Research Paper

# Positive and negative well-being of older adults with symptomatic peripheral artery disease: A population-based investigation

JRSM Cardiovascular Disease
Volume 0: 1–10

DOI: 10.1177/2048004020961717
journals.sagepub.com/home/cvd
SAGE

**Snorri Bjorn Rafnsson[1] and Gerry Fowkes[2]**

## Abstract

**Objective:** We investigated positive and negative subjective well-being in relation to lower-extremity peripheral artery disease (PAD) in a sample of older adults.

**Method:** 4760 participants in the English Longitudinal Study of Ageing (ELSA) provided baseline data on symptomatic PAD, sociodemographic characteristics, lifestyle risk factors, and co-morbid conditions. Baseline and two-year follow-up data were available for life satisfaction, quality of life, and depressive symptoms.

**Results:** Participants with PAD symptoms had lower baseline levels of life satisfaction ($\beta = -0.03$, $p < .05$) and quality of life ($\beta = -0.04$, $p < .01$), and more depressive symptoms ($\beta = 0.03$, $p < .05$). These associations remained statistically significant in multivariate analyses. Baseline PAD did not, however, influence well-being levels at two-year follow-up.

**Discussion:** Greater awareness of the potential for chronic vascular morbidity to disrupt the lives of older adults is needed to inform effective multidisciplinary support and interventions that help maintain the quality of life of those affected.

## Keywords

Peripheral artery disease, life satisfaction, quality of life, depressive symptoms, English Longitudinal Study of Ageing

Date received: 15 May 2020; Revised 27 July 2020; accepted: 31 August 2020

## Introduction

Subjective well-being is a multifaceted concept reflecting both positive and negative dimensions.[1,2] The positive aspects of well-being reflect how individuals judge their quality of life based on their own standards of what constitutes a good life (this reflects their satisfaction with life or *evaluative* well-being) and their perceived control over their lives and ability to enjoy it (also known as 'flourishing' or *eudemonic* well-being). On the other hand, the negative aspect of persons' well-being consists of moods and emotions, including feeling of sadness and anxiety (also known as negative *affective* well-being). As a marker of successful ageing, much effort has been made to document different well-being dimensions across the life course and to study their diverse determinants in later life.[3–5] Importantly, well-being and health are positively correlated[6]; this relationship may become increasingly important at older ages, not least because of the strong association between advancing age and prevalence of chronic illness, including atherosclerotic cardiovascular disease (CVD), which constitutes a major cause of mortality and ill health globally.[7–9]

With advancements in life expectancy and cardiovascular therapeutic improvements, maintaining life quality in older survivors remains an important goal given the potential of CVD to disrupt the lives of

[1]Geller Institute of Ageing and Memory, School of Biomedical Sciences, University of West London, London, UK
[2]Usher Institute for Population Health Sciences, University of Edinburgh, Edinburgh, UK

**Corresponding author:**
Snorri Bjorn Rafnsson, Geller Institute of Ageing and Memory, School of Biomedical Sciences, University of West London, St. Mary's Road, Ealing, London W5 5RF, UK.
Email: Snorri.Rafnsson@uwl.ac.uk

individuals by limiting their psychosocial capacity, functional status and productivity.[7,10,11] There is growing evidence documenting the diverse impact of different CVDs on the lives of older adults,[12] including those suffering from peripheral artery disease (PAD), defined as atherosclerosis of the distal aorta and/or lower-limb arteries causing arterial narrowing and disruption of blood flow to the legs.[13] The prevalence of PAD rises steeply with age and affects a substantial proportion of older adults.[14] It commonly presents as intermittent claudication, that is, pain usually in the calf occurring on exertion and resolving after rest; more severe forms of clinical disease include rest pain, gangrene or ulceration, occasionally leading to amputation.[15,16]

As a marker of generalised atherosclerosis, PAD risk factors mirror other forms of CVD; for example, smoking and type-2 diabetes are important factors associated with the development of clinical disease. Co-morbidity (e.g. coronary heart disease) is also highly prevalent and CVD mortality risk is elevated.[13,17] The impact of PAD on individuals' physical, psychological and social functional capacity has also attracted research interest. In the majority of investigations to-date, the main study outcome is health-related quality of life (HRQoL), which reflects persons' appraisal of their current level of functioning, often their ability to carry out predefined tasks.[18,19] Several small-scale studies of selected patient samples have reported reduced HRQoL levels in persons with symptomatic PAD[20–23] and amputees.[22,23] On the other hand, comprehensive evidence from community-derived samples of older survivors with PAD is lacking although two previous Scottish cross-sectional investigations[24,25] observed lower HRQoL in individuals with claudication (compared to those without symptoms) which was mainly attributed to poor physical capacity (mental functioning remained intact).

There is consensus that well-being denotes a broader concept than HRQoL given that it includes different evaluations of non-health related features of life,[18,26] such as being able to enjoy oneself or plan for the future. Importantly, impaired health does not necessarily equate to low well-being; in fact, there may be situations where persons may not be expected to return to normal activities yet manage to overcome disease-specific limitations (e.g. reduced walking distance) and adjust their lives accordingly.[19] In the context of living well with PAD, however, there is very limited evidence on the impact of lower-limb morbidity on the broader aspects of well-being, whether positive or negative, which extend beyond persons' ability to complete specific activities. Moreover, well-being levels are subject to substantial deterioration over time, especially in older adults in whom such decline is linked to progressive physical and mental impairment.[1,27] Given the current absence of relevant longitudinal evidence, however, it is not clear how any changes in well-being levels compare in older survivors with and without PAD, or to what extent lower-limb morbidity affects different well-being facets over time.

