
This is the **accepted version** of the journal article:

Aluja, Anton [et al.]. «Biological correlates of the Toronto Alexithymia Scale (TAS-20) in cardiovascular disease and healthy community subjects».

Physiology and Behavior, Vol. 227 (2020), art. 113151 DOI 10.1016/j.physbeh.2020.113151

This version is available at <https://ddd.uab.cat/record/324782>

under the terms of the  license.

Biological correlates of the Toronto Alexithymia Scale (TAS-20) in cardiovascular disease and healthy community subjects

Anton Aluja^{a,b,*}, Olga Malas^b, Patricia Urieta^{a,b}, Fernando Worner^{b,c}, Ferran Balada^{b,d}

a University of Lleida, Catalonia, Spain

b Institute of Biomedical Research, Lleida, Catalonia, Spain

c Cardiology Service of the Hospital Arnau de Vilanova de Lleida, Spain

d Universitat Autònoma de Barcelona. Catalonia. Spain

*** Corresponding author at: University of Lleida, Avda. De l'Estudi General, 4, 25001 Lleida, Catalonia, Spain.**

E-mail address: anton.aluja@udl.cat (A. Aluja).

Abstract: This research studies the relationship between Alexithymia, behavioral, biometric, biochemical and cardiovascular risk. There were 602 participants (mean age of 52.82 ± 10.59) divided into two groups. The first was made up of 202 patients (165 males and 37 females) who had suffered a cardiovascular disease (CVD), while the second was composed of 400 (285 males and 115 females) healthy volunteers without CVD diagnosis. A cardiovascular risk index (CRI) was developed with the high factorial loading of the following variables: systolic and diastolic blood pressure, total cholesterol/HDL, triglycerides, body mass index, glucose and alcohol and tobacco consumption. The results showed a significant correlation between Alexithymia and the CRI. After controlling for age, sex, occupation, alcohol and tobacco consumption, this correlation decreased but remained significant for most values. Alexithymia predicted 6% of CRI in the entire sample, once age and sex effect were discounted. Alexithymic subjects with scores above a cut-off point set at higher than 60 had higher levels of glucose, systolic, diastolic, cholesterol/HDL and cardiovascular risk. We discuss that Alexithymia scores contribute to cardiovascular risk, supporting previous findings.

Key words: Alexithymia, TAS-20, body mass index, cholesterol, triglycerides, blood pressure.

1. INTRODUCTION

Alexithymia, *-or absence of words to express one's emotions-*, is an old psychological construct that integrates feelings related to difficulty in identifying subjective emotional feelings and distinguishing between feelings and the bodily sensations of emotional arousal, difficulty describing feelings towards other people, an impoverished fantasy life, and a stimulus-bound, externally oriented cognitive style (Sifneos, 1973; Nemiah, Freyberger & Sifneos, 1976). Alexithymia is also considered a tendency to focus on and amplify the somatic sensations that accompany emotional activation, related to the aetiology of various psychosomatic and psychiatric disorders (Porcelli et al., 2003; Todarello, Taylor, James, & Fanelli, 1995). Its prevalence was originally estimated at around 8 percent in men and 1.8 percent in women (Shipko, 1982). In a large study, Kokkonen et al. (2001) found a prevalence of 9,4% in male subjects, while in female subjects it was 5,2%. The alexithymia values were stable even in long follow-ups (Tomulen et al. 2011).

The standard self-reported scale used in Alexithymia psychological research is the Toronto Alexithymia Scale (TAS-20) developed by Bagby, Parker, and Taylor (1994a, 1994b). The TAS-20 factorial structure and reliability of the dimensions ‘difficulty identifying feelings’ (DIF) and ‘difficulty describing feelings’ (DDF) were replicated in many studies (Taylor, Bagby, & Parker, 2003). However, in most studies, the dimension ‘externally oriented thinking’ (EOT) appears to be unreliable (Kooiman, Spinhoven, & Trijsburg, 2002). Müller, Bühner, and Ellgring (2003) found that EOT could be divided into two separate factors [*Pragmatic Thinking* (PR) and *Lack of Importance of Emotions* (IM)].

People with high scores in Alexithymia (TAS-20) have been associated with biochemical alterations, such as high cholesterol levels, triglycerides, glucose or body mass index and blood pressure, related to psychosomatic disorders. De Berardis et al.

(2014) found that alexithymic patients had altered serum lipid levels in comparison with non-alexithymics and healthy controls. Lower high density lipoproteins (HDL) and the difficulty in identifying feelings dimension of the TAS-20 were associated with higher suicidal ideation. DDF is an important predictor of glucose control. Scoring higher on this factor is related to poorer glycaemic control at admission (Luminet, De Timary, Buysschaert, & Luts, 2006). Alexithymic people were found to have poorer nutrition and a sedentary lifestyle (Helmerts & Mente, 1999).

Body mass index was significantly and positively associated with the TAS-20 score. The association remained statistically significant after adjustment for potential covariables or confounders (sex, marital status and several socio-economic indicators) (Ramzi et al., 2018). In a study about Alexithymia, hypertension, and subclinical atherosclerosis in the general population, the authors found that Alexithymia may represent a relevant and independent risk factor for hypertension and carotid atherosclerosis at the population level. Alexithymia was significantly associated with hypertension and with atherosclerotic plaques (Grabe et al., 2010).

