Ideal cardiovascular health in adolescents and young adults is associated with alexithymia over two decades later: findings from The Cardiovascular Risk in Young Finns Study

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Abstract

We evaluated the association of cardiovascular health in adolescence and young adulthood with alexithymia 25 years later. The study sample (n=1122) participated in evaluations conducted in 1986 (baseline) and in 2011−2012 (T2). Baseline health factors and behaviors were assessed utilizing seven ideal cardiovascular health metrics (ICH index) including blood pressure, cholesterol and glucose levels, smoking, physical activity, body-mass-index, and diet. The stability of the ICH index was evaluated with corresponding assessments in 2007 (T1). At T2, alexithymia was measured with the 20-item Toronto Alexithymia Scale (TAS-20). The main analyses were conducted using ANCOVA and adjusted for depression, age, and present social and lifestyle factors. TAS-20 subscales, Difficulty Identifying Feelings (DIF), Difficulty Describing Feelings (DDF), and Externally Oriented Thinking, were analyzed separately. The ICH index was significantly associated with the TAS-20 total score, as well as both with DIF and DDF. A less ideal cardiovascular health was associated with higher alexithymia scores. However, regarding the separate factors, only the association between non-ideal dietary habits and DIF was significant in the multivariate analyses. The baseline ICH index score was stable from baseline to T1. We conclude that non-ideal cardiovascular lifestyle habits in adolescence and young adulthood are significantly associated with later alexithymia.

Keywords: diet; emotions; ideal cardiovascular health index; lifestyle habits

1. Introduction

Alexithymia is a personality trait characterized by difficulties in identifying and expressing emotions, a limited imagination and a concrete, externally oriented way of thinking (Sifneos, 1973). A core reason for the interest in alexithymia is that it has been associated with a wide variety of not only mental disturbances, but also somatic illnesses, such as hypertension, metabolic syndrome, and diabetes mellitus (Chatzi et al., 2009; Grabe et al., 2010; Lemche et al., 2014; Karukivi et al., 2016). It is noteworthy, that several of the somatic illnesses and symptoms linked to alexithymia are known risk factors for cardiovascular morbidity. Taking also into account that alexithymia has been previously associated with cardiovascular mortality (Tolmunen et al., 2010), the association between alexithymia and cardiovascular health is of importance.

However, there is only a limited amount of longitudinal studies that clarify by which mechanisms alexithymia is connected to these illnesses (Kojima, 2012). One obstacle in the effort to clarify these links is that alexithymia appears to be related to similar risk factors as lifestyle-associated somatic illnesses. For example, alexithymia has been associated with physical inactivity, smoking, and hazardous substance use (Mattila et al., 2006; Lumley et al., 2007; Reis et al., 2011; Chomistek et al., 2015). Recently, alexithymia has also been associated with unhealthy food preferences and eating habits (Robino et al., 2016; Honkalampi et al., 2017). However, it is evident that alexithymia is linked to the illnesses not only through lifestyle factors, but also through shared physiological factors. For example, it has been hypothesized that individuals with alexithymic features may suffer from unnoticed chronic stress that manifests itself in irregularities in the autonomic nervous system and the immune system (e.g., Guilbaud et al., 2003; Waller and Scheidt, 2006). Furthermore, alexithymia and both mental and somatic illnesses share several risk factors, such as psychopathology in the family and low socio-economic status (Lumley et al., 1996; Franz et al., 2008).

One possible key factor regarding these associations is interoceptive awareness, which, for example, enables the capability to identify and distinguish emotions from physiological activations (Pollatos et al., 2007). The concept has later been suggested to include two partially different capabilities, that is,

interoceptive sensibility relating to the capacity to focus on internal sensations, while interoceptive accuracy relates to the capacity to identify and differentiate the sensations (Garfinkel et al., 2015). Alexithymia has been linked to lacking interoceptive awareness (Herbert et al., 2011; Ernst et al., 2014), which may explain why the chronic physiological stress related both to alexithymia and hypertension goes unnoticed. Additionally, although different kinds of hypotheses regarding the development of alexithymia have been suggested, the understanding of both the developmental processes and the mechanisms through which alexithymia possibly predisposes to the illnesses is still limited (Karukivi and Saarijärvi, 2014). One core reason for this is that the associations have been mostly studied in cross-sectional or retrospective settings and there is a clear lack of longitudinal studies. Thus, based on previous findings, it remains an open question, whether the association of alexithymia with poorer cardiovascular health is based on one predisposing to the other, or is it more of a concurrent process.

As a personality trait, alexithymia is a multi-dimensional phenomenon. The most widely used instrument for measurement of alexithymia is the 20-item Toronto Alexithymia Scale (TAS-20) (Bagby et al., 1994a, 1994b). It measures three of the four core features of alexithymia: difficulty identifying feelings (DIF), difficulty describing feelings (DDF), and externally oriented thinking (EOT). Although a rather crude measure of alexithymia, it has been extensively used in alexithymia literature. The TAS-20 subscales have been shown to markedly vary regarding their associations with different illnesses and recent studies have shown that it is plausible that even actual subtypes of alexithymia exist (Chen et al., 2011; Alkan Härtwig et al., 2014; Ueno et al., 2014; Kajanoja et al., 2017a). Based on these studies, individuals with high scores in DIF/DDF subscales appear to present significantly more psychopathology compared with those who have high EOT combined with low DIF/DDF subscale scores. Thus, it is apparent that in alexithymia studies, also the subscale scores should be analyzed.

The 2020 impact goals released by the American Heart Association (AHA) include seven metrics of ideal cardiovascular health (ICH): normal blood pressure, normal cholesterol and glucose levels, not smoking, being physically active, normal body-mass-index (BMI), and healthy eating habits (Lloyd-Jones et al., 2010). In previous studies, a high ICH index has been shown to significantly inversely associate with,

for example, a variety of cardiovascular disease outcomes and all-cause mortality (Folsom et al., 2011; Laitinen et al., 2012; Yang et al., 2012). Several of the factors included in the ICH metrics have earlier been associated also with alexithymia, for example, hypertension (Grabe et al., 2010), high BMI (Kajanoja et al., 2019), and unhealthy eating habits (Honkalampi et al., 2017). However, the ICH concept has sparsely been applied to psychological outcomes.