Our aim was to determine the above relationships in a sample of participants in the English Longitudinal Study of Ageing (ELSA), a large nationally representative panel study of people aged 50 years and older. Our objectives were three-fold: 1) to determine the direction and magnitude of any associations between symptomatic PAD and three indicators of positive (life satisfaction, quality of life) and negative (depressive symptoms) well-being; 2) to determine any differential associations between PAD and specific well-being indicators; and 3) to determine whether any observed associations existed independently of relevant potential confounding factors. Based on the previous evidence of the impact of morbidity on well-being in older adults,[27] we hypothesised that symptomatic PAD would be associated with lower positive, and higher negative, well-being levels. We also hypothesised that baseline PAD would be associated with greater deterioration in well-being over a two-year follow-up period.

## Methods

### *Data and sample*

The ELSA is a study of adults aged 50 years and over, who were living in private households in England at the time of the first wave of fieldwork in 2002/2003. Sampling and data collection procedures in ELSA have previously been described in detail.[28] Briefly, respondents in wave one (the baseline sample in ELSA), were approached two years later for a second wave (in 2004–2005) which provides the baseline data for the present analysis, as this was the first time information on symptomatic PAD was collected. Specifically, information on PAD symptoms, well-being measures and potential confounders were gathered from a total of 8,780 core participants using a computer assisted personal interview (CAPI) during a home visit and a self-completion questionnaire to be returned by post. The sample for the present investigation was restricted to 4760 core ELSA participants with complete outcome data at waves two (2004–2005) and three (2006–2007). Written informed consent was obtained from all participants, and ethical approval was granted by a Multicentre Research Ethics Committee (MREC).

### Peripheral artery disease

The presence of lower-extremity PAD was determined based on the Edinburgh Claudication Questionnaire (ECQ) which relies on self-report of lower-limb symptoms.[29] To qualify as having definite or typical claudication, a respondent needs to: 1) experience pain or discomfort on walking; 2) not get it when standing still or sitting; 3) the pain disappears in 10 minutes or less after rest; 4) experience the pain in the calf. Based on these criteria, the following classification of claudication case status was derived: 1) No PAD symptoms; 2) Typical Grade 1 claudication (applies if person experiences the pain when walking uphill or when in a hurry); and 3) Typical Grade 2 claudication (applies if individual experiences the pain when walking at an ordinary pace on level ground). For the purpose of the present analysis, participants reporting Grade 1 and Grade 2 claudication were combined and compared with those without such symptoms. Moreover, the presence of atypical claudication (i.e. pain in the thigh or buttocks in the absence of calf pain) or other atypical leg pain was not considered in this investigation.

### Well-Being measures

*Life satisfaction.* The Satisfaction with Life Scale (SWLS), which consists of five items, was used to assess how satisfied participants were with his or her life.[30] Responses are based on a seven-point scale (ranging from strongly disagree to strongly agree). A typical SWLS item would be 'In most ways my life is close to my ideal'. For the present analysis, responses were reversed and re-scaled, then summed for a total scale score ranging from 0 to 30; higher scores indicate greater overall satisfaction with life (Cronbach's alpha at waves two and three was 0.896 and 0.901, respectively).

*Quality of life.* Quality of life was determined using CASP-19, which is a summative scale of 19 items, comprising four main domains: control, autonomy, self-realization and pleasure.[31] The scale includes both positively and negatively worded statements, one example being 'I enjoy the things I do'. Each statement is scored on a four-point scale: 'never', 'not often', 'sometimes' and 'often'. For the present purpose, individual items were added to create a total score, ranging from 0 to 57; higher scores represented greater life quality (Cronbach's alpha ranged from 0.872 to 0.884 across waves two and three).

*Depressive symptoms.* Symptoms of depression were assessed using the eight-item Center for Epidemiologic Studies Depression Scale (CES-D), which is a brief self-report scale designed to measure depressive symptomatology in the general population.[32] Responses to all eight dichotomous questions (e.g. a typical question being 'how much of the time during the past week did you feel sad?') were combined to create a total scale score, ranging from 0 to 8, with higher scores indicating a greater degree of depression. The eight-item version has good internal consistency (Cronbach's alpha ranged from 0.789 at wave two to 0.786 at wave three) and other psychometric properties comparable to the full 20-item CES-D scale.

### Confounding variables

Based on the approach used in previous comparable studies,[24,25] an *a priori* model was specified which included the following potential confounders: Age (categorised into four age groups i.e. 50–59, 60–69, 70–79 and 80+); Gender (male versus female); Relationship status (married or cohabiting versus neither i.e. single, divorced or widowed); Total (non-pension) wealth, used here as an indicator of socioeconomic status; Highest education level completed (no qualification, intermediate, degree or higher); Smoking status (never, former or current smoker); Sedentary lifestyle (sedentary versus low to high physical activity); and self-reported doctor's diagnosis of diabetes (yes/no) and angina pectoris (yes/no).