Karukivi, Jula, Hutri-Kähönen, Juonala, and Raitakari (2016) long-established the previous finding of alexithymic features being dependently and significantly associated with hypertension. The association of Alexithymia with hypertension has had a solid support in the specialized literature (Gage & Egan, 1984; Jula, Salminen, & Saarijärvi, 1999; Todarello et al., 1995). In the Metabolic Syndrome, Alexithymia was also significantly and separately associated with waist circumference and triglycerides. Lemche, Chaban, and Lemche (2010) found significant correlations between Alexithymia and diabetes type 2 and triglyceride levels in patients with metabolic syndrome. Correlations were also significant for high blood pressure levels. Linear regression models established the existence of linear relationships for the observed

correlations. Additionally, nonalcoholic fatty liver disease and cardiovascular diseases (CVDs) have common metabolic risk factors (Stepanova & Younossi, 2012).

Associations between liver enzymes and the incidence of cardiovascular events independent of alcohol intake have been described in several prospective studies. Particularly, gamma glutamyl transpeptidase (GGT) and alanine aminotransferase (ALAT) were related with CVD (Ghouri, Preiss, & Sattar, 2010).

The present study was designed with the aim of studying the relationship between Alexithymia and biological cardiovascular risk variables in a population with at least one episode of cardiovascular disease, and in a healthy population, according to previous findings. We expected, in line with the literature revised, a positive association between Alexithymia scores and biological variables such as body mass index, cholesterol, glucose, triglycerides, liver enzymes and hypertension. This relationship may be influenced by covariates such as age, sex, occupation and consumption of alcohol and tobacco.

2. METHOD.

2.1. Participants and procedure

There were 602 participants in this study (450 males and 152), who were between 18 and 72 years old, with a mean age of 52.82 (SD: 10.59). The participants were distributed in two groups. The first consisted of 202 patients (165 males and 37 females) who had suffered an acute cardiovascular disease (myocardial infarction or unstable angina) and had been admitted in the cardiology service of the University Hospital. The second group were healthy subjects or without CVD diagnosis and was comprised of 400 volunteers (285 males and 115 females) from the community, who had been subjected to a recent routine medical control.

The only exclusion criterion was the presence of mental illness according to the clinical history. To be a member of the group of healthy subjects, the absence of a history of cardiovascular diseases was required. All participants completed a protocol with sociodemographic, clinical and psychometric data after signing the consent. All subjects participated voluntarily and anonymously. The ethics committee of the University authorized this study (CEIC-18/2013). The psychometric and biometric data, including a blood sample, were taken by one of the researchers on the first day of admission to the hospital (CVD) or medical center (healthy subjects).

2.2. Measures

2.2.1. Biometric and biochemical variables

For the calculation of the Body Mass Index (BMI), the Quetelet index was used, which follows the following formula: $BMI = \text{weight in kilograms} / \text{height in meters squared}$ (Quetelet, 1842). In addition, by means of blood analysis with fasting from 8 to 12 hours, cholesterol (mg/dl – milligrams per decilitre), triglycerides (mg/dl) and glucose (mg/dl) were analysed, as well as liver function alanine transaminase (ALT), aspartate transaminase (AST) and gamma-glutamyltransferase (GGT). For cholesterol measurements, total cholesterol (CT, mg/dl) was obtained, as well as high and low density lipoproteins (HDL and LDL; mg/dl) and the atherogenic index (or Castelli Index), which consists in dividing total cholesterol by high density lipoproteins (Cholesterol/HDL ratio, mg/dl). We also obtained measures of systolic (SBP) and diastolic (DBP) blood pressure - *expressed in millimetres of mercury (mmHg)* - by means of a digital tensiometer in the arm.

Alcohol consumption was determined from the average weekly consumption of beers, wine and spirits transformed into Standard Beverage Units or SBU. SBU is

considered to be 10 grams of alcohol. For example, 1 glass of wine or champagne = 1 SBU (100 ml), 1 beer = 1 SBU (250 ml), or ½ glass of liquor = 1 SBU (25 ml). Smokers were asked how many cigarettes they smoked per day.

2.2.2. *Toronto Alexithymia Scales (TAS-20)*

The TAS-20 is a 20-item self-report instrument rated on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) (Bagby, Parker, & Taylor, 1994a, 1994b). The three factors include difficulty identifying feelings (DIF), difficulty describing feelings (DDF) and externally-oriented thinking (EOT). We used a validated Spanish version published by Martínez-Sánchez (1996). The cut-off point to be considered alexithymic was determined as 60 or higher (Sayar & Gulec, 2001).

2.2.3. *The Brief Symptom Inventory (BSI)*

The Brief Symptom Inventory (BSI) (Derogatis, 1975) is a 53-item self-report questionnaire designed to offer a rapid screening of the symptoms of psychological disorders. We used a Spanish adaptation of the BSI by Ruipérez, Ibáñez, Lorente, Moro, and Ortet, (2001). In this research, we only used the Somatization, Anxiety, Depression and Hostility scales the alpha values being 0.88 for Somatization, 0.75 for Depression, 0.72 for Anxiety and 0.74 for Hostility.

2.2.4. *Cardiovascular risk index*

With the biometric, biochemical and alcohol/tobacco consumption variables related with cardiovascular risk used in this study, an analysis of the principal components analysis (PCA) using all subjects of a non-rotated factor was carried out with the objective of computing the different variables with greater factor loading in z scores.

Then, a cut-off point of 0.30 was established to isolate the variables with a greater factor loading, and therefore more closely related to each other, to form a cardiovascular risk index (CRI). The variables included in the index were: cholesterol total/HDL ratio, systolic blood pressure, triglycerides, diastolic blood pressure, body mass index, glucose, alcohol consumption and number of cigarettes smoked per day (Table 1).