To our best knowledge, there are no previous longitudinal studies where cardiovascular health in adolescence would have been assessed regarding its relation to alexithymia in adulthood. Thus, the main aim of the present study was to evaluate the association of cardiovascular health factors assessed using the ICH index in adolescence and young adulthood with alexithymia and its dimensions in adulthood. An evaluation of the stability of the ICH index was conducted in order to assess, whether the index was predictive also for cardiovascular health in adulthood. We hypothesized that factors associated to non-ideal cardiovascular health would be associated with later alexithymia.

2. Methods

2.1. Participants

The present study is based on data material from the Cardiovascular Risk in Young Finns Study (n=3596) (youngfinnsstudy.utu.fi), which is a multi-center follow-up study of cardiovascular risk factors from childhood to adulthood (Raitakari et al., 2008). The baseline of the study was in 1980 and since that, several follow-up studies have been conducted. The participants of the present study participated in the study conducted in 1986 (baseline, T0) and in the latest field study conducted in 2011−2012 (T2). Thus, the follow-up period was approximately 25 years. Complete data on the baseline ICH metrics were available for 1891 participants and of them, 1122 completely filled in the TAS-20 scale at T2 thus comprising the study sample. The ICH metrics were not assessed in 2011−2012 and thus, in order to assess cardiovascular health of the participants in a longitudinal setting, we evaluated the ICH metrics from the assessments conducted in 2007 (T1) enabling a

21-year follow-up period regarding cardiovascular health. The average age of the participants was 17.11 years (range 12−24 years) at baseline. At T2, the average age for females was 42.64 (4.20) years and for males 42.58 (4.17) years (p=0.51).

Comparing the non-participants with only baseline data (n=769) with the study sample (n=1122), those included in the present study were older (42.6 vs. 40.9 years, p<0.001) and more often female (48.1% vs. 57.2%, p<0.001). The baseline ICH index was higher among the participants (3.71 vs. 3.61, p=0.006), but regarding occupation at T2, no significant difference was found. The study protocol has been approved by the Ethics Committee of the University of Turku.

2.2. Metrics for cardiovascular health

Regarding the measurements conducted in 1986 (baseline) and 2007 (T1), the metrics described by the American Heart Association (AHA) were applied where possible (Lloyd-Jones et al., 2010). The childhood ideal cardiovascular health metric criteria were applied for participants ≤18 years of age and adult criteria for over 18-year-old participants. Ideal cardiovascular health (ICH) index is based on 7 criteria, comprised of 3 health factor criteria and 4 health behavior criteria. Each criterion is dichotomized as non-ideal or ideal. In the present study, the ICH index was used as a continuous variable ranging from 0 to 7, a higher index score indicating a more ideal cardiovascular health. Also complementary analyses with the separate criteria were conducted.

2.2.1. Health factors

Both in the 1986 and 2007 assessments, blood pressure was measured using a manual random zero sphygmomanometer in sitting position after 5 minutes rest. Korotkoff´s first sound was used as the sign of systolic blood pressure and fifth sound as the sign of diastolic blood pressure. Readings to the nearest even

number of mmHg were recorded. The average of three systolic and diastolic readings was used as the measure of blood pressure in analyses. For adolescents, ideal blood pressure was defined as systolic blood pressure <90th percentile and diastolic blood pressure <90th percentile. For adults, as systolic blood pressure <120 mmHg and diastolic blood pressure <80 mmHg. Ideal total cholesterol status was defined as <4.40 mmol/l (<170 mg/dl) for adolescents and <5.17 mmol/l (<200 mg/dl) for adults. Ideal fasting plasma glucose concentration was defined as <5.6 mmol/l (<10 mg/dl) for both adolescents and adults.

2.2.2. Health behaviors

In adolescents, ideal smoking status was defined as "never smoked a whole cigarette". In adults, current smokers were categorized as having a non-ideal smoking status and those, who had never smoked or were former smokers, as having an ideal smoking status. Physical activity was assessed by a self-report questionnaire. Parents assisted their children when necessary. For adolescents, ideal physical activity was defined as ≥60 minutes of moderate or vigorous daily activity (approximated as ≥7 hours of moderate or vigorous activity per week in the present study) and for adults, ≥150 minutes of moderate or vigorous activity per week (approximated as ≥1 hours/week vigorous or ≥2−3 hours/week moderate and/or vigorous activity in the present study). Height and weight measurements were used to calculate the body-mass index: BMI = weight in kilograms / (height in meters)^2. Ideal BMI was classified as <85th percentile.

In 1986, information on dietary habits of the participants was obtained with a non-quantitative food frequency questionnaire. Participants answered the questions themselves, assisted by their parents when necessary. The frequency of consumption of fruits and vegetables, fish, and soft drinks was assessed for the past month ranging from 1=daily to 6=more seldom than a couple of times per month. For example, participants were classified as having an ideal fruit and vegetable consumption, if they consumed both of them daily. Participants were classified as having an ideal healthy diet, if they had at least 2 of 3 ideal diet components. In 2007, a more detailed food frequency questionnaire was introduced and it provided an estimate of food consumption in grams per day. Ideal diet score was defined as achieving 4 or 5 of the 5 AHA

ideal dietary goals (Lloyd-Jones et al., 2010). The scoring has been described in more detail previously (Laitinen et al., 2012).

2.3. Measures

In 2011−2012 (T2), alexithymia was measured using the TAS-20 scale (Bagby et al., 1994a, 1994b). The psychometric properties of the scale have been shown to be good for numerous versions in different languages including the Finnish version (Parker et al., 2003; Taylor et al., 2003). The 20 items are scored from 1 to 5 and thus, the total score range is from 20 to 100. In statistical analyses, both the TAS-20 total score and the subscale scores (DIF, DDF, and EOT) were used as continuous variables.

The revised 21-item version of the Beck Depression Inventory (BDI-II) (Beck et al. 1996) was used to evaluate depression symptoms at T2. Each item is scored from 0 to 3 and the total score range is from 0 to 63. The reliability and validity of the scale, including its Finnish version, have been shown to be good (Beck et al., 1996, 2004). The BDI score was used as a continuous variable in the analyses.

Since both alexithymia and cardiovascular health are known to be related to social and lifestyle factors, several variables were included in the analyses in order to avoid overestimating the significance of the association between alexithymia and the ICH index. The variables were as follows: occupation (manual/lower non-manual/higher non-manual), smoking (current or former smoker/never smoked) and sports activities (passive/moderately or highly active). The sports activities variable was based on a sum score of five items that assessed, for example, the frequency and intensity of sports activities of the participant. Each item was rated on a three-point Likert-type scale (total score range 5−15). The cut-point for moderately or highly active was a score of 11 or more. These variables were assessed at the same time as TAS-20 and BDI.

