blood pressure (SBPcentr), central pulse pressure and pulse pressure amplification can be calculated.

The PWV measurements in duplicate were performed using a SphygmoCor apparatus (SphygmoCor system, AtCor Medical, Sydney, Australia) after a 10-minutes rest (supine position) (Laurent et al., 2006; Townsend et al., 2015). To reduce the effect of the circadian cycle, the participants were assessed at approximately the same time during the morning (Papaioannou et al., 2013). Measurements were performed on an empty stomach after instructions to refrain from any beverages of caffeine, ethanol and smoking at least 12 hours before the estimates. The measurement of arterial BP was preceded by a record of medical history and family history. PWV was registered between the carotid and femoral arteries in the supine position. The SphygmoCor probe over the carotid and femoral artery was used for non-invasive pulse measurements. Simultaneously, ECG record was

performed (Qureshi, Blaha, Nasir & Al-Mallah, 2013). The values of the distance from the carotid to femoral artery, measured directly between artery location and the supra-sternal notch, were entered into the SphygmoCor software database. PWV was automatically calculated using AtCor software.

2.2. Anxiety

Anxiety was measured by the Spielberger State-Trait Anxiety Inventory (STAI). The 40-item 4-point Likert scale was developed to measure anxiety in adults. The first subscale measures state anxiety and the second subscales measure trait anxiety (Spielberger, Gorsuch, Lushene, Vagg & Jacobs, 1983). Total scores obtained from the subscales range from 20 to 80 with higher scores indicating greater anxiety. In this study, the internal consistency of the STAI was very good; the Cronbach's alpha was 0.89 for state anxiety and 0.87 for trait anxiety.

2.3. Gelotophobia

GELOPH<46> (Ruch & Titze, 1998) - 46-item questionnaire was used for the subjective assessment of gelotophobia. Four-point answer scale (1 = strongly disagree, 2 = moderately disagree, 3 = moderately agree and 4 = strongly agree) is used. Using the factor analysis, Ruch and Proyer (2008) identified 15 items on the larger measurement as core items (the GELOPH<15>), which provide a reliable measure of gelotophobia. Ruch and Proyer (2009) reported that the overall score on the GELOPH<15> can be used as an indicator of gelotophobic tendencies from no gelotophobia (scores between 1.00 and 2.00) and borderline fearful (scores between 2.00 and 2.50) to a slight expression of gelotophobia (scores between 2.00 and 2.50), pronounced expression of gelotophobia (scores between 3.00 and 3.50) and extreme gelotophobia (scores above 3.50), which are scored on a scale of 0 (not present) to 4 (severe anxiety).

2.4. Demographical factors

Age, gender, smoking status, education, marital status and occupation were self-reported. Height and weight were used to determine the body mass index (BMI) in kilogrammes/meter squared (kg/m^2).

3. Participants and procedure

Fifty-five participants (43% men, 57% women, mean age 49.4 ± 8.0 years) were investigated. The participants were no hypertensive individuals (exclusion criteria were: BP >140/90 mmHg). People who took antihypertensive medications or other medications known to affect BP (e.g. β-blockers, thyroid, hormones or steroids) were excluded from the study. Participants with known cardiac conditions (e.g. heart failure, coronary artery disease and myocardial infarction) and known vascular conditions (e.g. peripheral vascular diseases) and those who were currently taking medications for a psychiatric disorder (e.g. schizophrenia or major depressive disorder) that may affect psychological measures were also excluded.

The study was conducted in Stara Zagora, Bulgaria, during March–June 2019. Before entering the study, all the participants provided written informed consent, conducted according to the principles of the Declaration of Helsinki (World Medical Association, 2001).