3. RESULTS

3.1. Demographic variables

Mean ages were 57.83 (SD: 8.49) for the CVD group and 54.30 (SD: 10.66) for the healthy group ($d = 0.353$). There were no differences in marital status (χ^2 : 5.70, d.f.: 4, χ^2 /df: 1.43, $p < 0.232$), but occupation variables were different in CVD and healthy subjects (χ^2 : 84.30, d.f.: 4, χ^2 /df: 21.08, $p < 0.001$) (active, unemployed, retired, others). No differences were found in the education variable (university, high school and primary school).

3.2. Factor analysis of Toronto Alexithymia Scale (TAS-20)

The factor structure of the TAS-20 items was analysed with the entire complete sample using the same method of extraction and rotation as in the original study by Bagby et al., (1994a), Principal Components (PC) and Varimax rotation. Initially, the structure was forced to three factors to calculate the factorial congruence with the original structure of three factors. The variance accounted for was 45%. F-I: 24.42%, F-II: 12.09% and F-III: 8.49 (see appendix, A.1). The first factor (DDF) had a congruence of 0.96 with the first original factor, the second factor (DIF) had a congruence of 0.93 and third factor (EOT) had a congruence of 0.78. The EOT factor had three items with insufficient factorial loadings on its original factor or high loading on the others. This

factor was different, which was the reason for the low congruence. Using the factor extraction criteria of Parallel Analysis (Horn, 1965), the extraction of four factors was deemed advisable (see appendix, A.2), and the analysis was repeated with four factors. This structure showed that the original EOT factor was divided into two factors, one comprising of items 5, 10, 18 and 19, and the other of items 8, 15, 16 and 20. The two separate EOT factors resembled the *Pragmatic Thinking* (PR) and *Lack of Importance of Emotions* (IM) obtained by Müller et al., (2003). When we used these two EOT factors as variables (EOT1 and EOT2), the four factors accounted for 51.57% of the total variance (see appendix, A.3).

To confirm the four-factor exploratory structure, a Confirmatory Factor Analysis (CFA) was performed using different goodness-of-fit indices to check the dimensionality of the scale (Aluja, Blanch & García, 2005; Aluja, Rolland, García & Rossier, 2007). The values obtained were the Non-Normed Fit Index (NNFI, Tucker & Lewis) = 0.982, the Root Mean Square Error of Approximation (RMSEA) = 0.031, the Comparative Fit Index (CFI) = 0.989, and the Adjusted Goodness of Fit Index (AGFI) = 0.984. All of them indicated an adequate adjustment to the data. The total congruence coefficient of 0.93 between the two factorial matrices (CVF and healthy) of the TAS-20 scale demonstrates their equivalence. Only factor II obtains a congruence coefficient slightly less than 0.90 (0.89) (see appendix, A.4). α reliabilities for the four factors were DDF: 0.82, DIF: 0.72, EOET1: 0.72, EOET2: 0.59 and TAS-20: 0.81.

3.3. Descriptive statistics and differences between CVD and healthy groups

Table 2 shows the descriptive statistics and differences between patients with CVD and healthy subjects in the biological and psychometric variables. The group of CVD patients obtained significantly lower levels in LDL and HDL and significantly

higher values in the other variables analysed, except in diastolic blood pressure and GGT, which were not significant. Note that the cardiovascular risk index (0.59 versus -0.30, $d = 0.982$), number of cigarettes per day (10.25 vs 4.5; $d = 0.681$) and Alexithymia (51.62 vs 46.35; $d = 0.578$) were also significantly higher in the CVD group. The CVD group also obtained high and significant scores in psychopathological variables.

3.4. Correlational analysis and linear regression analysis

Table 3 shows the inter-correlations between different biochemical variables and with the cardiovascular risk index (CRI). The correlations are the expected ones knowing the previous relationships between these variables, which gives validity to the data. ALAT and GGT correlate positively with the CRI and particularly with Cholesterol/HDL ratio and triglycerides. Table 4 shows the Pearson correlation between the total score in TAS-20 and CRI. The results shows that alexithymic people have higher cardiovascular risk ($r = 0.17$; $p < 0.01$), higher glucose levels ($r = 0.24$, $p < 0.001$), higher GGT ($r = 0.09$, $p < 0.05$), lower HDL ($r = -0.19$, $p < 0.01$), LDL ($r = -0.09$; $p < 0.05$), and a higher cholesterol/HDL ratio ($r = 0.10$, $p < 0.05$) and systolic blood pressure ($r = 0.13$, $p < 0.01$). Notice that all four TAS-20 factors correlated with the CRI. After controlling for age, sex, occupation and alcohol and tobacco consumption, the correlation between TAS-20 and biological variables descended, but most remained significant. Table 5 shows correlations between TAS-20 and BSI Depression Anxiety, Hostility and Somatization scales for both groups. TAS-20 total score obtained higher and significant correlations with the four BSI scales.

A multiple linear regression analysis is presented in Table 6. The cardiovascular risk index (CRI) is taken as a dependent variable and the TAS-20 factors, sex and age as independent variables. The variance accounted for was 14% and the TAS-20 factors

accounted for a not insubstantial 6% (excluding sex and age). However, when a regression analysis was conducted separately for the group of healthy subjects, the same variables accounted for 25% of the variance of the CRI (10%, excluding sex and age), and the p -value of EOT1 and EOT2 was 0.01 and 0.04, respectively (Tables A1-A4).

3.5. *Biological differences in alexithymic and non-alexithymic groups*

Figure 1 compares the means obtained by subjects with a score of over 60 in the TAS-20 with subjects with a score of 60 points or less. In the whole sample there are 10.8% of alexithymic subjects, 6.5% in the healthy sample and 19.3% in the CVD sample. In order to see the means in a bar chart, the biochemical values have been converted into T-scores. As can be seen, subjects with high scores at the 60 cut-off point have higher levels of Cholesterol/HDL ratio, glucose, systolic, diastolic and cardiovascular risk index ($p < 0.001$). Triglycerides show the same tendency, but do not reach statistical significance ($p < 0.10$).