2.4. Statistical methods

The normality of the distributions of the variables was assessed both graphically and with the Shapiro-Wilk Test. The continuous variables are presented as means with standard deviations (SD). The DIF, DDF, and BDI scores were characterized using medians and interquartiles (IQR), because the distributions of these variables were positively skewed.

The correlation analyses for the association of the TAS-20 total and subscale scores with BDI scores were performed using Spearman's correlation. Categorized variables were compared between sexes using the Chi-Square test. For continuous variables, the differences were analyzed using the t-test for normally distributed variables and the Mann-Whitney U Test for non-normally distributed variables. For group comparisons with ≥3 categories, the analyses were conducted with one-way ANOVA for normally distributed continuous variables and the Kruskall-Wallis Test for non-normally distributed variables. The significance of the baseline ICH score at predicting the ICH score in T1 was assessed with linear regression adjusted with age. The effect size for the mean score difference was estimated using Cohen's *d*.

The associations of the ICH index scores and covariates with the TAS-20 scores were analyzed using ANCOVA. All analyses were adjusted with age and BDI scores. The analyses included the variables that were significantly ($p<0.05$) associated with the TAS-20 total and subscale scores in the univariate analyses. In addition, we also conducted analyses with the separate ICH criteria. The fit of the models was evaluated based on the normality and variance of the residuals. Despite the nonparametric distribution for the DIF, DDF, and BDI variables, the residuals showed good fit and thus, the variables were used as parametric in the ANCOVA analyses.

The internal consistency for the TAS-20 total and subscale scores, as well as, for BDI was calculated using Cronbach's alpha. The Cronbach's alpha scores ranged from acceptable to excellent internal consistency: TAS-20 total score 0.85, DIF 0.85, DDF 0.76, EOT 0.69, and BDI 0.91. In all analyses, p-values <0.05 were considered statistically significant. Statistical analyses were carried out using the IBM SPSS software, Version 25.0.

3. Results

3.1. Characteristics of the study sample

Distributions of the ICH indices both at baseline and T1 are presented in Table 1. At baseline, participants met on average 3.78 (1.11) of all 7 ICH metrics, whereas at T1, the average score was 3.58 (1.45). At baseline, there was no significant difference in the average ICH scores between females (3.82, SD 1.13) and males (3.71, SD 1.07) (p=0.011). However, at T1, there was a significant difference between the sexes (p<0.001), due to the ICH score increase among females (3.99, SD 1.39) and decrease among males (2.99, 1.33).

Insert Table 1 here

The descriptive statistics for the follow-up variables in 2011-2012 (T2) are presented in Table 2. The differences between females and males regarding several of the variables, including the TAS-20 scores, were significant and thus, sex was included as a variable in the multivariate analyses.

Insert Table 2 here

3.2. Stability of the ICH score in the sample

The ICH metrics were available for n=867 participants both at baseline and T1. The ICH scores at these time-points were significantly correlated (r=0.244, p<0.001). The test-retest correlations were significant (p<0.001) also in the analyses conducted separately for females (r=0.209) and males (r=0.301). In a linear regression model adjusted with age, the beta coefficient for the mean ICH score at baseline predicting the ICH score at T1 was 0.41 and the standardized beta coefficient was 0.33 (t=6.46, <0.001). Adjusted R^2 was 0.12 (SE 1.25). The effect size for the mean score difference was *d*=0.19 suggesting a minimal difference.

3.3. Associations between the baseline ICH index and alexithymia at T2

All the TAS-20 scores were significantly correlated with the BDI scores: TAS-20 total score (ρ=0.36, p<0.001), DIF (ρ=0.49, p<0.001), DDF (ρ=0.29, p<0.001), and EOT (ρ=0.07, p=0.041). The associations of the TAS-20 total score with the categorized variables are presented in Table 3. A higher baseline ICH index was significantly associated with a lower TAS-20 total score at T2. In the multivariate test conducted with ANCOVA, the ICH index remained significantly associated with the TAS-20 score.

Insert Table 3 here

The TAS-20 subscale scores were analyzed separately and the results are presented in Table 4. In the univariate analyses, the ICH index was significantly associated with all the subscale scores with a higher ICH index being associated with less alexithymic features. In the multivariate analyses, the association between the ICH index and both the DIF and DDF scores remained significant, while for the model with the EOT score the association became non-significant.

Insert Table 4 here

3.4. Associations between the separate ICH criteria and the TAS-20 total score

For the separate ICH criteria, there were significant differences in the TAS-20 total and subscale scores for the participants in non-ideal and ideal categories (Table 5). Regarding the health factor criteria, no significant differences were observed, but for three (smoking, BMI, and diet) of the four health behavior criteria, the differences between the ideal and non-ideal categories were significant for the TAS-20 total score. Ideal behavior was associated to lower TAS-20 scores for the three criteria. For these criteria, separate models were built in order to assess their association with the TAS-20 total score at follow-up. The analyses were adjusted with the same variables as the analyses with the ICH index. In the multivariate models, the ideal

diet criterion was slightly non-significant (F=3.44, p=0.064). However, for all analyses, none of the three separate criteria remained associated with the TAS-20 total score.

Insert Table 5 here

3.5. Associations between the separate ICH criteria and the TAS-20 subscales

In the univariate analyses, both the DIF and DDF scores were significantly associated with one health behavior criterion, while EOT score was associated with two (Table 5). For all these comparisons, non-ideal behavior was associated with a higher TAS-20 subscale score. Separate models were built in order to analyze the criteria regarding their associations with the subscale scores. In these models, the non-ideal diet criterion was significantly associated with the DIF score (F=8.23, p=0.004). Regarding both the DDF and EOT scores, the associations with the separate health behavior criteria were statistically non-significant.

4. Discussion

In the present study, the main finding was that a non-ideal level in cardiovascular health metrics in adolescence and young adulthood was significantly associated with alexithymia 25 years later. Baseline cardiovascular health metrics were also significantly associated with cardiovascular health 21 years later indicating that the measurements were predictive for cardiovascular health in adulthood. The association regarding cardiovascular health in adolescence and young adulthood was significant for the TAS-20 total score, as well as the Difficulty Identifying Feelings and Difficulty Describing Feelings subscales, even when current lifestyle factors and depressive symptoms were adjusted for. In the univariate analyses, the association was related to non-ideal health behaviors, that is, unhealthy dietary habits, high BMI, and smoking. However, in the multivariate analyses assessing the links between the separate ICH criteria and the TAS-20 scores, only the association of non-ideal dietary habits with a higher DIF score was significant.

