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Symptom severity and quality of life in patients with atrial fibrillation: Psychological function outweighs clinical predictors

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ABSTRACT

Background: The key drivers of symptom severity and health-related quality of life (hr-QOL) in patients with atrial fibrillation (AF) remain unclear. We aimed to determine the relative contribution to symptom severity and hr-QOL of clinical factors including left ventricular (LV) diastolic function and ventricular rate control during AF and of psychological functioning.

Methods: Seventy-eight consecutive patients with symptomatic AF and preserved LV systolic function underwent detailed evaluation of *i*) AF symptom severity and hr-QOL; *ii*) clinical factors including left ventricular (LV) diastolic function, AF burden, and ventricular rate during AF and *iii*) state and trait aspects of psychological functioning.

Results: Moderate-to-severe AF-related symptoms were reported by 64% of the study population whilst 36% reported no more than mild symptoms. Worse symptom severity was associated with a higher score on the Perceived Stress Scale (16.7 ± 4.4 vs. 5.4 ± 4.4, $p < 0.0001$) and higher prevalence of the Type D Personality (20/50 vs. 4/28, $p = 0.012$). In multivariable models, only a predisposition to subjectively appraise life situations as stressful (higher PSS score) and a personality with a higher degree of negative affectivity and social inhibition (higher TDPS score) were independent predictors of higher AF symptom severity and poorer hr-QOL. No clinical factors including AF burden, ventricular rates during AF or LV diastolic function were significant predictors of AF-specific symptoms or hr-QOL.

Conclusion: In a tertiary AF population with preserved LV systolic function, only psychological functioning consistently predicts both AF-related symptoms and hr-QOL. LV diastolic function, AF burden, and ventricular rate during AF are not independent predictors.

1. Introduction

The severity of symptoms related to atrial fibrillation (AF) and their impact on health-related quality of life (hr-QOL) in human AF vary considerably [1–3]. Whilst many patients do experience severe symptoms and poor hr-QOL, the prime factors influencing the patient experience remain debated [4–7]. Disease-related symptoms are important determinants of health care utilization, including of procedures and hospitalization, which is rising rapidly in association with the rising prevalence of AF [8,9]. With indications for rhythm control in AF still centered on symptom severity and hr-QOL [10], better understanding the key determinants of the patient experience of AF may provide the opportunity for effective interventions to blunt these trends.

Abbreviations: AF, atrial fibrillation; AFSS, University of Toronto AF Severity Scale; BMI, body mass index; hr-QOL, health-related quality of life; ILR, implanted loop monitor; IVRT, isovolumic relaxation time; LA, left atrium; LV, left ventricle; LVMI, left ventricular mass index; OSA, obstructive sleep apnea; PSS, Global Measure of Perceived Stress Scale; ROI, region of interest; SF-36 PCS, Short Form (36) Health Survey physical component summary; TDPS, Type D (distressed) Personality Scale; TTE, transthoracic echocardiogram.

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In this study we therefore aimed to define the spectrum of AF-related symptoms and of hr-QOL in a population from a tertiary arrhythmia centre, differences in patient characteristics between those with mild and severe AF-related symptoms, and the contribution to AF symptom severity and hr-QOL of individual psychological function compared with the contribution of clinical factors including left ventricular (LV) diastolic function, AF burden and persistence, and ventricular rate control during AF. We hypothesized that individual psychological function is the dominant predictor of AF symptom severity and hr-QOL.

2. Methods

2.1. Study population

Seventy-eight consecutive consenting patients with symptomatic non-valvular AF and preserved LV systolic function (LV ejection fraction >50%) aged between 18 and 80 years referred for AF management to a tertiary arrhythmia referral service were recruited over a 4-month period. This represented 68% of the total population screened and eligible to participate. Exclusion criteria were impaired left ventricular (LV) systolic function (LV ejection fraction <50%), valvular heart disease, amiodarone use, age <18 years or >80 years, and inability to provide informed consent. The study was approved by the Melbourne Health Human Research Ethics Committee, and all participants provided written informed consent.