4. DISCUSSION

In this study comparative analysis indicates that the group of CVD patients presents significantly higher values in all the variables analysed (including psychopathology), with the exception of diastolic blood pressure and GGT. Pearson correlational analysis indicates that there is a significant relationship between Alexithymia and the cardiovascular risk index scores and particularly with glucose, HDL (negative), GGT, cholesterol and systolic blood pressure (positive). After controlling for several co-variables or confounders such as sex, age, occupation and alcohol/tobacco consumption, these correlations descended but remained significant for CRI, Glucose, HDL and systolic blood pressure. DIF conserves a p -value signification

with GGT and DDF with Cholesterol/HDL ratio. The DDF and EOT2 scales account for 6% of the variance of the total cardiovascular risk, excluding sex and age. These differences are confirmed when comparing people with extreme scores higher than 60 in TAS-20 with those who obtain scores below 60. Notice that in study we used a 4-factor version of the TAS-20 scale that best fits our data and in which the OET factor is broken down into two factors.

These findings are consistent with similar studies (Deary, Scorr & Wilson, 1997, Lumley & Norman, 1996). Alexithymic individuals with panic disorders show a cholesterol dysregulation that may be linked to suicide ideation (De Berardis et al., 2013). Diabetic patients reported significantly higher Alexithymia scores than the normal population (Markus, Katrin, Lisa, & Bernd, 2018) and scoring higher on DDF factor is related to poorer glycemic control at admission (Luminet, De Timary, Buysschaert & Luts, 2006). In our study, both dyslipidemia and hyperglycemia were related with Alexithymia.

Alexithymia was also significantly associated with hypertension (Gage & Egan, 1984; Jula, Salminen & Saarijärvi, 1999; Karuviri et al., 2016; Todarello et al., 1995) and with atherosclerotic plaques (Grabe et al., 2010). In this study, alexithymia has a positive correlation with systolic but not with diastolic blood pressure. Nevertheless, alexithymic participants, higher than 60 in TAS scores, showed higher diastolic blood pressure than the non alexithymic participants. It is well known that systolic pressure has a large effect on adverse cardiovascular events than diastolic pressure, although systolic and diastolic hypertension influenced them (Flint et al., 2019).

Alexithymic people take less care of their state of health or lead an unhealthy lifestyle. In other words, it is possible that alexithymic people lead a lifestyle that is not very beneficial for cardiovascular health (Helmers & Mente, 1999). In this study, the

average values (both groups) of alcohol and tobacco consumption are not excessively high. This could explain that the effect on cardiovascular risk, although it is important, has had little influence on the relationship between Alexithymia and the biological variables.

According to Rueda and Perez García (2007), alexithymic people tend to present emotional problems, such as anxiety, depression and hostility. These data are also confirmed in this study. These emotional problems also involve neglect of physical appearance and diet, and the use of alcohol/tobacco. The tendency towards obesity of alexithymic subjects has also been demonstrated (Adami, Campostano, Ravera, Leggieri, Scopinaro 2001; Kojima, Frasure-Smith, & Lespérance, 2001), as has the relationship of Alexithymia with hostility (Rueda, Pérez- García, Sanjuán, & Ruiz, 2007).

Alexithymia is a negative prognostic indicator for many psychological treatments, particularly those that focus on insight, emotional awareness, and a close alliance with a therapist. Alexithymia appears to have negative health implications, either by altering physiology, prompting symptom reporting, supporting unhealthy and compulsive behaviors, or by interfering with response to some treatments. Early detection of these emotional deficits can contribute to the prevention or treatment of cardiovascular disease.

The main strength of the present study is the broad sample, number and consistency of the biological and psychometric data provided. The Brief Symptom Inventory (Derogatis, 1975), could be considered old. However, this instrument is considered a classic on psychopathological symptoms and continues to be used.

One limitation, however, is that the correlational nature of the study does not allow us to establish a causal relationship between Alexithymia and the appearance of

cardiovascular risk factors, lifestyle, or symptomatology. However, more variables related to unhealthy lifestyle should be included, such as diet, sitting time, physical exercise or diabetes, medication, as well as alcohol and tobacco consumption. Nevertheless, the higher levels of cardiovascular risk, including the cholesterol/HDL ratio, triglycerides, glucose, and blood pressure in high Alexithymia subjects, suggests a relationship with cardiovascular disease in line with previous results.

A limitation of the present study was the control for covariates such as age is not generally appropriate in the absence of random assignment. When group membership is determined none randomly, there is typically no thorough basis for determining if the difference reflects random error or a true group difference (Miller & Chapman, 2001). Besides, unequal sample size of patients with CVD and healthy controls can result in a loss of statistical power.

In short, besides involving a deficit in the regulation and representation of emotions, Alexithymia is linked with a worse state of physical and emotional health. These data have been validated by the correlations between Alexithymia and the biological variables included in the cardiovascular risk index founded in previous studies. Alexithymia and the associated variables may increase the possibility of developing some type of cardiovascular disorder. However, this relationship does not show causality. The early detection of subjects high in Alexithymia may be useful in cardiovascular risk prevention programs.