One shortcoming in previous studies is that that solid comparisons between the TAS-20 subscales are scarce. Previously, Chen et al. (2011) suggested a model that included three subtypes of alexithymia: general-high alexithymia characterized by high scores for all three TAS-20 subscales, introvert-high alexithymia characterized by high DIF and DDF scores and low EOT scores, and extrovert-high alexithymia characterized by high EOT scores and normal DIF and DDF scores (Chen et al., 2011). The core finding, emphasizing the existence of DIF/DDF and EOT high subtypes, has been repeated in three studies conducted in three different countries (Alkan Härtwig et al., 2014; Ueno et al., 2014; Kajanoja et al., 2017a). In the present study, we did not observe a straightforward difference between DIF/DDF and EOT. In all, the subscale differences were rather small, although the trend regarding the inverse association of a higher ICH index score with lower alexithymia scores was quite consistent. The association between the ICH index and EOT became non-significant in the multivariate analysis. Additionally, although a similar trend was apparent with the separate ICH criteria, most of the associations were non-significant. As noted, only unhealthy diet habits were significantly related to the DIF scores. Interestingly, this differs from the findings observed in a previous cross-sectional study evaluating the association of alexithymia with metabolic syndrome (MetS) in the same cohort, where the MetS components were mostly associated with EOT and DDF, while the associations for DIF were non-significant (Karukivi et al., 2016).

In previous studies, the EOT subscale has been shown to function differently compared with the DIF and DDF subscales. Due to both its lacking associations with mental illness symptoms and typically weaker internal reliability, the authenticity of the EOT subscale has been criticized (Kooiman et al., 2002). In previous studies, EOT has been negatively associated, for example, with emotional intelligence and empathy (Parker et al., 2001; Grynberg et al., 2010). In a recent study, Preece et al. (2017) formulated an attention-appraisal model of alexithymia and suggested that EOT is linked to a deficit in the attentional phase of emotions, whereas DIF/DDF is associated to lacking appraisal of emotions (Preece et al., 2017). The model has an plausible link with interoceptive awareness, interoceptive sensibility relating to attention towards emotions and interoceptive accuracy being associated with lack of appraisal (Garfinkel et al., 2015).The model enables a hypothesis that individuals with emphasized externally oriented thinking may be less prone

to recognize and report depressive and anxiety symptoms, and instead regulate their emotions by externalizing behaviors, such as eating unhealthy and smoking (Kajanoja et al., 2017b).

In the present study, there was a significant difference in the EOT scores regarding both non-ideal smoking and dietary habits criteria in the univariate analyses. However, these associations were non-significant in the multivariate models and, while it is possible that EOT plays a more central role regarding the association of alexithymia with lifestyle habits, we were not able to confirm this. Additionally, regarding the whole ICH index, the association with DIF and DDF scores was more significant. In previous cross-sectional studies, alexithymic features have been associated with similar non-ideal habits, such as a sedentary lifestyle, smoking, hazardous drinking, and unhealthy eating habits (Mattila et al., 2006; Lumley et al., 2007; Thorberg et al., 2009; Chomistek et al., 2015; Robino et al., 2016; Honkalampi et al. 2017). There is an increasing amount of evidence linking lifestyle habits, development of the central nervous system and mental disorders in novel ways. For example, although still quite hypothetical, it is possible that via the gut-brain axis, diet and subsequent gut microbiome alterations may be associated with the development of emotional regulation (de Weerth, 2017). However, the possible links between alexithymia and gut-brain-axis has not been yet studied. In an earlier study by Robino et al. (2016), high alexithymia scores were associated with liking foods associated with high level of pleasure and palatability, such as alcohol and sweets, and low alexithymia scores with healthier food preferences, such as vegetables (Robino et al., 2016). In the present study, a non-ideal diet was significantly associated with the DIF subscale, while the association with the TAS-20 total score was slightly non-significant.

To date, numerous studies assessing the stability of alexithymia have been published. Although the majority of the studies are conducted in clinical populations, the absolute and relative stability of alexithymia in Finnish non-clinical populations appears to be quite high, also in late adolescents (Tolmunen et al., 2011; Karukivi et al., 2014; Hiirola et al., 2017). In the present study, the setting did not allow the measurement of alexithymia at baseline, and therefore we can only speculate whether the levels were similar already at baseline or not. However, we found support that the ICH index measured at baseline was stable at least over a 20-year long follow-up period. Thus, while the study setting didn't allow us to assess causality,

we may conclude that a singificant link between cardiovascular health in adolescence and alexithymia in adulthood exists, and it appears to be particularly related to health behaviors.

The present study has some limitations. The studied non-clinical sample is representative of both sexes, but the long follow-up period for the cohort leads to some selection in the sample. Therefore, the current sample represents a relatively healthy population sample. Regarding the methods, a limitation is the non-quantitative food frequency questionnaire used at baseline. One significant limitation is that alexithymia was measured only at follow-up, because the TAS-20 scale did not exist at the time of the baseline measurements. This precluded the possibility to adjust the analyses for alexithymia at baseline and thus, we cannot exclude the possibility that alexithymic features would have had an effect on lifestyle habits already at that stage. Significant strengths include the novel aim of the study, community-based sample, the combination of self-assessment instruments with both biological and social variables, and the long follow-up period for the cardiovascular health variables.

To conclude, in the present study we found non-ideal lifestyle habits in adolescence and young adulthood to be significantly associated with alexithymia measured 25 years later. Health factors and behaviors were evaluated using a novel method in alexithymia literature, that is, the ICH metrics released by the AHA. The study setting didn't allow us to assess causality and thus, our findings mainly suggest that the findings in earlier cross-sectional studies may portray certain trajectories. As well as a process where one predisposes to another, the entanglement of cardiovascular health with alexithymia may well be a concurrent process. Taking into account that both the ICH index and alexithymia have been significantly associated with cardiovascular morbidity and clinically severe outcomes (Tolmunen et al., 2010, Folsom et al., 2011; Laitinen et al., 2012; Yang et al., 2012), clarifying these associations in future studies is of importance. If the association exists already in adolescence, it has far-reaching consequences. Thus, at its best, measures taken to alleviate alexithymia might also improve cardiac health. It is also apparent that the dimensional nature of alexithymia has to be taken into account in alexithymia studies. This is particularly vital in studies assessing the links between alexithymia and lifestyle habits and somatic illnesses, since the associations appear to be somewhat different compared with mental illnesses. Due to the evident complexity

of these associations, longitudinal studies including multifaceted assessment methods and even younger participants than in the present study are encouraged.