2.2. Clinical evaluation

All participants underwent detailed assessment at a dedicated study visit, which occurred following the initial clinical consultation. Baseline assessment included *i*) detailed recording of AF history, comorbidities and anthropometry, *ii*) a transthoracic echocardiogram (TTE) allowing for detailed assessment of LV diastolic function and strain-based assessment of LA function, *iii*) a 24 hour Holter monitor to allow assessment of mean and maximum ventricular rates during periods of AF and *iv*) an ambulatory sleep study to identify the presence of obstructive sleep apnea (OSA) (Somté, Compumedics Ltd., Abbotsford, Vic, Australia). Consenting participants (62 of 78, 80%) also underwent implantation of a 'Reveal' implanted loop recorder (ILR; Medtronic Inc., Minneapolis, MN, USA) for quantification of AF burden over a defined 3-month period after device implant. Devices were programmed using the manufacturer's nominal settings and AF burden was quantified using the automated device-based algorithm that relies on the irregularity of R–R intervals as detected on a double-sector Lorenz plot, with manual over-reading of available stored episodes.

2.3. Echocardiography and strain measurement

A standardized transthoracic echocardiographic study was performed with a Vivid 7 ultrasound system (GE Healthcare, Little Chalfont, Bucks, UK) and an M4S matrix array cardiac transducer. Measurements were performed according to American Society of Echocardiography (ASE) guidelines. LA sizes were measured from the apical views at end-systole, with volumes calculated using the biplane method of discs. From pulsed-wave Doppler tracings taken during the apical 4-chamber view the early (E) transmitral flow velocity and the isovolumic relaxation time (IVRT) were measured. Tissue Doppler imaging was used to measure the peak diastolic filling velocity (E′) at the septal and lateral aspects of the mitral valve annulus. The E/E′ was calculated as E divided by the mean of the septal and lateral E′ velocities. All data were digitally stored for off-line analysis (EchoPAC, GE Healthcare). Analysis was performed by 2 investigators blinded to participant identification.

Global longitudinal LA myocardial strain and strain rate were measured by 2-dimensional speckle-tracking echocardiography [11,12]. Apical 4- and 2-chamber views were obtained using conventional 2-dimensional grey-scale echocardiography during breath hold and with a frame rate of >80 fps. Mean values were determined over 3 consecutive cardiac cycles. Strain analysis was performed offline by 2 operators with no knowledge of other clinical or echocardiographic parameters, using commercially-available semi-automated software (EchoPAC, GE Healthcare). The LA endocardial border was manually traced and an epicardial line was generated automatically by the software, thereby delineating a region of interest (ROI) composed of 6 discrete segments for each view. After manual adjustment of the ROI and segmental tracking quality analysis, LA strain and strain rate curves were generated automatically for each atrial segment, with an additional global curve. For all studies, analysis was performed with gating of the cardiac cycle to the R-R interval [12], allowing total strain to be determined as a marker of passive LA reservoir function, a parameter taken in previous studies to be an indirect marker of LA structural remodelling [13,14]. For participants in sinus rhythm, an additional late diastolic negative strain rate value representing LA contractile function was measured from the corresponding strain rate curve.

2.4. Assessment of atrial fibrillation symptom severity and health related quality of life

Two validated questionnaires were completed by each study participant in order to quantify AF-related symptoms and hr-QOL. Part C of the University of Toronto Atrial Fibrillation Severity Scale (AFSS) [1,15] was used to quantify AF symptom severity. This self-administered questionnaire provides a disease-specific measure of quality of life in atrial fibrillation, and part C is an instrument that measures the presence and severity of individual symptoms attributable to AF over the preceding 4 weeks, with 7 individual symptoms (including palpitation frequency, dyspnea, fatigue, and exercise intolerance) scored on 5-point Likert scales and with higher values reflecting more severe AF symptoms (AFSS Symptom score). Mild AF symptom severity was defined as a score <8/35 and moderate-severe AF symptom severity was defined as a score ≥8/35, based on the mean AFSS Symptom score of 7.8 ± 6.3 in the RACE II Study [16] and the relationship of the AFSS Symptom score to the Canadian Cardiovascular Society Severity in Atrial Fibrillation Scale classes [15].

The physical component summary score (SF-36 PCS score) of the SF-36 questionnaire [17] was used to quantify physical hr-QOL [18]. This generic scale has minimal overlap with AFSS items. It measures eight key health concepts (physical functioning, role limitations due to physical health problems, bodily pain, general health, vitality, social functioning, role limitations due to emotional problems and mental health) over a 4-week recall period, with a normative scoring system applied to generate a profile of individual domain scores and thence derive physical and mental component summary scores, with lower scores denoting poorer life quality.