### Statistical analysis

Descriptive analyses were performed on baseline data stratified for participants with or without PAD. Non-pension wealth was divided into quintiles because its distribution was positively skewed. Age was used as a four-level categorical variable in bivariate analyses but as a continuous variable in multivariable analyses. Pearson $\chi^2$ (Chi-square) was used to test relationships between binary categorical variables; for assessment of trends for ordinal categorical variables, the $\chi^2$ trend (Linear-by-Linear Association) test was used. An independent-samples t-test was conducted to compare well-being levels at baseline and follow-up in those with and without PAD.

Multiple hierarchical linear regression analysis was used for modelling the association between lower-limb symptoms and individual well-being measures. First, we determined the cross-sectional relationship between PAD and well-being at baseline, adjusting only for age and gender, followed by progressively introducing other potential confounding variables into the model. In a second step, we determined the influences of PAD on follow-up well-being levels using lagged hierarchical regression models that first adjusted for age, gender and the respective baseline well-being measure, followed by successively adding other confounding

variables. Using the baseline measure of the dependent variable as a covariate is considered superior to using raw change scores as it obviates the potential spurious correlation between baseline and change scores.[33]

The following major assumptions underlying multiple linear regression analysis were assessed using relevant graphs and statistics: multicollinearity was checked for using Tolerance/variance inflation factor (VIF) values; the independence of residuals was tested for using the Durbin-Watson statistic; homoscedasticity and distribution of residuals were determined through visual inspection of relevant scatter plots; Cook's Distance values were computed to assess the presence of outliers or significant data points. Overall model goodness-of-fit was determined based on the total variance explained or $R^2$. All statistical tests were two-tailed and p values $< .05$ were considered to be statistically significant. All data analyses were performed using IBM SPSS Statistics version 24.

## Results

### Baseline sample characteristics

We excluded 4020 ELSA participants without complete follow-up well-being data, leaving 4760 individuals for the present analysis. Compared to those not included in the analysis, the analytical sample proved to be: comparatively younger at baseline ($p < .001$); included more men ($= .038$); was better educated ($p < .001$); was better off socioeconomically ($p < .001$); was more likely to have never smoked ($p < .001$); and had less diabetes ($p < .001$) and angina ($p < .001$). In contrast, the baseline frequency of PAD did not differ statistically between the two samples ($p = .17$).

Table 1 compares the baseline characteristics of analytical sample participants with and without PAD. Participants with PAD proved to be comparatively older ($p < .001$), more likely to be single ($p = .004$), and were both less educated ($p < .001$) and well-to-do

**Table 1.** Baseline characteristics of analytical sample participants[a] with and without symptomatic peripheral artery disease (PAD).[b]

| Variables | No symptoms (n = 4633) | PAD symptoms (n = 127) | p value[c] |
|---|---|---|---|
| *Age, % (n)* | | | |
| 50–59 | 35.7 (1654) | 20.5 (26) | |
| 60–69 | 36.5 (1691) | 31.5 (40) | |
| 70–79 | 21.7 (1007) | 32.3 (41) | |
| 80+ | 6.1 (281) | 15.7 (20) | <.001 |
| *Gender, % (n)* | | | |
| Female | 53.9 (2498) | 51.2 (65) | .54 |
| *Relationship Status, % (n)* | | | |
| Married/cohabiting | 74.3 (3443) | 63.0 (80) | .004 |
| *Education, % (n)* | | | |
| No qualification | 28.6 (1324) | 49.6 (63) | |
| Intermediate | 55.3 (2563) | 43.3 (55) | |
| Degree or higher | 16.1 (745) | 7.1 (9) | <.001 |
| *Non-pension wealth, % (n)* | | | |
| Lowest quintile | 17.2 (788) | 32.3 (41) | |
| 2nd | 19.4 (886) | 22.0 (28) | |
| 3rd | 19.9 (910) | 15.0 (19) | |
| 4th | 21.2 (971) | 17.3 (22) | |
| Highest quintile | 22.3 (1019) | 13.4 (17) | <.001 |
| *Smoking status, % (n)* | | | |
| Never smoker | 38.9 (1803) | 17.3 (22) | |
| Former smoker | 48.2 (2235) | 51.2 (65) | |
| Current smoker | 12.9 (596) | 31.5 (40) | <.001 |
| *Sedentary lifestyle, % (n)* | | | |
| Yes | 2.3 (108) | 3.9 (5) | .24 |
| *Diabetes, % (n)* | | | |
| Yes | 6.3 (293) | 15.7 (20) | <.001 |
| *Angina Pectoris, % (n)* | | | |
| Yes | 8.2 (380) | 26.0 (33) | <.001 |

[a]4760 core ELSA participants with complete outcome data at Waves two and three.

[b]Persons with typical grades 1 and 2 combined.

[c]Probability values were derived using either Pearson Chi Square test (test of difference between two proportions) or Linear by Linear Association test (test of trend for ordinal categories).

socioeconomically ($p < .001$). The presence of lower-limb symptoms was also related to significantly higher levels of current and former smoking ($p < .001$), and to a higher prevalence of both comorbid diabetes ($p < .001$) and angina ($p < .001$).