5. REFERENCES

- Adami, G.F., Campostano, A., Ravera, G., Leggieri, M., & Scopinaro, N. (2001). Alexithymia and body weight in obese patients. *Behavioral Medicine*, 27, 121-126. doi: 10.1080/08964280109595778
- Aluja, A., Rolland, J.P., García, L.F., & Rossier, J. (2007). Dimensionality of the Rosenberg self-esteem scale and its relationships with the three - and the five - factor personality models. *Journal of Personality Assessment*. 88(2), 246-249. doi: 10.1080/00223890701268116
- Aluja, A., Blanch, A., & García, L.F. (2005). Dimensionality of the Maslach Burnout Inventory in School Teachers: A Study of Several Proposals. *European Journal of Psychological Assessment*, 21(1), 67-76. doi: 10.1027/1015-5759.21.1.67
- Bagby, R.M., Parker, J.D., & Taylor, G.J. (1994a). The twenty-item Toronto Alexithymia Scale: I. Item selection and cross-validation of the factor structure. *Journal of Psychosomatic Research*, 38, 23-32. doi: 10.1016/0022-3999(94)90005-1
- Bagby, R.M., Taylor, G.J., & Parker, J.D. (1994b). The twenty-item Toronto Alexithymia Scale: II. Convergent, discriminant, and concurrent validity. *Journal of Psychosomatic Research*, 38, 33-40. doi: 10.1016/0022-3999(94)90006-X
- Buja, A., & Eyuboglu, N. (1992). Remarks on parallel analysis. *Multivariate Behavioral Research*, 27(4), 509-540. doi:10.1207/s15327906mbr2704_2
- Cohen, J. (1988). Statistical power analysis for the behavioural sciences, 2nd edn. (Hillsdale, NJ: L. Erlbaum Associates).
- De Berardis, D., Serroni, N., Marini, S., Rapini, G., Carano, A., Valchera, A., ... & Perna, G. (2014). Alexithymia, suicidal ideation, and serum lipid levels among

- drug-naïve outpatients with obsessive-compulsive disorder. *Revista Brasileira de Psiquiatria*, 36(2), 125-130. doi: 10.1590/1516-4446-2013-1189
- Deary, I.J., Scott, S., & Wilson, J.A. (1997). Neuroticism, alexithymia and medically unexplained symptoms. *Personality and Individual Differences*, 22, 551-564. doi: 10.1016/S0191-8869(96)00229-2
- Derogatis, L. (1975). Brief Symptom Inventory (Baltimore, Clinical Psychometric Research). *Psychopathology*, 27(1-2), 14-18. doi: 10.1016/S0191-8869(96)00229-2
- Flint, A. C., Conell, C., Ren, X., Banki, N. M., Chan, S. L., Rao, V. A., Melles, R. B., & Bhatt, D. L. (2019). Effect of Systolic and Diastolic Blood Pressure on Cardiovascular Outcomes. *The New England journal of medicine*, 381(3), 243–251. <https://doi.org/10.1056/NEJMoa1803180>
- Gage, B.C., & Egan, K.J. (1984). The effect of Alexithymia on morbidity in hypertension. *Psychotherapy and Psychosomatics*, 41, 136-144. doi: 10.1159/000287801
- Ghouri, N., Preiss, D., & Sattar, N. (2010). Liver enzymes, nonalcoholic fatty liver disease, and incident cardiovascular disease: a narrative review and clinical perspective of prospective data. *Hepatology*, 52(3), 1156-116. doi: 10.1002/hep.23789
- Grabe, H. J., Schwahn, C., Barnow, S., Spitzer, C., John, U., Freyberger, H. J., ... & Völzke, H. (2010). Alexithymia, hypertension, and subclinical atherosclerosis in the general population. *Journal of Psychosomatic Research*, 68(2), 139-147. doi: 10.1016/j.jpsychores.2009.07.015

- Helmers, K.F., & Mente, A. (1999). Alexithymia and health behaviors in health male volunteers. *Journal of Psychosomatic Medicine*, 47, 635-645.
doi: 10.1016/S0022-3999(99)00067-7
- Horn J. L. (1965). A rationale and test for the number of factors in factor analysis. *Psychometrika*, 30, 179–185. <https://doi.org/10.1007/BF02289447>
- Jula, A., Salminen, J.K., & Saarijärvi, S. (1999). Alexithymia: A facet of essential hypertension. *Hypertension*, 33, 1057-1061. doi: 10.1161/01.HYP.33.4.1057
- Karukivi, M., Jula, A., Hutri-Kähönen, N., Juonala, M., & Raitakari, O. (2016). Is alexithymia associated with metabolic syndrome? A study in a healthy adult population. *Psychiatry Research*, 236, 58-63. doi: 10.1016/j.psychres.2015.12.034
- Kojima, M., Frasere-Smith, N., & Lespérance, F. (2001). Alexithymia following myocardial infarction psychometric properties and correlates of the Toronto Alexithymia Scale. *Journal of Psychosomatic Research*, 51, 487-495. doi: 10.1016/S0022-3999(01)00253-7
- P. Kokkonen, J.T. Karvonen, J. Veijola, K. Läksy, J. Jokelainen, (2001) Perceived and sociodemographic correlates of alexithymia in a population sample of young adults, *Comprehensive Psychiatry* 42 (6) 471–476,
doi:10.1053/comp.2001.27892.
- Kooiman, C. G., Spinhoven, P., & Trijsburg, R. W. (2002). The assessment of alexithymia: a critical review of the literature and a psychometric study of the Toronto Alexithymia Scale-20. *Journal of psychosomatic research*, 53(6), 1083-1090. doi: 10.1016/S0022-3999(02)00348-3
- Lemche, A. V., Chaban, O. S., & Lemche, E. (2010). P02-310-Alexithymia predicts triglyceride level, systolic blood pressure, and diabetic status in metabolic

syndrome. *European Psychiatry*, 25, 1019. doi: 10.1016/S0924-9338(10)71009-

9

Luminet, O., De Timary, P. H., Buysschaert, M., & Luts, A. (2006). The role of alexithymia factors in glucose control of persons with type 1 diabetes: a pilot study. *Diabetes and Metabolism*, 32(5), 417-424. doi: 10.1016/S1262-3636(07)70299-9