References

Alkan Härtwig, E., Crayen, C., Heuser, I., Eid, M., 2014. It's in the mix: psychological distress differs between combinations of alexithymic facets. Front. Psychol. 5, 1259. https://doi.org/10.3389/fpsyg.2014.01259

Bagby, R., Parker, J., Taylor, G., 1994a. The 20-item Toronto Alexithymia Scale, I: item selection and cross-validation of the factor structure. J. Psychosom. Res. 38, 23–32. https://doi.org/10.1016/0022-3999(94)90005-1

Bagby, R., Taylor, G., Parker, J., 1994b. The 20-item Toronto Alexithymia Scale, II: convergent, discriminant and concurrent validity. J. Psychosom. Res. 38, 33–40. https://doi.org/10.1016/0022-3999(94)90006-X

Beck, A.T., Steer, R.A., Brown, G.K., 1996. Manual for the Beck Depression Inventory-II. Psychological Corporation, San Antonio, TX.

Beck, A.T., Steer, R.A., Brown, G.K., 2004. Manual for the Beck Depression Inventory-II. Psychological Corporation, San Antonio, TX. Finnish translation copyright. Psykologien kustannus Oy, Helsinki.

Chatzi, L., Bitsios, P., Solidaki, E., Christou, I., Kyrlaki, E., Sfakianaki, M., Kogevinas, M., Kefalogiannis, N., Pappas, A., 2009. Type 1 diabetes is associated with alexithymia in non-depressed, non-mentally ill diabetic patients: a case-control study. J. Psychosom Res. 67, 307–313. https://doi.org/10.1016/j.psychores.2009.04.011

Chen, J., Xu, T., Jing, J., Chan, R.C., 2011. Alexithymia and emotional regulation: A cluster analytical approach. BMC Psychiatry 11, 33. https://doi.org/10.1186/1471-244X-11-33

Chomistek, A.K., Chiuve, S.E., Eliassen, A.H., Mukamal, K.J., Willett, W.C., Rimm, E.B., 2015. Healthy lifestyle in the primordial prevention of cardiovascular disease among young women. J. Am. Coll. Cardiol. 65, 43–51. https://doi.org/10.1016/j.jacc.2014.10.024

de Weerth, C., 2017. Do bacteria shape our development? Crosstalk between intestinal microbiota and HPA axis. Neurosci. Biobehav. Rev. 83, 458–471. https://doi.org/10.1016/j.neubiorev.2017.09.016

Ernst, J., Böker, H., Hättenschwiler, J., Schüpbach, D., Northoff, G., Seifritz, E., Grimm, S., 2014. The association of interoceptive awareness and alexithymia with neurotransmitter concentrations in insula and anterior cingulate. Soc. Cogn. Affect. Neurosci. 9, 857–863. https://doi.org/10.1093/scan/nst058

Franz, M., Popp, K., Schaefer, R., Sitte, W., Schneider, C., Hardt, J., Decker, O., Braehler, E., 2008. Alexithymia in the German general population. Soc. Psychiatry Psychiatr. Epidemiol. 43, 54–62. https://doi.org/10.1007/s00127-007-0265-1

Folsom, A.R., Yatsuya, H., Nettleton, J.A., Lutsey, P.L., Cushman, M., Rosamond, W.D., ARIC Study Investigators., 2011. Community prevalence of ideal cardiovascular health, by the American Heart Association definition, and relationship with cardiovascular disease incidence. J. Am. Coll. Cardiol. 57, 1690–1696. https://doi.org/10.1016/j.jacc.2010.11.041

Garfinkel, S.N., Seth, A.K., Barret A.B., Suzuki, K., Critchley H.D., 2015. Knowing our own heart: distinguishing interoceptive accuracy from interoceptive awareness. Biol. Psychol. 104, 65–74. https://doi.org/10.1016/j.biopsycho.2014.11.004

Grabe, H.J., Schwahn, C., Barnow, S., Spitzer, C., John, U., Freyberger, H.J., Schminke, U., Felix, S., Völzke, H., 2010. Alexithymia, hypertension, and subclinical atherosclerosis in the general population. J. Psychosom. Res. 68, 139−147. https://doi.org/10.1016/j.psychores.2009.07.015

Grynberg, D., Luminet, O., Corneille, O., Grèzes, J., Berthoz, S., 2010. Alexithymia in the interpersonal domain: A general deficit of empathy? Personal. Individ. Differ. 49, 845−850. https://doi.org/10.1371/journal.pone.0042429

Guilbaud, O., Corcos, M., Hjalmarsson, L., Loas, G., Jeammet, P., 2003. Is there a psychoneuroimmunological pathway between alexithymia and immunity? Immune and physiological correlates of alexithymia. Biomed. Pharmacother. 57, 292−295. https://doi.org/10.1016/S0753-3322(03)00085-4

Herbert, B.M., Herbert, C., Pollatos, O., 2011. On the relationship between interoceptive awareness and alexithymia: is interoceptive awareness related to emotional awareness? J. Pers. 79, 1149–1175. https://doi.org/j.1467-6494.2011.00717.x

Hiirola, A., Pirkola, S., Karukivi, M., Markkula, N., Bagby, R.M., Joukamaa, M., Jula, A., Kronholm, E., Saarijärvi, S., Salminen, J.K., Suvisaari, J., Taylor, G., Mattila, A.K., 2017. An evaluation of the absolute and relative stability of alexithymia over 11 years in a Finnish general population. J. Psychosom. Res. 95, 81−87. https://doi.org/10.1016/j.jpsychores.2017.02.007

Honkalampi, K., Ruusunen, A., Viinamäki, H., Koivumaa-Honkanen, H., Valkonen-Korhonen, M., Lehto, S.M., 2017. Dietary patterns are associated with the prevalence of alexithymia. Scand. J. Psychol. 58, 318−323. https://doi.org/10.1111/sjop.12370