### Peripheral artery disease and well-being levels

As shown in Table 2, participants with PAD had comparatively lower life satisfaction levels at baseline ($p = .003$); although the mean levels declined for both groups over time, these differences persisted at the two-year follow-up ($p = .009$). Similarly, the mean quality of life levels at baseline ($p < .001$) and follow-up ($p < .001$) were also found to differ statistically between those with and without PAD despite deteriorating over time in both groups. Lastly, participants with PAD showed statistically higher levels of depressive symptoms at both baseline and follow-up ($p < .001$ and $p = .015$, respectively) despite declining in both groups over time.

### Multivariate associations between peripheral artery disease and well-being at baseline

The results from the multiple linear regression analysis of the cross-sectional relationship between PAD and individual well-being measures are shown in Table 3. After adjusting for age and gender (model 1), PAD was associated with both lower levels of life satisfaction ($\beta = -0.05$, $p < .001$) and quality of life ($\beta = -0.07$, $p < .001$). Moreover, PAD was also related to comparatively higher levels of depressive symptoms ($\beta = 0.06$, $p < .001$). After progressively controlling for socioeconomic factors (model 2), lifestyle factors (model 3) and comorbid conditions (model 4), all associations remained statistically significant, albeit reduced in magnitude. Of the three well-being indicators, the greatest relative influence of PAD was observed for quality of life.

### Multivariate associations between baseline peripheral artery disease and follow-up well-being

Table 4 shows the results from the lagged linear regression analysis which modelled the relationship between baseline PAD and follow-up well-being levels. After adjusting for age, gender and the relevant baseline well-being measure (model 1), we observed a negative yet statistically non-significant influence of PAD on both life satisfaction ($\beta = -0.01$, $p > .05$) and quality of life ($\beta = -0.01$, $p > .05$). The association with depressive symptoms was positive and also

**Table 2.** Unadjusted comparisons of well-being levels (means, standard deviation) at baseline and two-year follow-up in participants with and without peripheral artery disease (PAD).[a]

| | Life satisfaction | | | |
|---|---|---|---|---|
| | Baseline | | Follow-up | |
| PAD status | Mean | SD | Mean | SD |
| No symptoms | 21.6 | 5.9 | 20.3 | 6.2 |
| PAD symptoms | 19.9 | 6.6 | 18.8 | 6.6 |
| *MD (95% CI)[b], p value* | *1.70 (0.56 to 2.64), .003* | | *1.45 (0.37 to 2.58), .009* | |
| | Quality of life | | | |
| | Baseline | | Follow-up | |
| | *Mean* | *SD* | *Mean* | *SD* |
| No symptoms | 43.6 | 8.2 | 41.9 | 8.4 |
| PAD symptoms | 39.7 | 8.6 | 37.8 | 8.1 |
| *MD (95% CI), p value* | *3.90 (2.43 to 5.33), <.001* | | *4.05 (2.58 to 5.52), <.001* | |
| | Depressive symptoms | | | |
| | Baseline | | Follow-up | |
| | *Mean* | *SD* | *Mean* | *SD* |
| No symptoms | 1.32 | 1.78 | 1.24 | 1.77 |
| PAD symptoms | 1.94 | 2.13 | 1.63 | 1.97 |
| *MD (95% CI), p value* | *0.62 (0.31 to 0.94), <.001* | | *0.39 (0.07 to 0.70), .015* | |

[a]Persons with typical grades 1 and 2 combined (typical grade 1 applies if a person experiences the pain when walking uphill or when in a hurry while typical grade 2 applies if a person experiences the pain when walking at an ordinary pace on level ground).
[b]MD (mean difference) and 95% confidence intervals.

**Table 3.** Multiple linear regression models of the relationships between peripheral artery disease (PAD) and subjective well-being at baseline.

| | | | Life satisfaction | | Quality of life | | Depressive symptoms | |
|---|---|---|---|---|---|---|---|---|
| Model | Covariates | PAD status | B | $\beta$ | B | $\beta$ | B | $\beta$ |
| 1 | Age, gender | No symptoms | Ref. | — | Ref. | — | Ref. | — |
| | | PAD symptoms | −1.86 (0.53) | −0.05*** | −3.73 (0.74) | −0.07*** | 0.63 (0.16) | 0.06*** |
| *F for* $\Delta R^2$ | | | *13.373*** | | *12.343*** | | *40.451*** | |
| 2 | Age, gender + socioeconomic factors[a] | No symptoms | Ref. | — | Ref. | — | Ref. | — |
| | | PAD symptoms | −1.32 (0.50) | −0.04** | −2.75 (0.71) | −0.05*** | 0.50 (0.16) | 0.04** |
| *F for* $\Delta R^2$ | | | *186.209*** | | *149.178*** | | *68.967*** | |
| 3 | Age, gender + socioeconomic factors + lifestyle factors[b] | No symptoms | Ref. | — | Ref. | — | Ref. | — |
| | | PAD symptoms | −1.21 (0.50) | −0.03* | −2.55 (0.71) | −0.05*** | 0.46 (0.16) | 0.04** |
| *F for* $\Delta R^2$ | | | *7.080*** | | *39.815*** | | *21.837*** | |
| 4 | Age, gender + socioeconomic factors + lifestyle factors + comorbidity[c] | No symptoms | Ref. | — | Ref. | — | Ref. | — |
| | | PAD symptoms | −1.06 (0.50) | −0.03* | −2.07 (0.71) | −0.04** | 0.39 (0.16) | 0.03* |
| *F for* $\Delta R^2$ | | | *5.043*** | | *26.018*** | | *12.684*** | |
| *Overall model fit* ($R^2$) | | | *0.12*** | | *0.12*** | | *0.08*** | |