Lumley, M.A., & Norman, S. (1996). Alexithymia and health care utilization. *Psychosomatic Medicine*, 58, 197-202. doi:10.1097/00006842-199605000-00001

Markus, S., Katrin, N., Lisa, F., & Bernd, H. (2018). Alexithymia in Type I and Type II Diabetes. *Interventions Obes Diabetes*. 1(3). doi: 10.31031/IOD.2018.01.000512

Martínez- Sánchez, F. (1996). The Spanish version of the Toronto Alexithymia Scale (TAS-20). *Clínica y Salud*, 7(1), 19– 32.

Miller, G. A., & Chapman, J. P. (2001). Misunderstanding analysis of covariance. *Journal of abnormal psychology*, 110(1), 40. DOI: 10.1037//0021-843X.110.1.40

Müller, J., Bühner, M., & Ellgring, H. (2003). Is there a reliable factorial structure in the 20-item Toronto Alexithymia Scale? A comparison of factor models in clinical and normal adult samples. *Journal of Psychosomatic Research*, 55, 561-568. doi: 10.1016/S0022-3999(03)00033-3

Nemiah, J.C., Freyberger, H., & Sifneos, P.E. (1976). Alexithymia: a view of the psychosomatic process. In: Hill OW, editor. Modern trends in psychosomatic medicine, vol. 2. London: Butterworth, 1976. pp. 26– 34. doi: 10.1017/S0033291700045475

- Porcelli, P., Bagby, M., Taylor, G.J., De Carne, M., Leandro, G., & Todarello, O. (2003). Alexithymia as predictor of treatment outcome in patients with functional gastrointestinal disorders. *Psychosomatic Medicine*, 65, 911-918. doi: 10.1097/01.PSY.0000089064.13681.3B
- Quetelet, A. (1842). A Treatise on Man and the Development of his Faculties. *Originally published in 1842. Reprinted in 1968 by*. Burt Franklin, New York. doi: 10.1002/j.1550-8528.1994.tb00047.x
- Ramzi, N. H., Yiorkas, A. M., Sebert, S., Keinänen-Kiukaanniemi, S., Ala-Mursula, L., Svento, R., ... & Dovey, T. M. (2018). Relationship between BMI and emotion-handling capacity in an adult Finnish population: The Northern Finland Birth Cohort 1966. *PloS one*, 13(9), e0203660. doi: 10.1371/journal.pone.0203660
- Rueda, B., & García, A. M. P. (2007). Estudio de la alexitimia y de los procesos emocionales negativos en el ámbito de los factores de riesgo y la sintomatología cardiovascular. *Revista de Psicopatología y Psicología Clínica*, 12(2), 105-116. doi: 10.5944/rppc.vol.12.num.2.2007.4037
- Rueda, B., Pérez-García, A.M., Sanjuán, P., y Ruiz, M.A. (2007). Relación entre alexitimia y hostilidad: ¿Una asociación influida por el malestar psicológico? *Análisis y Modificación de Conducta*, 32, 263-286.
- Ruiperez, M. A., Ibáñez, M. I., Lorente, E., Moro, M., & Ortet, G. (2001). Psychometric properties of the Spanish version of the BSI - Contributions to the relationship between personality and psychopathology. *European Journal of Psychological Assessment*, 17(3), 241-250. doi:10.1027//1015-5759.17.3.241
- Sayar, K., & Gulec, H., Ak.I. (2001). Reliability and Validity Study of Toronto Alexithymia Scale. 37th National Psychiatry Symposium, Istanbul; October 2–6, 2001:130

- Shipko, S (1982). Alexitimia and somatization. *Psychotherapy and Psychosomatics*, 37, 193. doi: 10.1159/000287573
- Sifneos, P.E. (1973). The prevalence of 'alexithymic' characteristics in psychosomatic patients. *Psychotherapy and Psychosomatic*, 22, 255-262. doi: 10.1159/000286529
- Stepanova, M., & Younossi, Z. M. (2012). Independent association between nonalcoholic fatty liver disease and cardiovascular disease in the US population. *Clinical Gastroenterology and Hepatology*, 10(6), 646-650. doi: 10.1016/j.cgh.2011
- Taylor, G. J., Bagby, R. M., & Parker, J. D. (2003). The 20-Item Toronto Alexithymia Scale: IV. Reliability and factorial validity in different languages and cultures. *Journal of psychosomatic research*, 55(3), 277-283. doi: 10.1016/S0022-3999(02)00601-3
- Todarello, O., Taylor, G.J., James, D.A., & Fanelli, M. (1995). Alexithymia in essential hypertensive and psychiatric outpatients: A comparative study. *Journal of Psychosomatic Research*, 39, 987-994. doi: 10.1016/0022-3999(95)00506-4
- Tolmunen, T., Heliste, M., Lehto, S. M., Hintikka, J., Honkalampi, K., & Kauhanen, J. (2011). Stability of alexithymia in the general population: an 11-year follow-up. *Comprehensive psychiatry*, 52(5), 536–541.
<https://doi.org/10.1016/j.comppsy.2010.09.007>

TABLES AND FIGURE

Table 1. Biometric, biochemical and alcohol/tobacco variables ordered by factor loadings with a cut-off of 0.30. Unrotated factor.