Kajanoja, J., Scheinin, N.M., Karlsson, L., Karlsson, H., Karukivi, M., 2017a. Illuminating the clinical significance of alexithymia subtypes: A cluster analysis of alexithymic traits and psychiatric symptoms. J. Psychosom. Res. 97, 111−117. https://doi.org/10.1016/j.psychores.2017.04.010

Kajanoja, J., Scheinin, N., Karlsson, L., Karlsson, H., Karukivi, M., 2017b. Alexithymia as a health risk and resilience factor: Response to Dr. Davydov. J. Psychosom. Res. 101, 135−136. https://doi.org/10.1016/j.jpsychores.2017.08.007

Kajanoja, J., Karukivi, M., Scheinin, N.M., Tuulari, J., Ahrnberg, H., Karlsson, L., Karlsson, H., 2019. Alexithymia, Body Mass Index and Gestational Diabetes in Pregnant Women – FinnBrain Birth Cohort Study. J. Psychosom. Res. 124, 109742. https://doi.org/10.1016/j.jpsychores.2019.109742

Karukivi, M., Saarijärvi, S., 2014. Development of alexithymic personality features. World J. Psychiatry 4, 91−102. https://doi.org/10.5498/wjp.v4.i4.91

Karukivi, M., Pölönen, T., Vahlberg, T., Saikkonen, S., Saarijärvi, S., 2014. Stability of alexithymia in late adolescence: results of a 4-year follow-up study. Psychiatry Res. 219, 386−390. https://doi.org/10.1016/j.psychres.2014.05.058

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 Res. 236, 58−63. https://doi.org/10.1016/j.psychres.2015.12.034

Kojima, M., 2012. Alexithymia as a prognostic risk factor for health problems: a brief review of epidemiological studies. Biopsychosoc. Med. 6, 21. https://doi.org/10.1186/1751-0759-6-21

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. J. Psychosom. Res. 53, 1083−1090. https://doi.org/10.1016/S0022-3999(02)00348-3

Laitinen, T.T., Pahkala, K., Magnussen, C.G., Viikari, J.S., Oikonen, M., Taittonen, L., Mikkilä, V., Jokinen, E., Hutri-Kähönen, N., Laitinen, T., Kähönen, M., Lehtimäki, T., Raitakari, O.T., Juonala, M., 2012. Ideal Cardiovascular Health in Childhood and Cardiometabolic Outcomes in Adulthood: the Cardiovascular Risk in Young Finns Study. Circulation 125, 1971−1978. https://doi.org/10.1161/CIRCULATIONAHA.111.073585

Lemche, A.V., Chaban, O.S., Lemche, E., 2014. Alexithymia as a risk factor for type 2 diabetes mellitus in the metabolic syndrome: a cross-sectional study. Psychiatry Res. 215, 438−443. https://doi.org/10.1016/j.psychres.2013.12.004

Lloyd-Jones, D.M., Hong, Y., Labarthe, D., Mozaffarian, D., Appel, L.J., Van Horn, L., Greenlund., K., Daniels, S., Nichol, G., Tomaselli, G.F., Arnett, D.K., Fonarow, G.C., Ho, P.M., Lauer, M.S., Masoudi, F.A., Robertson, R.M., Roger, V., Schwamm, L.M., Sorlie, P., Yancy, C.W., Rosamond, W.D.; American Heart Association Strategic Planning Task Force and Statistics Committee, 2010. Defining and setting national goals for cardiovascular health promotion and disease reduction: the American Heart Association's strategic Impact Goal through 2020 and beyond. Circulation 121, 586−613. https://doi.org/10.1161/CIRCULATIONAHA.109.192703

Lumley, M.A., Mader, C., Gramzow, B.A., Papineau, K., 1996. Family factors related to alexithymia characteristics. Psychosom. Med. 58, 211–216. https://doi.org/10.1097/00006842-199605000-00003

Lumley, M.A., Neely, L.C., Burger, A.J., 2007. The assessment of alexithymia in medical settings: implications for understanding and treating health problems. J. Pers. Assess. 89, 230−246. https://doi.org/10.1080/00223890701629698

Mattila, A.K., Salminen, J.K., Nummi, T., Joukamaa, M., 2006. Age is strongly associated with alexithymia in the general population. J. Psychosom. Res. 61, 629−635. https://doi.org/10.1016/j.psychores.2006.04.013

Parker, J., Taylor, G., Bagby, R., 2001. The relationship between emotional intelligence and alexithymia. Personal. Individ. Differ. 30, 107−115. https://doi.org/10.1016/S0191-8869(00)00014-3

Parker, J., Taylor, G., Bagby, R., 2003. The 20-item Toronto Alexithymia Scale, III: reliability and factorial validity in a community population. J. Psychosom. Res. 55, 269−275. https://doi.org/10.1016/S0022-3999(02)00578-0

Pollatos, O., Graman, K., Schandry, R., 2007. Neural systems connecting interoceptive awareness and feelings. Hum. Brain. Mapp. 28, 9−18. https://doi.org/10.1002/hbm.20258

Preece, D., Becerra, R., Allan, A., Robinson, K., Dandy, J., 2017. Establishing the theoretical components of alexithymia via factor analysis: Introduction and validation of the attention-appraisal model of alexithymia. Personal. Individ. Differ. 119, 341−352. https://doi.org/10.1016/j.paid.2017.08.003

Raitakari, O.T., Juonala, M., Rönnemaa, T., Keltikangas-Järvinen, L., Räsänen, L., Pietikäinen, M., Hutri-Kähönen, N., Taittonen, L., Jokinen, E., Marniemi, J., Jula, A., Telama, R., Kähönen, M., Lehtimäki, T., Akerblom, H.K., Viikari, J.S., 2008. Cohort profile: the cardiovascular risk in Young Finns Study. Int. J. Epidemiol. 37, 1220−1226. https://doi.org/10.1093/ije/dym225

Reis, J.P., Loria, C.M., Sorlie, P.D., Park, Y., Hollenbeck, A., Schatzkin, A., 2011. Lifestyle factors and risk for new-onset diabetes: a population-based cohort study. Ann. Intern. Med. 155, 292−299. https://doi.org/10.7326/0003-4819-155-5-201109060-00006

Robino, A., Mezzavilla, M., Pirastu, N., La Bianca, M., Gasparini, P., Carlino, D., Tepper, B.J., 2016. Understanding the role of personality and alexithymia in food preferences and PROP taste perception. Physiol. Behav. 157, 72−78. https://doi.org/10.1016/j.physbeh.2016.01.022