Note: B = unstandardized coefficients (standard errors are reported in parentheses). $\beta$ = standardised coefficients.
[a]Socioeconomic factors: Education, non-pension wealth, relationship status.
[b]Lifestyle factors: Smoking, sedentary lifestyle.
[c]Comorbidity: Diabetes, angina. *p < .05; **p < .01; ***p < .001. Ref: Reference.

non-significant ($\beta = 0.00$, $p > .05$). Further adjustment for confounding factors (models 2–4) resulted in progressively weaker, non-significant associations.

## Discussion

To the best of our knowledge, the present investigation is the first to report on the influence of symptomatic, lower-extremity PAD on both positive and negative aspects of well-being in a large population sample of relatively healthy and socioeconomically affluent older adults. Specifically, our results extend the current evidence by demonstrating an association of PAD with reduced life satisfaction and quality of life, as well as greater depressive symptoms. After adjusting for important potential confounders, including socioeconomic characteristics, lifestyle factors, and comorbid conditions, the independent effects of PAD symptoms remained, albeit reduced in magnitude. On the other hand, we failed to observe any independent influences of baseline PAD on follow-up well-being levels.

Direct comparison of the present results with those from earlier studies is hampered by differences in study design and methodology, including the type of study sample and methods employed for both exposure and outcome assessment. Only a few population-based investigations have examined quality of life in relation to symptomatic PAD in older adults. Two previous cross-sectional investigations by Inglis et al.[25] and Dumville et al.[24] observed comparatively lower overall HRQoL levels in persons with claudication in multivariate analyses. In both instances, HRQoL was determined using generic health status instruments (SF-12 and SF-36, respectively) which reflect domain-specific functional and role limitations, including pain, discomfort, and reduced mobility. The use of such HRQoL instruments for measuring quality of life has been called into question as they only measure self-perceived health status.[18] In contrast, broader positive well-being reflects individuals' conscious judgment of the quality of, and satisfaction with, their life. In other words, commonly-used HRQoL questionnaires tend to assess what patients should be able to do rather than what they themselves consider to be important in life.

These broader well-being dimensions are rarely included in HRQoL questionnaires; yet poor positive well-being has been associated with reduced longevity and a greater chronic disease risk.[34] As a marker for successful ageing, positive well-being of older adults has increasingly become an important objective for both financial and health policy.[6] In this context, our study adds relevant evidence on the negative impact of chronic PAD on older adults' satisfaction with, and quality of, life, including their sense of autonomy and

**Table 4.** Multiple linear regression models of the relationships between baseline peripheral artery disease (PAD) and follow-up subjective well-being levels.

| | | | Life satisfaction | | Quality of life | | Depressive symptoms | |
|---|---|---|---|---|---|---|---|---|
| Model | Covariates | PAD status | B | $\beta$ | B | $\beta$ | B | $\beta$ |
| 1 | Age, gender, baseline well-being | No symptoms | Ref. | — | Ref. | — | Ref. | — |
| | | PAD symptoms | –0.33 (0.40) | –0.01 | –0.79 (0.50) | –0.01 | 0.03 (0.14) | 0.00 |
| *F for* $\Delta R^2$ | | | *1144.691**** | | *1584.778**** | | *445.468**** | |
| 2 | Age, gender, baseline well-being + socioeconomic factors[a] | No symptoms | Ref. | — | Ref. | — | Ref. | — |
| | | PAD symptoms | –0.26 (0.40) | –0.01 | –0.64 (0.50) | –0.01 | –0.06 (0.14) | –0.00 |
| *F for* $\Delta R^2$ | | | *12.645**** | | *18.952**** | | *47.008**** | |
| 3 | Age, gender, baseline well-being + socioeconomic factors + lifestyle factors[b] | No symptoms | Ref. | — | Ref. | — | Ref. | — |
| | | PAD symptoms | –0.17 (0.40) | –0.01 | –0.64 (0.49) | –0.01 | –0.09 (0.14) | –0.01 |
| *F for* $\Delta R^2$ | | | *10.257**** | | *4.665*** | | *8.799**** | |
| 4 | Age, gender, baseline well-being + socioeconomic factors + lifestyle factors + comorbidity[c] | No symptoms | Ref. | — | Ref. | — | Ref. | — |
| | | PAD symptoms | –0.11 (0.40) | –0.00 | –0.53 (0.50) | –0.01 | –0.12 (0.14) | –0.01 |
| *F for* $\Delta R^2$ | | | *1.771* | | *3.336** | | *1.337* | |
| *Overall model fit($R^2$)* | | | *0.50**** | | *0.58**** | | *0.30**** | |

Note: B = unstandardized coefficients (standard errors are reported in parentheses); $\beta$ = standardised coefficients. *p < .05; **p < .01; ***p < .001.
[a]Socioeconomic factors: Education, non-pension wealth, relationship status.
[b]Lifestyle factors: Smoking, sedentary lifestyle.
[c]Comorbidity: Diabetes, angina. Ref: Reference.

