

Depression and neuroticism in patients with peripheral arterial disease: a cross-sectional study

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Research article

Keywords: Peripheral arterial disease, Depression, Neuroticism, Personality, Descriptive survey study

Posted Date: September 27th, 2019

DOI: <https://doi.org/10.21203/rs.2.15275/v1>

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Version of Record: A version of this preprint was published on June 22nd, 2020. See the published version at <https://doi.org/10.1186/s12872-020-01586-y>.

Abstract

Background: The aim of this study was to examine the relationship of depressive symptomatology and personality traits with peripheral arterial disease (PAD). **Methods:** The sample comprised of 300 individuals (Mean age=65.3±8.7 years, 61.0% female) recruited from the offices of 33 general practitioners. Based on at-rest ankle-brachial index (ABI) values and claudication symptoms, four subsamples were formed: clear PAD-positive, clear PAD-negative, ABI-negative but symptomatic, and a non-compressible-artery group. The concurrent role of depression (assessed by a shortened version of the Beck Depression Inventory), and five-factor personality traits (measured with the Big Five Inventory) in predicting PAD status was examined using multinomial logistic regression analysis – controlled for sex, age, hypertension, diabetes, smoking, hazardous drinking, and body mass index. **Results:** Depressive symptomatology was significant in predicting peripheral arterial disease status even after controlling for both traditional risk factors and personality traits. Among the Big Five personality traits, neuroticism showed the most consistent relationship with PAD – independently of depression. **Conclusions:** Patients with PAD – even those with asymptomatic forms of the disease – are at higher risk for suffering from depression compared to individuals without PAD, independently of neuroticism, other Big Five personality dimensions or traditional risk factors for cardiovascular diseases.

Background

As a result of population growth, global ageing and diabetes, in the last decade the number of peripheral arterial disease (PAD) patients has increased by 23 % (1). Even though it is estimated to affect over 200 million people worldwide, individuals in early stages of PAD either do not experience or under-report claudication (lower extremity pain) symptoms, thus PAD frequently remains undetected and untreated (2).

There is evidence to suggest that depressed patients with PAD, even with minimal symptoms of depression (3), have more severe PAD symptoms and more imperiled physical function compared to non-depressed patients (4, 5). Big Five Personality traits, for instance lower openness and extraversion, have also been linked to poorer cardiovascular outcomes (6). In addition, higher neuroticism, lower extraversion and lower conscientiousness have also been linked to depressive symptoms in both healthy and clinical populations (7, 8).

Studies to date aiming to investigate psychosocial factors related to PAD have not included personality variables and have not considered the multifaceted clinical presentation of PAD. Therefore, the aim of the present study was to investigate the relationship between personality traits, depression, and PAD – controlling for well-known risk factors for cardiovascular diseases. When doing so, three different presentations of PAD were considered to provide a more nuanced picture of the relationship between the psychological variables and disease progress.

Methods

Participants and procedure

The study was approved by the Scientific and Research Ethics Committee of the Medical Research Council, Semmelweis University (ETT TUKEB 285/2015) and was carried out in accordance with the tenets of the Declaration of Helsinki. Data collection took place between November 2015 and February 2018, with participants recruited from the practices of 33 general practitioners from across Hungary.

PAD usually appears after the age of 50 years, with an exponential increase after the age of 65 years. According to governmental regulations of the country of study, it is obligatory to record every patients' ankle-brachial index (ABI) values every two years after reaching the age of 45; therefore, the target population included men and women aged 45 or older with at least one major vascular risk factor (current smoking, type 2 diabetes, or hypertension). Altogether, 300 ($M_{age} = 65.3$ years, $SD = 8.7$ years; 61.0% female) individuals agreed to participate in the present study. Patients provided written informed consent.

Participants' medical history and the presence of major cardiovascular risk factors were recorded based on the health records kept by their general practitioners. The in-person examination started by completing the Edinburgh Claudication Questionnaire, a validated and frequently used method of screening for intermittent claudication. The Questionnaire has a sensitivity of over 80-90% and a specificity of over 95% (9). Second, the basic body measurements (height and weight) were performed. After a 5-minute rest, blood pressure and pulse were measured on both upper extremities (using a blood pressure manometer, Bosch Konstante) three times. Following current recommendations for the calculation of the ankle-brachial index (ABI) (1), systolic pressure on all four extremities was also measured with a continuous wave Doppler-US instrument at 8 MHz (multiDOPPY).