Sifneos, P., 1973. The prevalence of "alexithymic" characteristics in psychosomatic patients. Psychother. Psychosom. 22, 255−262. https://doi.org/10.1159/000286529

Taylor, G., Bagby, R., Parker, J., 2003. The 20-item Toronto Alexithymia Scale, IV: reliability and factorial validity in different languages and cultures. J. Psychosom. Res. 55, 277−283. https://doi.org/10.1016/S0022-3999(02)00601-3

Thorberg, F.A., Young, R.M., Sullivan, K.A., Lyvers, M., 2009. Alexithymia and alcohol use disorders: a critical review. Addict. Behav. 34, 237−245. https://doi.org/10.1016/j.addbeh.2008.10.016

Tolmunen, T., Lehto, S.M., Heliste, M., Kurl, M.B., Kauhanen, J., 2010. Alexithymia is associated with increased cardivascular mortality in middle-aged Finnish men. Psychosom. Med. 72, 187−191. https://doi.org/10.1097/PSY.0b013e3181c65d00

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. Compr. Psychiatry 52, 536−541. https://doi.org/10.1016/j.comppsych.2010.09.007

Ueno, M., Maeda, M., Komaki, G., 2014. Different subgroups of high-scorers on the TAS-20 scale based on the big five personality traits. Personal. Individ. Differ. 68, 71−76. https://doi.org/10.1016/j-paid.2014.04.012

Waller, E., Scheidt, C.E., 2006. Somatoform disorders as disorders of affect regulation: a development perspective. Int. Rev. Psychiatry 18, 13−24. https://doi.org/10.1080/09540260500466774

Yang, Q., Cogswell, M.E., Flanders, W.D., Hong, Y., Zhang, Z., Loustalot, F., Gillespie, C., Merrit, R., Hu F.B., 2012.. Trends in cardiovascular health metrics and associations with all-cause and CVD mortality among US adults. JAMA 307, 1273−1283. https://doi.org/10.1001/jama.2012.339

Table 1

Distributions of the Ideal Cardiovascular Health (ICH) Index by gender at baseline (T0) in 1986 and T1 follow-up in 2007.

		All (n=1122)	Females (n=642)	Males (n=480)	
Baseline T0		n (%)	n (%)	n (%)	P[a]
Ideal CVH Index	0	1 (0.1)	0 (0)	1 (0.2)	0.37
	1	14 (1.2)	8 (1.2)	6 (1.3)	
	2	107 (9.5)	61 (9.5)	46 (9.6)	
	3	344 (30.7)	194 (30.2)	150 (31.3)	
	4	384 (34.2)	207 (32.2)	177 (36.9)	
	5	207 (18.4)	129 (20.1)	78 (16.3)	
	6	55 (4.9)	36 (5.6)	19 (4.0)	
	7	10 (0.9)	7 (1.1)	3 (0.6)	
T1 follow-up		All (n=867)	Females (n=514)	Males (n=353)	P
Ideal CVH Index	0	9 (1.0)	3 (0.6)	6 (1.7)	<0.001
	1	61 (7.0)	18 (3.5)	43 (12.2)	
	2	150 (17.3)	63 (12.3)	87 (24.6)	
	3	179 (20.6)	98 (19.1)	81 (22.9)	
	4	211 (24.3)	121 (23.5)	90 (25.5)	
	5	183 (21.1)	144 (28.0)	39 (11.0)	
	6	69 (8.0)	62 (12.1)	7 (2.0)	
	7	5 (0.6)	5 (1.0)	0 (0.0)	

[a]Chi-Square test, comparison between sexes

Table 2

Descriptives and distributions of the study variables by gender at T2 follow-up in 2011−2012.

Variable		All (n=1122)		Females (n=642)		Males (n=480)		
		n (%)	Mean (SD) or Median [IQR]	n (%)	Mean (SD) or Median [IQR]	n (%)	Mean (SD) or Median [IQR]	P
Occupation (n=1016)	Manual	200 (17.8)		49 (8.4)		151 (34.6)		<0.001[a]
	Lower non-manual	383 (34.1)		301 (51.9)		82 (18.8)		
	Higher non-manual	433 (38.6)		230 (39.7)		203 (46.6)		
Sports activities (n=1075)	Passive	854 (79.4)		481 (77.7)		373 (81.8)		0.11[a]
	Moderately or highly active	221 (20.6)		138 (22.3)		83 (18.2)		
Smoking (n=1120)	Current of former smoker	512 (45.7)		265 (41.4)		247 (51.5)		0.001[a]
	Never smoked	608 (54.3)		375 (58.6)		233 (48.5)		
TAS-20 Total score			41.70 (10.27)		40.20 (10.63)		43.71 (9.52)	<0.001[b]
DIF			10.00 [6.00]		10.00 [6.00]		10.00 [7.00]	0.12[c]
DDF			9.00 [5.00]		9.00 [5.00]		10.00 [5.00]	<0.001[c]
EOT			20.19 (4.87)		19.01 (4.96)		21.78 (4.28)	<0.001[b]
BDI			3.00 [6.00]		4.00 [7.00]		2.00 [6.00]	<0.001[c]

[a]Chi-Square test, comparison between the sexes

[b]T-test, comparison between genders

[c]Mann-Whitney U Test, comparison between the sexes

TAS-20 = 20-item Toronto Alexithymia Scale, DIF = Difficulty identifying feelings, DDF = Difficulty describing feelings, EOT = Externally oriented thinking, BDI = Beck Depression Inventory, SD = Standard deviation, IQR = Interquartile range

Table 3
Associations of the categorized variables with the 20-item Toronto Alexithymia Scale (TAS-20) total scores.

		TAS-20 Total Score			Multivariate analysis[c]		
Variable		Mean	SD	P	F	Mean Square	P
Sex	Female	40.20	10.63	<0.001[a]	15.63	1086.83	<0.001
	Male	43.71	9.52				
Ideal CVH Index score at baseline	0	55.00	-	0.001[b]	2.89	201.07	0.005
	1	41.64	14.06				
	2	44.61	10.26				
	3	42.65	10.35				
	4	41.36	9.88				
	5	40.16	10.21				
	6	39.04	10.49				
	7	36.90	12.22				
Occupation at T2	Manual	45.34	8.92	<0.001[b]	6.25	434.26	0.002
	Lower non-manual	41.91	10.26				
	Higher non-manual	39.18	9.55				
Sports activities at T2	Passive	41.79	10.37	0.081[a]	-		
	Moderately or highly active	40.43	9.89				
Smoking at T2	Current of former smoker	42.84	10.45	0.001[a]	0.006	0.34	0.94
	Never smoked	40.71	10.03				
Intercept					107.84	7496.84	<0.001
Corrected model					6.66	463.07	<0.001

[a]T-test
[b]One-way ANOVA
[c]ANCOVA. The analysis included the variables that were significantly associated with the TAS-20 total score in the univariate analyses and was adjusted with age and the Beck Depression Inventory scores.