control. Leading a high quality life is based on the premise that individuals feel in control of their lives and can choose what activities they engage in and when.[31] Individuals with PAD, however, may feel their life is restricted and beyond their control.[35] For some, it means fluttering between wellness when remaining indoors, or sitting still, and illness when ambulating; the onset of lower-limb pain or discomfort may force them to learn how to move around in new ways, and any attempts towards maintaining normal life is likely to require thorough planning and continual adjusting.[35,36]

Similarly, we observed relatively more depressive symptoms in participants with PAD which corroborates some previous cross-sectional reports of a higher prevalence of depressive symptoms among diseased individuals.[37] In contrast, multivariate analyses by Inglis et al.[25] and Dumville et al.[24] did not show any significant differences in HRQoL mental health subcomponent scores between participants with and without PAD. Although this discrepancy may to an unknown extent be attributed to between-study differences in the measurement of depressive symptoms, more recent findings based on a similar geriatric depression scale to the one used in the present study show comparatively higher prevalence and incidence of depressive symptoms in persons with PAD.[38] Negative affective experiences in these individuals may partly stem from fear of experiencing leg pain; furthermore, their ability to be spontaneous may be reduced which may force them to give up long-favoured activities, including travelling, hiking etc.[35] Fear of pain may also result in stress, frustration and other negative emotional reactions. For many, living with symptomatic PAD means leading a strenuous life with a largely invisible condition.[39] Such existence may negatively impact on their self-identity and pride. Lastly, feelings of sadness about their changed life, and concerns about the future that are associated with living with systemic vascular disease, are commonly expressed by individuals with PAD.[35,36]

An examination of our multivariate models shows that, for the three well-being measures, the associations with PAD were attenuated following the adjustment

for sociodemographic, lifestyle and comorbid factors. This suggests that the well-being impact of PAD is partly accounted for by these factors although additional mechanisms (not considered in our analysis) may also be involved. Most importantly, PAD is associated with a high burden of physical functional limitations,[40] including mobility loss, which may erode well-being levels. For example, the onset of pain or discomfort when ambulating, particularly when attempting to walk faster or on slopes, may be the most common barrier to physical activity in affected individuals.[41] In response, they may deliberately slow their walking speed, or limit their walking activity, in order to avoid exertional leg symptoms.[40] As a marker of impaired physical functioning, reduced walking distance has been found to be a significant predictor of general health, physical and social function in those with PAD.[42]

Furthermore, lower-limb vascular morbidity is associated with diverse psychosocial experiences which may adversely influence individuals' perceived well-being. For example, affected persons often lack appropriate understanding of the underlying pathophysiology and risk factors for PAD;[41] PAD symptoms may also be confused with other diagnoses, including chronic venous or musculoskeletal conditions. Some individuals assume that their pain will dissipate with time, whereas others consider their leg symptoms to be part of normal ageing. Uncertainty about whether lifestyle changes, such as walking, actually help or make the condition worse, may be common.[41] Persons with PAD have also expressed lack of understanding and empathy from others, including from health professionals, resulting in feelings of being dismissed and left on their own.[39] Negative experiences such as these may potentially induce feelings of anxiety and fear in those affected by PAD[37] which subsequently could undermine their sense of independence or satisfaction with life.

### *Study limitations and future directions*

Some potential limitations of the present study should be considered: First, the sample size available for the present analysis was reduced due to missing data on key variables. Although we are aware of the potential benefits (and caveats) of known methods for imputing missing data, we decided not the pursue this option in light of the findings from some previous analyses of well-being outcomes in ELSA that used multiple imputation; despite increasing the available sample size, these analyses produced similar results.[43] Second, although the ELSA study participants were drawn from a nationally representative sample, our analytical sample proved to be comparatively healthier and more socioeconomically advantaged compared to those excluded from the analysis. As such, the present findings may not directly generalise beyond the study sample. Moreover, although our baseline data were collected in 2005, we consider them to be still clinically relevant because 1) the specific PAD and well-being measures we employed continue to be valid and widely used in population studies;[28] 2) the prevalence of PAD in the older adult UK population has declined only slightly over the past two decades;[44] 3) a significant proportion of older adults living with PAD fail to receive guideline-recommended care and well-being support,[44] and; 4) the relevant evidence based remains poor given that few investigations similar to the present one have been undertaken since 2005. Third, it is possible that additional characteristics, not considered in the present study (e.g. the duration of symptoms or PAD treatment), might to an unknown extent have confounded the association between PAD and well-being. Fourth, we only examined well-being at two waves, two-years apart. Our chosen well-being measures reflect broad experiences which may be influenced by diverse conditions,[6] health being only one, and yet are unlikely to be subject to significant short-term fluctuations. Possibly for these reasons, our initial predictions were only partly met as we observed no independent influence of baseline PAD on follow-up well-being levels. Lastly, as with any cross-sectional findings, we are limited in our ability to infer causality between self-reporting of PAD symptoms and the three well-being measures.