Based on at-rest ABI values and symptoms, four patient-groups were determined. Patients with negative at-rest ABI results without any symptoms indicating sclerosis were considered as 'clear PAD-negative'. Patients with normal at-rest ABI values but whose Edinburgh Questionnaire results revealed symptoms of intermittent claudication (e.g., pain following walking uphill or climbing stairs) were coded as 'ABI-negative-symptomatic'. The 'clear PAD-positive' group comprised patients whose ABI results were positive and clearly suffered from atherosclerosis, asymptomatic or symptomatic stenosis or occlusion reducing the blood flow. Patients, whose major arteries are hardened for various reasons (such as medial sclerosis), have non-compressible arteries. Due to this, blood pressure values at the ankle often show false high values; the Doppler Index is over 1.4. This subgroup of participants was labelled as the 'non-compressible-artery group'.

Psychological instruments

Depressive symptoms were measured with the shortened Hungarian version of the Beck Depression Inventory (BDI), which is a 9-item questionnaire to assess depression severity (10). Each item is scored on a 4-point scale ranging from 0 (not at all characteristic of me) to 3 (very characteristic of me). Internal consistency of the scale proved to be excellent in the current sample (Cronbach's $\alpha = .86$). To allow

international comparability, the total score of the 9-item version was transformed to its equivalent in the 21-item original version by multiplying the total scores by 2.22. The cut off score indicating the presence of at least mild depression was therefore identical to that in the international literature (≥ 10).

Personality dimensions (extraversion, agreeableness, conscientiousness, neuroticism and openness) were measured with the Big Five Inventory (BFI-44) (11). On the 44-item questionnaire, each item is rated on a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree). Internal consistency of the dimensions was good in the current sample (Cronbach's α -s of .89, .75, .71, .84, and .90, respectively).

Statistical analyses

The Kolmogorov-Smirnov test indicated that the distribution of all continuous variables differed significantly from the normal distribution. Therefore, when investigating the relationship between peripheral arterial disease status and these variables, the non-parametric Kruskal-Wallis test was used. When examining the association between the dependent variable and the categorical independent variables, the chi square test was employed. On the multivariate level, a multinomial logistic regression analysis was conducted to investigate the role of all independent variables in differentiating between those intact from peripheral arterial disease ('clear PAD-negative') versus those affected ('ABI-negative-symptomatic', 'non-compressible-artery' and 'clear PAD-positive').

Results

The descriptive data indicated that the prevalence of depression was 63% in the clear PAD-positive subgroup, 59% in those who were symptomatic, but whose ABI values did not show abnormalities, and only 20% in the non-compressible-artery group in contrast to the 8% prevalence rate among those without any signs of PAD (Table 1). Results of the bivariate analyses indicated that all independent variables, but hypertension and diabetes status were significantly associated with peripheral arterial disease status (Table 1). The data showed that those without any signs of peripheral arterial disease reported lower levels of depressive symptomatology than the rest of the sample.

Similar findings emerged from the multivariate analyses (Table 2): results of the multinomial logistic regression analysis ($\chi^2 = 181.5$, $p < .001$, Cox and Snell $R^2 = .456$) indicated that depressive symptomatology was significant in predicting peripheral arterial disease even after controlling for both traditional risk factors and personality traits. In each pair of comparison, increased level of depressive symptomatology was associated with a higher likelihood of presenting with symptoms of peripheral arterial disease. Among the Big Five personality traits, neuroticism showed the most consistent relationship with peripheral arterial disease: in each comparison, those with a higher level of neuroticism had a higher likelihood of suffering from the symptoms of peripheral arterial disease.

Discussion

The aim of the present study was to shed light on the pattern of relationships existing between personality traits, depression and peripheral arterial disease considering a more complex taxonomy than the simple presence or absence of PAD. The results revealed that patients with PAD – even those suffering from asymptomatic forms of the disease – are at higher risk for suffering from depression compared to people without PAD, independently of neuroticism or other Big Five personality traits. These findings are consistent with prior studies indicating a larger prevalence of depression in individuals with PAD than in those without (4). These results also confirm that the relationship between PAD and depression cannot be explained by the influence of a general proneness to negative affectivity (neuroticism); the clinical symptoms of depression have a distinct relationship with PAD.