Table 4
Associations of the categorized variables with the Difficulty Identifying Feelings (DIF), Difficulty Describing Feelings (DDF), and Externally Oriented Thinking (EOT) scores.

		DIF						DDF						EOT					
		Univariate analysis			Multivariate analysis[e]			Univariate analysis			Multivariate analysis[e]			Univariate analysis			Multivariate analysis[e]		
Variable		Median	IQR	P	F	Mean Square	P	Median	IQR	P	F	Mean Square	P	Mean	SD	P	F	Mean Square	P
Sex	Female	10.00	6.00	0.118[a]	-			9.00	5.00	<0.001[a]	7.50	87.37	0.006	19.01	4.96	<0.001[c]	38.33	737.20	<0.001
	Male	10.00	7.00					10.00	5.00					21.78	4.28				
Ideal CVH Index score at baseline	0	19.00	-	0.007[b]	2.69	33.62	0.009	18.00	-	0.024[b]	3.09	35.97	0.003	18.00	-	0.018[d]	0.75	14.43	0.63
	1	10.00	7.00					11.00	9.00					19.07	6.81				
	2	11.00	7.00					10.00	6.00					21.00	4.59				
	3	11.00	7.00					10.00	6.00					20.51	4.81				
	4	10.00	5.00					9.00	5.00					20.30	4.71				
	5	9.00	6.00					9.00	6.00					19.69	4.84				
	6	9.00	7.00					9.00	4.00					18.64	5.69				
	7	11.00	8.00					7.50	7.00					17.30	6.57				
Occupation at T2	Manual	11.00	7.00	<0.001[b]	4.56	57.43	0.010	11.00	6.00	<0.001[b]	2.18	25.40	0.11	22.41	3.89	<0.001[d]	4.90	94.18	0.008
	Lower non-manual	11.00	7.00					9.00	5.00					20.23	5.00				
	Higher non-manual	9.00	6.00					9.00	5.00					18.96	4.62				
Sports activities at T2	Passive	10.00	7.00	0.24[a]	-			9.00	5.00	0.29[a]	-			20.20	4.86	0.21[c]	-		
	Moderately or highly active	10.00	6.00					9.00	5.00					19.74	4.83				
Smoking at T2	Current of former smoker	11.00	7.00	<0.001[a]	0.004	0.045	0.95	10.00	5.00	0.19[a]	-			20.62	4.86	0.007[c]	0.082	1.59	0.77
	Never smoked	10.00	6.00					9.00	5.00					19.83	4.86				
Intercept					18.97	236.90	<0.001				27.89	325.06	<0.001				143.48	2759.66	<0.001
Corrected model					14.32	178.76	<0.001				6.32	73.62	<0.001				3.74	71.94	<0.001

[a]Mann-Whitney U Test
[b]Kruskall-Wallis Test
[c]T-test
[d]One-way ANOVA
[e]ANCOVA. The analysis included the variables that were significantly associated with the corresponding subscale (DIF, DDF, EOT) in the univariate analyses and was adjusted with age and the Beck Depression Inventory scores.

Table 5
Comparison of the 20-item Toronto Alexithymia Scale (TAS-20) total and subscale scores in 2011−2012 (T2) based on the separate ideal cardiovascular health (ICH) criteria measured at baseline in 1986 (n=1122).

			TAS-20 Total score			DIF			DDF			EOT		
ICH criterion		n (%)	Mean	SD	P[a]	Median	IQR	P[b]	Median	IQR	P[b]	Mean	SD	P[a]
Ideal Blood pressure	Non-ideal	348 (31.0)	42.49	10.05	0.89	11.00	6.00	0.098	10.00	6.00	0.062	20.49	4.75	0.18
	Ideal	774 (69.0)	41.35	10.41		10.00	7.00		9.00	5.00		20.06	4.92	
Ideal Total cholesterol	Non-ideal	647 (57.7)	41.69	10.32	0.96	10.00	6.00	0.13	10.00	5.00	0.47	19.99	4.76	0.11
	Ideal	475 (42.3)	41.72	10.31		10.00	7.00		9.00	5.00		20.46	5.02	
Ideal Fasting Plasma Glucose	Non-ideal	24 (2.1)	43.13	10.58	0.50	9.50	6.00	0.96	9.00	6.00	0.19	20.83	5.35	0.52
	Ideal	1098 (97.9)	41.67	10.31		10.00	6.00		9.00	5.00		20.18	4.86	
Ideal Smoking	Non-ideal	704 (62.7)	42.43	10.40	0.002	11.00	9.00	0.11	10.00	6.00	0.16	20.54	4.85	0.002
	Ideal	418 (37.3)	40.49	10.06		10.00	6.00		9.00	5.00		19.61	4.86	
Ideal Physical activity	Non-ideal	887 (79.1)	41.98	10.47	0.080	10.00	6.00	0.21	9.00	5.00	0.28	20.28	4.88	0.25
	Ideal	235 (20.9)	40.66	9.62		10.00	7.00		9.00	5.00		19.87	4.85	
Ideal Body-mass index	Non-ideal	152 (13.5)	43.61	10.86	0.014	11.00	8.00	0.12	10.00	6.00	0.017	20.74	4.88	0.13
	Ideal	970 (86.5)	41.41	10.20		10.00	6.00		9.00	5.00		20.11	4.87	
Ideal Diet	Non-ideal	861 (76.7)	42.18	10.17	0.005	10.00	6.00	0.010	9.00	5.00	0.086	20.42	4.78	0.007
	Ideal	261 (23.3)	40.13	10.63		9.00	6.00		9.00	6.00		19.45	5.11	

DIF=Difficulty Identifying Feelings, DDF=Difficulty Describing Feelings, EOT=Externally Oriented Thinking

[a]T-test

[b]Mann-Whitney U Test