After the introduction to the study and collection of demographic data (age, gender, education, marital status and occupation), smoking status and body weight, all the individuals were subjected to instrumental measurement of the condition of the arterial walls using applanation tonometry, ECG and BP measurement. These operations were performed by a qualified physician, with the help of a few medical students. To reduce the effect of the circadian cycle, the participants were assessed at approximately the same time during the morning (Papaioannou et al., 2013). The instrumental

measurements were performed on an empty stomach after instructions to refrain from any beverages of caffeine, ethanol and smoking at least 12 hours before the estimates. The measurement of arterial BP was preceded by a record of medical history and family history. A self-assessment questionnaire, measuring anxiety and gelotophobia and conducted by a qualified psychologist, was handed out to the subjects after that.

4. Statistical analyses

The Statistical Package for the Social Sciences (SPSS) version 20.0 (IBM SPSS Corp.) was used for study statistical analyses. The significance was evaluated at the level of $p < 0.05$. Stratified percentages were used for descriptive statistics. The Pearson's correlation analysis was used to assess the relationship between study variables. A multiple linear regression was calculated to examine whether age, BMI, SBP, diastolic blood pressure (DBP), gelotophobia, state anxiety and trait anxiety were the significant independent predictors of arterial stiffness. To examine the internal consistency and test-retest reliability of the used scales, the Cronbach's alpha was examined.

5. Results

The psychological variables such as gelotophobia, state and trait anxiety were significantly related to each other. It was found that gelotophobia is related to state anxiety ($r = 0.43$, $p < 0.001$) and trait anxiety ($r = 0.48$, $p < 0.001$).

Arterial stiffness was associated with factors related to hypertension. Specifically, the higher levels of arterial stiffness were associated with higher age ($r = 0.63$, $p < 0.001$) and BMI ($r = 0.31$, $p = 0.005$).

Arterial stiffness did not differ by gender, education and smoking status.

Finally, higher arterial stiffness was also associated with higher SBP ($r = 0.48$, $p < 0.001$) and DBP ($r = 0.46$, $p < 0.001$).

The correlations of arterial stiffness and BP with psychological variables are shown in Table 1. Whilst arterial stiffness was not related to state anxiety, it was significantly related to gelotophobia and trait anxiety. SBP was related to state anxiety. DBP was not significantly related to any of the psychological variables.

Table 1. Correlation of arterial stiffness and BP with psychological variables ($n = 55$)

	cfPWV r(p)	SBP r(*p*)	DBP r(*p*)
State anxiety	0.16 (0.095)	0.21 (0.043)	0.04 (0.723)
Trait anxiety	0.31 (0.002)	0.08 (0.397)	0.13 (0.233)
Gelotophobia	0.28 (0.006)	0.19 (0.098)	0.12 (0.296)

The results of a multiple linear regression analysis are shown in Table 2. The multiple regression result showed that age, SBP, gelotophobia and trait anxiety were the significant independent predictors of arterial stiffness.

Table 2. Multiple regressions on arterial stiffness

	β	SE	*p*-value
Age	0.28	0.17	0.001
BMI	0.02	0.08	0.133
SBP	0.21	0.11	0.004
DBP	0.24	0.13	0.072
Gelotophobia	0.19	0.18	0.005
State anxiety	0.05	1.07	0.721
Trait anxiety	0.22	0.20	0.005

RSquare = 0.5372 ($F = 15.43$, $p < 0.0001$).

6. Discussion

This study shows that social rejection measured by a combination between anxiety and gelotophobia significantly predicted arterial stiffness as measured by cfPWV. Age is also a determinant of arterial stiffness (Lee & Oh, 2010). That is why it is important to control BP and age whilst assessing the effects of predictors on arterial stiffness. (Logan, Barksdale, Carlson, Carlson & Rowsey, 2012). On the other hand, trait anxiety and gelotophobia were significantly related to cfPWV. Many studies support the idea that arterial stiffness is identified as a causative factor for hypertension, and we can connect these findings with the conclusion that arterial stiffness may be a pathway to explain the connection between anxiety and hypertension risk. In addition, the results show that we can have in mind one more additional factor except anxiety—gelotophobia (as a manifestation of social rejection). We have to mention that the social rejection is a well-known factor connected with heart-related health problems (Compare et al., 2013).