The present results suggest health professionals need to be aware of the potential impact of chronic PAD on both positive and negative aspects of well-being of older adults. However, to better understand the influence of PAD on positive and negative well-being domains, future studies should also examine well-being in relation to other PAD syndromes, including asymptomatic PAD which may be associated with reduced functional performance.[40] In addition, more studies are needed that track symptomatic individuals over time in order to determine any concomitant changes in well-being levels; this is important given that self-reported improvement or stabilisation of PAD symptoms may actually be a response to the underlying condition rather than improvement of functional performance.[40] Moreover, it is currently not clear how the different aspects of the clinical care (e.g. medical treatment, patient education etc.) provided to older adults with PAD influences their perceptions and experiences of living with chronic vascular morbidity. Finally, in light of the growing evidence linking positive and negative well-being with subsequent health outcomes,[6,34] future research should consider the potential prognostic role well-being measures

might play (regarding treatment compliance, effective lifestyle modification etc.) in the context of living with lower-extremity vascular morbidity.

## Conclusion

This investigation observed independent influences of PAD symptoms on positive and negative well-being levels among community-residing older participants in the ELSA study. Specifically, older adults with lower-limb symptoms were found to have lower levels of both quality of life and satisfaction with life, and more depressive symptoms. Further studies are required to help elucidate the potential mechanisms underlying this association, including how symptom severity, comorbid conditions, or specific functional limitations may act separately, or in combination, to influence different aspects of the well-being of those affected by PAD. With much emphasis nowadays on maintaining quality of life of persons suffering from vascular diseases, greater awareness of their potential life-disrupting influences is needed to inform effective multidisciplinary support and interventions for those living and ageing with chronic vascular morbidity.

### Acknowledgements

The authors are grateful for the constructive feedback received following the peer-review of an earlier version of this manuscript.

**Contributorship**

SBR, FGRF – Study conceptualisation. SBR - Data curation. SBR – Formal analysis. SBR, FGRF – Interpretation of the results. SBR, FGRF – Drafting and critical review of the manuscript.

### Declaration of conflicting interests

The authors declare no potential conflict of interest with respect to the research, authorship, and/or publication of this article.

**Ethical approval**

The English Longitudinal Study of Ageing was granted an ethical approval by a Multicentre Research Ethics Committee.

### Funding

The authors received no specific funding for this work. The English Longitudinal study of Ageing is funded by the National Institute of Aging (Grants 2RO1AG7644-01A1 and 2RO1AG017644) and by a consortium of UK government departments coordinated by the Office for National Statistics. The data are lodged with the UK Data Archive.

### Guarantor

SBR is the guarantor of the integrity of this work.

### ORCID iD

Snorri Bjorn Rafnsson https://orcid.org/0000-0002-7985-912X

### References

1. Jivraj S, Nazroo J, Vanhoutte B, et al. Aging and subjective well-being in later life. *J Gerontol B Psychol Sci Soc Sci* 2014; 69: 930–941.
2. Vanhoutte B. The multidimensional structure of subjective well-being in later life. *J Popul Ageing* 2014; 7: 1–20.
3. George LK. Still happy after all these years: research frontiers on subjective well-being in later life. *J Gerontol B Psychol Sci Soc Sci* 2010; 65B: 331–339.
4. Kamat R, Martin AS and Jeste DV. 2017. Successful aging. In: H Chiu and K Shulman (eds) *Mental health and illness of the elderly*. Singapore: Springer Singapore, pp.7–28.
5. Lupien S and Wan N. Successful ageing: from cell to self. *Philos Trans R Soc Lond B Biol Sci* 2004; 359: 1413–1426.
6. Steptoe A, Deaton A and Stone AA. Subjective well-being, health, and ageing. *Lancet* 2015; 385: 640–648.
7. McGrath R, Al Snih S, Markides K, et al. The burden of health conditions for middle-aged and older adults in the United States: disability-adjusted life years. *BMC Geriatr* 2019; 19: 100.
8. North BJ and Sinclair DA. The intersection between aging and cardiovascular disease. *Circ Res* 2012; 110: 1097–1108.
9. Roth GA, Johnson C, Abajobir A, et al. Global, regional, and national burden of cardiovascular diseases for 10 causes, 1990 to 2015. *J Am Coll Cardiol* 2017; 70: 1–25.
10. Kolh P. Improving quality of life in patients with peripheral arterial disease: an important goal. *Eur J Vasc Endovasc Surg* 2010; 40: 626–627.
11. Rafnsson SB, Deary IJ, Smith FB, et al. Cardiovascular diseases and decline in cognitive function in an elderly community population: the Edinburgh artery study. *Psychosom Med* 2007; 69: 425–434.
12. Mark D. Assessing quality of life outcomes in cardiovascular clinical research. *Nat Rev Cardiol* 2016; 13: 286–308.
13. Fowkes FGR, Aboyans V, Fowkes FJI, et al. Peripheral artery disease: epidemiology and global perspectives. *Nat Rev Cardiol* 2017; 14: 156–170.
14. Criqui MH and Aboyans V. Epidemiology of peripheral artery disease. *Circ Res* 2015; 116: 1509–1526.
15. Dhaliwal G and Mukherjee D. Peripheral arterial disease: epidemiology, natural history, diagnosis and treatment. *Int J Angiol* 2007; 16: 36–44.
16. Peach G, Griffin M, Jones KG, et al. Diagnosis and management of peripheral arterial disease. *BMJ* 2012; 345: e5208.
17. Shu J and Santulli G. Update on peripheral artery disease: Epidemiology and evidence-based facts. *Atherosclerosis* 2018; 275: 379–381.
18. Karimi M and Brazier J. Health, health-related quality of life, and quality of life: What is the difference? *PharmacoEconomics* 2016; 34: 645–649.