2.5. Assessment of psychology

Participants completed 2 validated questionnaires examining psychological functioning, the Global Measure of Perceived Stress Scale (PSS) as a measure of situational or state-based function [19,20], and the Type D (distressed) Personality Scale (TDPS) [21] as a measure of more enduring trait-based function. All questionnaires were completed by the patient at home, after the initial clinical consultation and subsequent recruitment into the study.

The 10-item PSS, derived from the original 14-item instrument [19,20,22], measures the degree to which life situations are subjectively appraised to have be stressful over the last month. It focuses on the subjective experience and how life is unpredictable, uncontrollable, and overloading. The PSS is correlated with life event scores [19], but is considered a more accurate reflection of stress experienced, measuring a cognitively mediated emotional response that incorporates an individual's social support system, robustness, and locus of control [19,20], and which is amenable to change with psychological intervention [23]. Each item is scored on a 5-point Likert scale from 0 to 4, with higher total scores indicating greater perceived stress. The Cronbach α co-efficient of internal consistency is high (0.78–0.91 [19,20]), as is test-retest stability (0.85–0.90 [20,22]).

The Type D personality denotes a high degree of negative affectivity and social inhibition in the personality structure. It has been identified as a risk factor for adverse cardiovascular outcomes [24,25] and has been associated with poor hr-QOL in AF [26]. The TDPS is a 14-item questionnaire, with each item scored between 0 and 4 [27]. It includes 2 subscales, the Negative Affectivity and the Social Inhibition subscales, with the Type D Personality considered to be present based on a score on both of these subscales of ≥10. Cronbach's α co-efficient of internal consistency is between 0.86 and 0.88 [21,24].

2.6. Statistical analysis

Statistical analysis was performed using commercially available software (STATA version 12.1, StataCorp, College Station, Texas, USA). Normally-distributed data are presented as mean ± SD and otherwise as a median with interquartile range. Between-group comparisons were made using Student's *t*-test, the Wilcoxon rank sum test and the Chi-square test as appropriate. Statistical significance was set at the 0.05 level.

The relationships between independent variables and continuous outcome variables were tested using general linear models. The association of clinical and personality variables with symptom severity and hr-QOL was tested using simple linear regression, after demonstrating normally-distributed residuals with homoscedasticity in their variance. Due to co-linearity, the PSS score and the TDPS score were subsequently fitted separately within multivariable models, along with the clinical variables that demonstrated an association with the relevant outcome variable on univariable analysis at a significance level of <0.1.

3. Results

The study cohort had a mean age of 60 ± 9 years and 74% had paroxysmal AF. There was a male predominance, mean BMI was 29.9 ± 5.2 kg/m^2, and the prevalence of hypertension, diabetes and vascular disease was 46%, 15% and 21% respectively, making it broadly representative of AF patients referred for management to tertiary arrhythmia centres (Table 1). Of the overall study population, 57% were anticoagulated, 47% were taking an AV nodal blocking medication and 49% an anti-arrhythmic drug. The mean AFSS Symptom score was 11.3 ± 8.5 and the mean SF-36 PCS score was 43.1 ± 10.1.

3.1. Differences between patients with severe and those with mild AF symptom severity

Fifty participants (64%) reported moderate-to-severe AF-related symptoms based on an AFSS Symptom score of ≥8 (Group 1), whereas

Table 1
Baseline characteristics of study participants.