Variables	Loadings
Cholesterol total/HDL ratio	0.652
Systolic blood pressure.	0.648
Triglycerides	0.613
Diastolic blood pressure.	0.589
Body mass index	0.533
Glucose	0.455
Alcohol consumption (SBU)	0.352
Number of cigarettes	0.301

Note: HDL: High density lipoproteins. SBU: Standard Beverage Units.

Table 2. Biometric, biochemical, toxicological variables (tobacco and alcohol) and TAS-20/BSI variables for CVD and community samples. Descriptive and group differences.

	CVD (n=202)			Health (n=400)			
	Mean	SD	SE	Mean	SD	SE	Cohen's <i>d</i>
Age	57.83	8.49	0.60	54.30	10.66	0.54	0.353
Body mass index	27.74	4.65	0.33	26.18	4.16	0.21	0.360
Waist circumference (cms)	102.87	12.09	0.99	96.52	13.64	0.74	0.483
Number of cigarettes	10.25	13.05	0.92	4.15	7.79	0.39	0.681
Years smoking	17.50	19.02	1.36	8.86	13.07	0.66	0.564
Alcohol (SBU)	9.86	18.21	1.28	6.64	11.45	0.58	0.229
Systolic blood pressure	135.12	25.41	2.00	125.97	12.79	0.77	0.508
Diastolic blood pressure	76.97	13.83	1.09	76.54	10.25	0.62	0.033
Cholesterol LDL (mg/dl)	105.08	35.23	2.59	122.19	22.43	2.33	-0.625
Cholesterol HDL (mg/dl)	39.59	10.01	0.74	59.20	9.67	1.01	-2.004
Cholesterol/HDL ratio (mg/dl)	4.43	1.16	0.09	3.58	0.65	0.07	0.994
Triglycerides (mg/dl)	138.93	72.92	5.37	121.34	47.46	5.06	0.307
Glucose (mg/dl)	118.70	37.39	2.77	93.19	9.03	0.96	1.116
AST (U/L)	70.39	82.01	6.27	27.27	3.97	1.02	0.906
ALT (U/L)	34.88	26.57	1.94	26.42	10.93	1.22	0.476
GGT (U/L)	41.95	35.23	2.58	37.17	30.46	3.28	0.149
Cardiovascular risk index	.59	1.13	0.73	-.30	0.77	0.54	0.982
<i>Alexithymia (TAS-20)</i>							
DDF	18.97	5.39	0.43	16.24	5.23	0.27	0.517
DIF	11.02	3.21	0.25	10.13	3.02	0.15	0.289
EOT1	10.12	2.78	0.21	9.55	2.66	0.14	0.211
EOT2	11.54	3.07	0.24	10.45	3.77	0.14	0.379
TAS-20	51.62	9.41	0.75	46.35	8.96	0.46	0.578
<i>Psychopathology (BSI)</i>							
Anxiety	5.25	4.00	0.29	3.68	3.05	0.15	0.205
Depression	4.18	4.34	0.31	2.67	3.00	0.15	0.431
Somatization	6.32	4.69	0.34	3.12	3.63	0.18	0.797
Hostility	3.80	3.57	0.25	3.00	3.13	0.16	0.244

Note: CVD: Cardiovascular disease; SD: Standard Deviation; SBU: Standard Beverage Units; LDL: Low density lipoproteins-cholesterol; HDL: High density lipoproteins-cholesterol; ASAT: Aspartate transaminase; ALAT: Alanine transaminase; GGT: Gamma glutamyl transpeptidase; DDF: difficulty describing feeling; DIF: difficulty identifying feelings; EOT: externally-oriented thinking and TAS-20: Toronto Alexithymia Scales. Cohen's *d* effect size: 0.01 = very small, 0.20 = small, 0.50 = medium, 0.80 = large, 1.20 = very large.

Table 3. Inter- correlation matrix between biochemical variables of cardiovascular risk.

	AST	ALT	GGT	Cholesterol -HDL	Cholesterol -LDL	Cholesterol /HDL	Triglycerides	Cardiovascular risk index
Glucose	0.22 ***	0.14 ***	0.04	-0.39 ***	-0.22 ***	0.21 ***	0.19 ***	0.46 ***
AST		0.67 ***	0.06	-0.21 ***	-0.06	0.06	0.12 **	0.14 ***
ALT			0.38 ***	-0.22 ***	-0.03	0.21 ***	0.26 ***	0.25 ***
GGT				-0.05	0.03	0.13 **	0.20 ***	0.26 ***
Cholesterol HDL					0.28 ***	-0.66 ***	-0.33 ***	-0.54 ***
Cholesterol LDL						0.41 ***	0.14 ***	0.13 **
Cholesterol/HDL							0.54 ***	0.65 ***
Triglycerides								0.61 ***

Note: AST: Aspartate transaminase; ALT: Alanine transaminase; GGT: Gamma glutamyl transpeptidase; HDL: High density lipoproteins; LDL: Low density lipoproteins. ** $p < 0.01$, *** $p < 0.001$. (n= 602).

Table 4. Significant Pearson and partial correlations between TAS-20 factors and individual biological variables.