However, the cross-sectional design of the present study does not allow firm conclusions to be drawn regarding the nature of the relationship between PAD and depression. Even though a previous study found no difference in depressive symptomatology before and after the effective treatment of PAD (12) – suggesting that depression is not a consequence of PAD-related functional limitations –; at this point, it is not clear whether depressive symptoms contribute to the pathogenesis of PAD or whether the limitations caused by this cardiovascular disorder exacerbates depressive symptoms or even so, whether the relationship between the two conditions is rather bidirectional as suggested by a prospective cohort study (13). It is also possible that the relationship between the two disorders can be traced back to the influence of one or more external variables – such as the increased production of inflammatory cytokines (14) – that seems to be a correlate of both conditions. Further research with longitudinal designs and the parallel investigation of physiological and psychological variables could help us better understand the nature of the relationship between depression and PAD.

A major strength of the present study was the nuanced operationalization of PAD. Although the PAD subcategories employed in the present analyses are in general use in clinical practice, none of the previous studies considered ABI-negative-symptomatic or the non-compressible-artery patients when investigating the relationship between depression and PAD, although individuals with these different presentations of PAD have the same mortality rate (15). Limitations of the present study also need to be acknowledged. First, recruitment of participants was not systematic or random and occurred in the primary care setting making it difficult to evaluate the generalizability of the findings. Further, the simultaneous presence of a relatively large number of independent variables and the relatively small sample of individuals in the ‘ABI-negative-symptomatic’ and the ‘Non-compressible-artery’ group also limits the reliability of the regression models for these subgroups.

Conclusions

Despite these limitations, results of the present study call our attention to the fact that people with PAD – even those with asymptomatic forms of the disease – are at higher risk for depression compared to people without PAD, independently of neuroticism. These results underscore the importance of a multidisciplinary approach when providing care for individuals suffering from PAD and in order to provide

comprehensive assessment and treatment preventing poor prognoses in either the somatic or mental health domain.

Abbreviations

PAD: peripheral arterial disease

ABI: ankle-brachial index

BDI: Beck Depression Inventory

BFI-44: Big Five Inventory

Declarations

Ethics approval and consent to participate

The study was approved by the Scientific and Research Ethics Committee of the Medical Research Council, Semmelweis University (ETT TUKEB 285/2015) and was carried out in accordance with the tenets of the Declaration of Helsinki. Patients provided written informed consent.

Consent for publication

Not applicable.

Availability of data and materials

The datasets generated and analyzed during the current study are not yet publicly available but are available from the corresponding author on reasonable request or will be placed in a public repository if requested.

Competing interests

The authors declare that they have no competing interests.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. While working on this manuscript, financial support was provided to the first author by Semmelweis University (grant # EFOP-3.6.3-VEKOP-16-2017-00009). Semmelweis University did not have a role in the study design, collection, analysis or interpretation of the data, writing the manuscript, or the decision to submit the paper for publication.

Authors' contributions

Gergely Tóth-Vajna, Zsombor Tóth-Vajna and Piroska Balog designed the study and wrote the protocol. Gergely Tóth-Vajna, Zsombor Tóth-Vajna, Piroska Balog and Barna Konkoly Thege conducted the literature searches and provided summaries of previous research studies. Barna Konkoly Thege conducted the statistical analysis. Gergely Tóth-Vajna wrote the first draft of the manuscript and all authors contributed to and have approved the final manuscript.

Acknowledgements

The authors express their gratitude to Professor Ferenc Túry for his comments on an earlier version of the manuscript and to Audree Francis for the English language proof reading.

Additional information

The abstract 'Depression and neuroticism in patients with peripheral arterial disease: a cross-sectional study' was presented as an oral presentation in 'Semmelweis University PhD Scientific Days 2019, Budapest, April 25–26, 2019' but was not published before as an article.

Tables

Table 1. Characteristics of the sample stratified by peripheral arterial disease status