	Overall study population (n = 78)	Group 1 (n = 50)	Group 2 (n = 28)	*p*-Value
Paroxysmal AF (n (%))	58 (74)	41 (82)	17 (61)	**0.039**
Age (y)	60 ± 9	58 ± 11	64 ± 9	**0.014**
Male (n (%))	60 (77)	38 (76)	22 (79)	0.796
BMI (kg/m^2)	29.9 ± 5.2	30.5 ± 5.9	28.8 ± 3.5	0.162
OSA (n (%))	22 (28)	17 (34)	5 (18)	0.129
CHA_2DS_2Vasc score	1 (0–3)	1 (0–2)	2 (0.5–3)	0.094
AF burden (%)	10 (0.3–100)	5 (0.1–100)	35 (0.5–100)	0.117
Mean AF rate (bpm)	82 ± 13	81 ± 12	83 ± 16	0.692
Max AF rate (bpm)	166 ± 35	167 ± 36	164 ± 35	0.745
E/E'	8.3 ± 2.8	8.0 ± 2.9	8.8 ± 2.7	0.240
IVRT (ms)	95.4 ± 22.3	97.9 ± 22.6	90.8 ± 21.5	0.211
LVMI (g/m^2)	85.9 ± 24.5	86.2 ± 26.4	85.3 ± 20.8	0.878
LA volume (mL/m^2)	47.2 ± 15.2	47.6 ± 15.5	46.5 ± 15.0	0.778
Total LA strain (%)	21.1 ± 9.4	22.4 ± 9.4	18.7 ± 8.9	0.100
LA contractile strain rate (s^{-1})	−1.54 ± 0.36	−1.53 ± 0.33	−1.57 ± 0.43	0.773
Perceived Stress Scale	12.5 ± 8.4	16.7 ± 4.4	5.4 ± 4.4	<**0.0001**
Type D Personality Scale	9.4 ± 7.2	11.9 ± 7.1	5.1 ± 5.0	<**0.0001**
Type D Personality (n (%))	24 (31)	20 (40)	4 (14)	**0.012**

AF – atrial fibrillation; BMI – body mass index; OSA – obstructive sleep apnea; IVRT – isovolumic relaxation time; LVMI – left ventricular mass index; LA – left atrium.
Group 1: moderate-to-severe AF-related symptoms (AFSS Symptom score of ≥8).
Group 2: no more than mild AF-related symptoms (AFSS Symptom score of <8).
The boldface is used simply to highlight comparisons between groups 1 and 2 that had a *p*-value of <0.05.

28 participants (36%) reported no more than mild AF-related symptoms based on an AFSS Symptom score of <8 (Group 2). There was a significant difference in hr-QOL between these groups, with a significantly lower score on the SF-36 PCS scale in the group manifesting more severe AF-related symptoms (38.9 ± 10.1 vs. 50.1 ± 5.1, $p < 0.0001$). Participants in Group 1 were younger (58 ± 11 vs. 64 ± 9, $p = 0.014$) and more likely to manifest paroxysmal AF (41/50 vs. 18/28, $p = 0.039$) than Group 2 participants (Table 1) but there were no significant between-group differences in any other clinical variable including use of AV nodal blocking medications, anti-arrhythmic drugs and systemic anticoagulation. Those with moderate-to-severe AF symptom severity did, however, have a significantly higher score on the PSS (16.7 ± 4.4 vs. 5.4 ± 4.4, $p < 0.0001$) and were significantly more likely to manifest the Type D Personality (20/50 vs. 4/28, $p = 0.012$) than those with no more than mild symptoms (Table 1).

3.2. Predictors of AF-specific symptom severity

The only variables associated with a higher AFSS Symptom score at the 0.1 level by univariable analysis were younger age, paroxysmal AF, higher BMI, OSA, exposure to flecainide and higher scores on each of the psychological function assessment instruments (Table 2). There was no association with AF burden, variables of LV diastolic function, ventricular rate during periods of AF or variables of LA remodelling. On multivariable modelling, only a predisposition to subjectively appraise life situations as stressful (higher score on the PSS) and a personality with a higher degree of negative affectivity and social inhibition (higher score on the TDPS) were independent predictors of more severe AF-specific symptoms (Table 3).

3.3. Predictors of health-related quality of life

The only variables associated with a lower SF-36 PCS score at a 0.1 level by univariable analysis were higher BMI, female gender, higher CHA_2DS_2Vasc score, exposure to β-blockers and calcium channel blockers, lack of exposure to sotalol, and higher scores on each of the psychological function assessment instruments (Table 4). Again, there was no association with AF burden, ventricular rates during periods of AF, variables of LV diastolic function or variables of LA remodelling. In multivariable models, only a higher score on the PSS and a higher score on the TDPS remained as independent predictors of poorer hr-QOL as measured by the SF-36 PCS score (Table 3).