<i>Cardiovascular risk index</i>			Body mass index	Glucose	ALT	GGT	Cholesterol HDL	Cholesterol LDL	Cholesterol/HDL ratio	Systolic pressure							
<i>Pearson correlations</i>																	
DDF	0.13	***	0.05	0.23	***	0.04	0.05	-0.18	***	-0.05	0.11	**	0.07				
DIF	0.10	*	0.04	0.12	**	0.08	*	0.13	***	-0.08	*	-0.06	0.04	0.08	*		
EOT1	0.14	***	0.03	0.06		0.03	0.05	-0.10	*	-0.07	0.07		0.12	**			
EOT2	0.10	*	0.11	**	0.21	***	0.04	0.01	-0.12	**	-0.09	*	-0.01	0.09	*		
TAS-20	0.17	***	0.08	*	0.24	***	0.07	0.09	*	-0.19	***	-0.10	*	0.09	*	0.13	***
<i>Partial correlations controlling for age, sex, occupation, alcohol and tobacco consumption</i>																	
DDF	0.13	***	0.04	0.19	***	0.04	0.05	-0.17	***	-0.04	0.11	**	0.06				
DIF	0.09		0.02	0.12	**	0.07	0.10	*	-0.07	-0.05	0.02		0.07				
EOT1	0.11	**	0.00	0.03		0.00	0.02	-0.05	-0.05	0.02			0.10	*			
EOT2	0.08		0.08	0.13	***	0.04	0.01	-0.07	-0.06	-0.02			0.05				
TAS-20	0.15	***	0.06	0.20	***	0.06	0.07	-0.15	***	-0.08	0.07		0.10	*			

Note: ALT: Alanine transaminase; GGT: Gamma glutamyl transpeptidase; HDL: High density lipoproteins; LDL: Low density lipoproteins; DDF: difficulty describing feeling; DIF: difficulty identifying feelings; EOT: externally-oriented thinking. * $p < 0.05$; ** $p < 0.01$; ***, $p < 0.001$ (n= 602). Significant correlations $p < 0.001$ in boldface. The differences in the p -values of some similar correlations are attributable to the different number of degrees of freedom for Pearson and partial correlations.

Table 5. Correlations between CRI and TAS-20/BSI psychopathological scales.

	Depression	Anxiety	Hostility	Somatization
<i>CVD</i> (<i>n</i> =202)				
CRI	-0.03	-0.04	-0.05	0.07
DDF	0.34 ***	0.32 ***	0.25 ***	0.25 ***
DIF	0.29 ***	0.14	0.15 *	0.10
EOT1	0.09	0.10	0.16 *	0.07
EOT2	0.19 **	0.13	0.10	0.08
TAS-20	0.39 ***	0.30 ***	0.28 ***	0.23 ***
<i>Healthy</i> (<i>n</i> =400)				
CRI	0.02	0.04	0.15 *	0.06
DDF	0.33 ***	0.37 ***	0.30 ***	0.42 ***
DIF	0.15 **	0.16 **	0.13 *	0.20 ***
EOT1	-0.03	-0.02	0.02	0.03
EOT2	0.05	0.05	0.01	0.10 *
TAS-20	0.25 ***	0.28 ***	0.23 ***	0.34 ***

Note: CRI: Cardiovascular Risk Index. DDF: difficulty describing feeling; DIF: difficulty identifying feelings; EOT: externally-oriented thinking and TAS-20: Toronto Alexithymia Scales. * $p < 0.05$; ** $p < 0.01$. *** $p < 0.001$. Significant correlations $p < 0.001$ in boldface. The differences in the p -values of some similar correlations are attributable to the different number of subjects in each group.

Table 6. Linear multiple regression analysis using a CRI as a dependent variable and TAS-20 factors, gender and age as independent variables (n = 602)

R: .39	Standardized coefficients	<i>t</i>	Sig.
R ² adjusted: .14	Beta		<i>p-value</i>
(Constant)		-2.45	0.007
Gender	-0.279	-7.11	0.001
Age	0.184	3.61	0.001
DDF	0.111	2.54	0.011
DIF	0.010	0.23	0.820
EOT1	0.055	1.40	0.161
EOT2	0.117	1.97	.0048

Note: DDF: difficulty describing feeling; DIF: difficulty identifying feelings; EOT: externally-oriented thinking

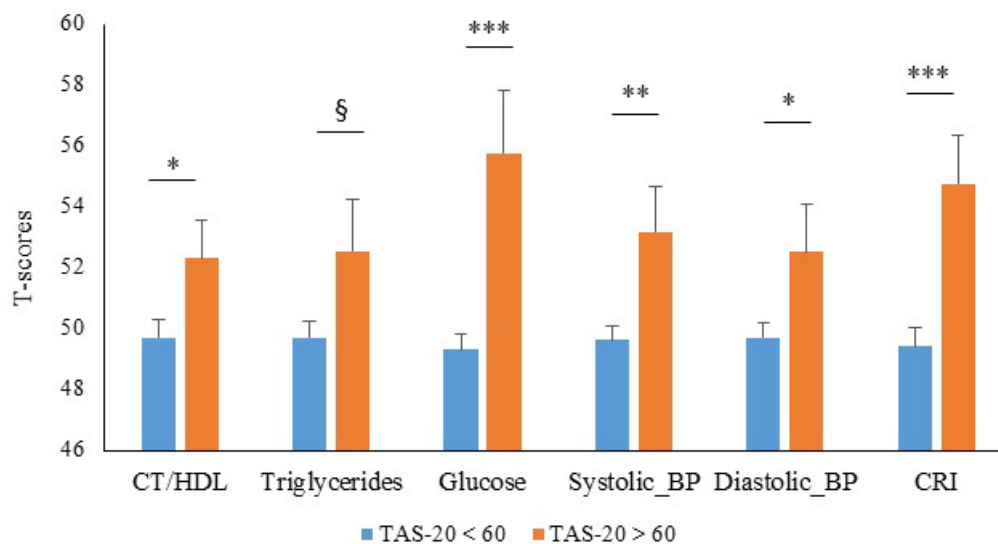


Figure 1. Means comparison including standard errors of cholesterol/HDL, triglycerides, glucose, systolic and diastolic blood pressure and cardiovascular risk index (CRI). § $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.