19. Megari K. Quality of life in chronic disease patients. *Health Psychol Res* 2013; 1: e27.
20. Barletta G, Perna S, Sabba C, et al. Quality of life in patients with intermittent claudication: relationship with laboratory exercise performance. *Vasc Med* 1996; 1: 3–7.
21. Breek JC, Hamming JF, De Vries J, et al. Quality of life in patients with intermittent claudication using the World Health Organization (WHO) questionnaire. *Eur J Vasc Endovasc Surg* 2001; 21: 118–122.
22. Remes L, Isoaho R, Vahlberg T, et al. Quality of life among lower extremity peripheral arterial disease patients who have undergone endovascular or surgical revascularization: a case-control study. *Eur J Vasc Endovasc Surg* 2010; 40: 618–625.
23. Remes L, Isoaho R, Vahlberg T, et al. Quality of life three years after major lower extremity amputation due to peripheral arterial disease. *Aging Clin Exp Res* 2010; 22: 395–405.
24. Dumville JC, Lee AJ, Smith FB, et al. The health-related quality of life of people with peripheral arterial disease in the community: the Edinburgh artery study. *Br J Gen Pract* 2004; 54: 826–831.
25. Inglis SC, Lewsey JD, Lowe GDO, et al. Angina and intermittent claudication in 7403 participants of the 2003 Scottish health survey: impact on general and mental health, quality of life and five-year mortality. *Int J Cardiol* 2013; 167: 2149–2155.
26. Wikman A, Wardle J and Steptoe A. Quality of life and affective well-being in middle-aged and older people with chronic medical illnesses: a cross-sectional population based study. *PLoS One* 2011; 6: e18952.
27. Lucas RE. Long-term disability is associated with lasting changes in subjective well-being: evidence from two nationally representative longitudinal studies. *J Pers Soc Psychol* 2007; 92: 717–730.
28. Steptoe A, Breeze E, Banks J, et al. Cohort profile: the English longitudinal study of ageing. *Int J Epidemiol* 2013; 42: 1640–1648.
29. Lend GC and Fowkes FGR. The Edinburgh claudication questionnaire: an improved version of the WHO/rose questionnaire for use in epidemiological surveys. *J Clin Epidemiol* 1992; 45: 1101–1109.
30. Diener E, Emmons RA, Larsen RJ, et al. The satisfaction with life scale. *J Pers Assess* 1985; 49: 71–75.
31. Hyde M, Wiggins RD, Higgs P, et al. A measure of quality of life in early old age: the theory, development and properties of a needs satisfaction model (CASP-19). *Aging Ment Health* 2003; 7: 186–194.
32. Radloff LS. The CES-D scale: a self-report depression scale for research in the general population. *Appl Psychol Meas* 1977; 1: 385–401.
33. Campbell K and Kenny D. A primer on regression artifacts, www.guilford.com/books/A-Primer-on-Regression-Artifacts/Campbell-Kenny/9781572308596 (1999, accessed 14 September 2020).
34. Rosella LC, Fu L, Buajitti E, et al. Death and chronic disease risk associated with poor life satisfaction: a population-based cohort study. *Am J Epidemiol* 2019; 188: 323–331.
35. Egberg L, Andreassen S and Mattiasson A-C. Experiences of living with intermittent claudication. *J Vasc Nurs* 2012; 30: 5–10.
36. Schorr EN, Peden-McAlpine C, Treat-Jacobson D, et al. Characterization of the peripheral artery disease symptom experience. *Geriatr Nurs* 2015; 36: 293–300.
37. Smolderen KG, Hoeks SE, Pedersen SS, et al. Lower-leg symptoms in peripheral arterial disease are associated with anxiety, depression, and anhedonia. *Vasc Med* 2009; 14: 297–304.
38. McDermott MM, Greenland P, Guralnik JM, et al. Depressive symptoms and lower extremity functioning in men and women with peripheral arterial disease. *J Gen Intern Med* 2003; 18: 461–467.
39. Gorely T, Crank H, Humphreys L, et al. "Standing still in the street": experiences, knowledge and beliefs of patients with intermittent claudication – a qualitative study. *J Vasc Nurs* 2015; 33: 4–9.
40. McDermott MM. Functional impairment in peripheral artery disease and how to improve it in 2013. *Curr Cardiol Rep* 2013; 15: 347.
41. Bridgwood BM, Nickinson AT, Houghton JS, et al. Knowledge of peripheral artery disease: what do the public, healthcare practitioners, and trainees know? *Vasc Med* 2020; 25: 263–273.
42. Pell JP. Impact of intermittent claudication on quality of life. The Scottish vascular audit group. *Eur J Vasc Endovasc Surg* 1995; 9: 469–472.
43. Netuveli G, Wiggins RD, Hildon Z, et al. Quality of life at older ages: evidence from the English longitudinal study of aging (wave 1). *J Epidemiol Community Health* 2006; 60: 357–363.
44. Cea-Soriano L, Fowkes F, Johansson S, et al. Time trends in peripheral artery disease incidence, prevalence and secondary preventive therapy: a cohort study in the health improvement network in the UK. *BMJ Open* 2018; 8: e018184.