4. Discussion

The key finding of this study is that, in a tertiary AF population, no clinical variable including AF burden, LV diastolic function or ventricular rate during AF episodes predict AF symptom severity or hr-QOL. Only a state-based predisposition to subjectively appraise life situations as stressful (higher score on the PSS) and a personality with a higher degree of negative affectivity and social inhibition (higher score on the TDPS) were consistent independent predictors of higher AF-specific symptoms and a poorer hr-QOL.

Several groups have studied the impact of psychology on the patient experience of AF, in isolation from consideration of clinical or organic cardiac factors. Anxiety and depression have been associated with

Table 2
Relationship of clinical/organic variables and of personality trait scores to the AFSS Symptom score by univariable analysis.

	Adjusted R^2	β	SE	*t*	*p*-Value
Persistent AF	0.07	−5.49	2.20	−2.50	**0.015**
AF burden	0.008	−0.03	0.03	−1.25	0.216
Mean AF rate	0.002	0.09	0.08	1.05	0.296
Max AF rate	−0.01	0.02	0.03	0.60	0.552
Age	0.07	−0.22	0.09	−2.52	**0.014**
BMI	0.06	0.43	0.19	2.30	**0.025**
Female	−0.01	1.42	2.49	0.57	0.570
OSA	0.03	3.89	2.18	1.79	**0.078**
CHA_2DS_2Vasc score	−0.009	−0.34	0.57	−0.59	0.559
Warfarin	−0.01	1.19	2.10	0.57	0.573
NOAC	0.02	−2.87	2.52	−1.54	0.128
β-Blocker	0.01	2.86	2.06	1.39	0.169
Calcium channel blocker	−0.01	1.28	3.42	0.37	0.710
Flecainide	0.03	5.14	2.75	1.87	**0.066**
Sotalol	−0.01	−0.10	2.14	−0.05	0.964
E/E' ratio	0.01	−0.44	0.35	−1.27	0.209
IVRT	−0.008	0.03	0.05	0.71	0.478
LVMI	−0.01	0.01	0.05	0.29	0.774
LA volume	−0.009	0.04	0.07	0.64	0.527
Total LA strain	0.009	0.14	0.11	1.28	0.203
LA contractile strain rate	−0.02	−2.05	4.01	−0.51	0.613
Perceived Stress Scale	0.46	0.70	0.09	7.78	<**0.001**
Type D Personality Scale	0.25	0.61	0.12	4.96	<**0.001**

AF – atrial fibrillation; BMI – body mass index; OSA – obstructive sleep apnea; NOAC – novel oral anticoagulant; IVRT – isovolumic relaxation time; LVMI – left ventricular mass index; LA – left atrium.
The boldface data delineate those relationships for which the *p*-value was <0.1, and thus it identifies the variables that were included in the multivariable model.

Table 3
Multivariable models relating to the AFSS Symptom score and to the SF-36 PCS score each of the clinical and personality style variables identified as significantly associated on univariable testing.

	Co-efficient	SE	*t*	*p*-Value
AFSS Symptom Score				
Perceived Stress Scale				
Persistent AF	−3.73	1.87	−1.98	0.052
Age	−0.03	0.08	−0.39	0.694
BMI	0.09	0.16	0.55	0.587
OSA	0.91	1.91	0.48	0.635
Flecainide	1.24	2.30	0.54	0.592
Perceived Stress Scale	0.63	0.10	6.28	<**0.001**
Type-D Personality Scale				
Persistent AF	−3.24	2.14	−1.51	0.135
Age	−0.06	0.09	−0.70	0.485
BMI	0.11	0.19	0.59	0.554
OSA	2.23	2.15	1.03	0.305
Flecainide	2.96	2.59	1.14	0.257
Type D Personality Scale	0.55	0.13	4.20	<**0.001**
SF-36 PCS Score				
Perceived Stress Scale				
BMI	−0.28	0.24	−1.15	0.254
Female	−4.70	2.85	−1.65	0.104
CHA_2DS_2Vasc score	−0.54	0.74	−0.73	0.467
β-Blocker	−2.13	2.75	−0.78	0.441
Calcium channel blocker	−4.18	4.08	−1.02	0.310
Sotalol	1.45	2.72	0.53	0.595
Perceived Stress Scale	−0.45	0.14	−3.22	**0.002**
Type D Personality Scale				
BMI	−0.30	0.25	−1.22	0.227
Female	−4.15	2.89	−1.44	0.156
CHA_2DS_2Vasc score	−0.28	0.74	−0.38	0.704
β-Blocker	−1.63	2.80	−0.58	0.561
Calcium channel blocker	−3.67	4.14	−0.89	0.379
Sotalol	2.98	2.74	1.08	0.282
Type D Personality Scale	−0.48	0.17	−2.93	**0.005**