	Clear-PAD- negative (n = 126)	ABI-negative- symptomatic (n = 49)	Non-compressible-artery group (n = 39)	Clear-PAD- positive (n = 86)	Test statistics
Sex					$\chi^2 = 9.047, p = .029$
Female	87 (69.05)	27 (55.10)	26 (66.67)	43 (50.00)	
Male	39 (30.95)	22 (44.90)	13 (33.33)	43 (50.00)	
Age (years)	63.52 (8.88)	66.14 (7.30)	66.62 (9.12)	66.90 (8.45)	$K-W \chi^2 = 10.955, p = .012$
Hypertonia					$\chi^2 = 3.530, p = .317$
No	31 (24.60)	8 (16.33)	9 (23.08)	13 (15.12)	
Yes	95 (75.40)	41 (83.67)	30 (76.92)	73 (84.88)	
Diabetes					$\chi^2 = 3.210, p = .360$
No	83 (65.87)	33 (67.35)	20 (51.28)	53 (61.63)	
Yes	43 (34.13)	16 (32.65)	19 (48.72)	33 (38.37)	
Smoking					$\chi^2 = 17.295, p = .001$
No	108 (85.71)	34 (69.39)	31 (79.49)	53 (61.63)	
Yes	18 (14.29)	15 (30.61)	8 (20.51)	33 (38.37)	
Hazardous drinking	1.11 (1.33)	1.06 (1.65)	1.23 (1.66)	2.05 (2.30)	$K-W \chi^2 = 11.506, p = .009$
Body mass index	30.91 (5.49)	29.48 (5.28)	31.85 (6.33)	28.19 (4.59)	$K-W \chi^2 = 16.489, p = .001$
Extraversion	29.44 (6.67)	26.02 (7.15)	29.97 (7.05)	23.13 (6.87)	$K-W \chi^2 = 45.823, p < .001$
Agreeableness	35.75 (4.26)	34.86 (4.87)	36.32 (5.06)	31.45 (5.70)	$K-W \chi^2 = 33.824, p < .001$

	Clear-PAD- negative (n = 126)	ABI-negative- symptomatic (n = 49)	Non-compressible-artery group (n = 39)	Clear-PAD- positive (n = 86)	Test statistics
Conscientiousness	37.58 (4.68)	36.61 (4.07)	37.67 (4.35)	35.10 (4.38)	$K-W \chi^2 = 16.470, p = .001$
Neuroticism	21.85 (5.10)	26.37 (5.47)	24.05 (6.17)	28.58 (6.14)	$K-W \chi^2 = 63.708, p < .001$
Openness	32.32 (8.57)	28.02 (8.22)	33.31 (9.25)	25.66 (6.16)	$K-W \chi^2 = 41.448, p < .001$
Depression (continuous)	3.82 (6.29)	12.28 (8.41)	6.03 (6.15)	16.31 (10.42)	$K-W \chi^2 = 98.393, p < .001$
Depression (categorical)	10 (7.94)	29 (59.18)	8 (20.51)	54 (62.79)	$\chi^2 = 87.325, p < .001$

Note. Descriptive values are frequencies (and percentages) for categorical variables, while means (and standard deviations) for continuous variables. $K-W \chi^2$: Kruskal-Wallis χ^2

Table 2. Predictors of peripheral arterial disease status (multinomial logistic regression)

	ABI-negative-symptomatic†			Non-compressible-artery group †			Clear-PAD-positive†		
	<i>OR</i>	<i>95% CI</i>	<i>p</i>	<i>OR</i>	<i>95% CI</i>	<i>p</i>	<i>OR</i>	<i>95% CI</i>	<i>p</i>
Sex (male)	1.888	0.798-4.466	.148	1.145	0.453-2.892	.775	1.654	0.723- 3.786	.234
Age	1.046	0.994-1.101	.082	1.059	1.005-1.116	.032	1.057	1.009- 1.107	.020
Hypertonia	1.742	0.612-4.958	.299	1.059	0.393-2.858	.909	1.944	0.719- 5.257	.190
Diabetes	1.180	0.508-2.742	.700	1.723	0.742-3.998	.205	1.549	0.712- 3.372	.270
Smoking	5.757	2.089- 15.868	.001	3.515	1.183-10.448	.024	6.829	2.589- 18.018	< .001
Hazardous drinking	0.925	0.702-1.220	.582	1.100	0.831-1.456	.505	1.211	0.967- 1.516	.095
Body mass index	0.987	0.914-1.067	.746	1.056	0.981-1.137	.146	0.937	.868-1.012	.099
Extraversion	1.031	0.945-1.125	.492	1.033	0.938-1.138	.505	1.005	0.926- 1.090	.914
Agreeableness	1.160	1.039-1.294	.008	1.105	0.985-1.240	.089	1.042	0.943- 1.151	.420
Conscientiousness	1.078	0.978-1.189	.129	1.051	0.950-1.162	.335	1.040	0.950- 1.138	.399
Neuroticism	1.097	1.004-1.198	.041	1.120	1.025-1.225	.012	1.102	1.015- 1.196	.021
Openness	0.973	0.901-1.051	.486	1.032	0.953-1.118	.437	1.012	0.941- 1.088	.750
Depression (continuous)	1.451	1.241-1.697	< .001	1.218	1.024-1.448	.026	1.436	1.240- 1.662	< .001

† Reference category: Clear-PAD-negative. *OR*: odds ratio; *CI*: confidence interval for the odds ratio

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