The relationship between anxiety and arterial stiffness is discussed in a large number of studies, but the results are inconsistent (Lewis et al., 2010; Midei & Matthews, 2009; Yeragani, Tancer, Seema, Josyula & Desai, 2006). For example, Midei and Matthews (2009) have studied 156 Americans and have found that trait anxiety and arterial stiffness measured by cfPWV show a significant correlation. On the other hand, there are studies that have found different results—Lewis's et al. (2010) study with 2,488 older adults reported that anxiety symptoms were not related to cfPWV. We can discuss possible reasons for the lack of consistency. They could be the use of different measures for anxiety or exploring different age, cultural or sex groups. That means that it would be useful for future research to investigate the reliability of anxiety scales in connection to the health status of the subjects as well as the specific characteristics of different subgroups of people in their physiological reactions to anxiety and social rejection.

In this study, we are discussing the trait anxiety and the gelotophobia as strongly connected signs of social rejection. The interpretation of the results that these two factors are significant predictors of arterial stiffness may include the role of autonomic function as a mediator (Watkins, Grossman, Krishnan & Sherwood, 1998). Anxiety may induce an increase of sympathetic function and a decrease of parasympathetic function (Thayer, Friedman & Borkovec, 1996; Yeragani et al., 1993). The dysregulation of autonomic function can be connected to increased arterial stiffness (Williams, Din-Dzietham & Szklo, 2006). The previous studies have investigated associations between autonomic function and arterial stiffness in healthy adults and have found that arterial stiffness was related to heart rate variability. This relationship remained significant after controlling for age, BP and plasma noradrenaline levels. Based on these results, the authors conclude that arterial stiffness is related to the increased sympathetic activity (Nakao, Nomura, Karita, Nishikitani & Yano, 2004).

A recent systematic review of 16 prospective longitudinal studies shows that loneliness and social isolation are in correlation with increased risks of CHD (29%) and stroke (32%) (Valtorta, Kanaan, Gilbody, Ronzi & Hanratty, 2016). The association is similar to the connection between CVD anxiety and job stress, which are well-known risk factors for CHD. This finding supports the idea that loneliness and social isolation are additional risk factors of CVD (Holt-Lunstad & Smith, 2016). Gelotophobia is a specific variant of shame-bound anxiety which is a consequence of long-lasting consequences of exposure to ridicule and mockery (Platt, 2008; Titze, 2009). Physiological symptoms are racing heartbeat, muscle twitches, blushing, trembling and speech impediments (Titze, 2009). Papousek et al. (2014) found that individuals with gelotophobia showed a heart rate acceleration in response to laughter. As an extreme consequence, gelotophobic individuals avoid social interplay as a pathway to escape these feelings and remove themselves from others. According to these findings, we can conclude that it is worth to investigate gelotophobia as a predictor of social isolation and to explore its correlation to CVD.

One of the advantages of this approach is the possibility to generate ideas for specific target psychotherapeutic techniques which would be helpful for individuals suffering from CVD and having

gelotophobia features. For example, relaxation training could help the individual to know that although being autonomic, physical responses could be recognised and changed. According to the existing studies, deep breaths cause decrease in heart rate as well as minimise the feeling of anxiety (Podell, Mychailyszyn, Edmunds, Puleo & Kendal, 2010).

7. Conclusions and recommendations

In this study, individuals with a specific fear of being laughed at and ridiculed, who always perceive other persons' laughter as a threat, showed the higher PWV. This is a confirmation of the idea that social rejection is a significant factor for CVD and a confirmation of the usefulness of the assessment of gelotophobia in the process of clarifying social rejection.

The analysis of the correlation between social rejection and cardiovascular risk factors points out the ideas for novel therapeutic strategies, and the initiation of clinical interventions amongst the population at risk of developing heart disease, or in those already diagnosed with CVD.

The main benefit of this study is the accentuation on the fear of being laughed at (gelotophobia) as a sign and predictor of social rejection and social isolation. On this point, the future research can be addressed to the creation of interventions for social rejection relief and early detection and reduction of subclinical cardiovascular symptoms, before the development of cardiovascular health problems.

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