AFSS Symptom score:
PSS model: F = 10.91, Prob > F < 0.0001, adjusted R^2 = 0.47, root MSE = 6.14.
Type D Personality Scale model: F = 6.35, Prob > F < 0.0001, adjusted R^2 = 0.32, root MSE = 6.93.
SF-36 PCS score:
PSS model: F = 4.96, Prob > F = 0.0002, adjusted R^2 = 0.29, root MSE = 8.79.
Type D Personality Scale model: F = 4.62, Prob > F = 0.0003, adjusted R^2 = 0.27, root MSE = 8.90.
The boldface data delineate those relationships within the multivariable model for which the *p*-value was <0.05, and thus it identifies the variables that are in dependent predictors of the relevant outcome.

Table 4
Relationship of clinical/organic variables and of personality trait scores to the SF-36 PCS score by univariable analysis.

	Adjusted R^2	β	SE	*t*	*p*-Value
Persistent AF	−0.01	0.90	2.71	0.33	0.740
AF burden	−0.009	−0.02	0.03	−0.61	0.542
Mean AF rate	−0.01	0.04	0.10	0.45	0.655
Max AF rate	−0.02	0.002	0.04	0.05	0.957
Age	−0.01	0.005	0.11	0.05	0.963
BMI	0.14	−0.76	0.22	−3.52	**0.001**
Female	0.10	−7.77	2.72	−2.85	**0.006**
OSA	−0.0005	−2.56	2.61	−0.98	0.330
CHA_2DS_2Vasc score	0.03	−1.14	0.66	−1.73	**0.088**
Warfarin	0.02	−3.81	2.42	−1.57	0.120
NOAC	−0.001	2.81	3.01	0.94	0.353
β-Blocker	0.03	−4.57	2.42	−1.89	**0.063**
Calcium channel blocker	0.03	−6.88	3.73	−1.85	**0.069**
Flecainide	−0.01	−2.58	3.32	−0.78	0.440
Sotalol	0.03	4.31	2.45	1.75	**0.084**
E/E' ratio	−0.003	0.40	0.45	0.89	0.377
IVRT	−0.002	0.05	0.06	0.92	0.361
LVMI	−0.004	−0.05	0.06	−0.86	0.395
LA volume	0.006	−0.10	0.08	−1.19	0.239
Total LA strain	−0.01	−1.11	3.63	−0.30	0.788
LA contractile strain rate	0.01	−5.31	4.32	−1.23	0.227
Perceived Stress Scale	0.19	−0.55	0.13	−4.25	<**0.001**
Type D Personality Scale	0.20	−0.64	0.15	−4.27	<**0.001**

AF – atrial fibrillation; BMI – body mass index; OSA – obstructive sleep apnea; NOAC – novel oral anticoagulant; IVRT – isovolumic relaxation time; LVMI – left ventricular mass index; LA – left atrium.
The boldface data delineate those relationships for which the *p*-value was <0.1, and thus it identifies the variables that were included in the multivariable model.

more severe AF-related symptoms and a lower hr-QOL [6,28], and several aspects of personality style including anxiety sensitivity [29], stress perception [30], somatization [31], personal negativity [26], optimism [29] and neuroticism [32] have been associated with the subjective experience of AF. The current study reinforces the centrality of psychological function in this subjective experience, with both state and trait-based aspect of function remaining the key predictors of symptom severity and hr-QOL even when performing a detailed evaluation of clinical factors.

This simultaneous consideration of clinical variables potentially of importance to the severity of AF symptoms alongside psychological variables is the key element of this study. Previous studies have found it difficult to identify a significant role for clinical variables [33], which in turn have not been the focus of the studies exploring psychological function. Consistent with the data in this study, female gender has been associated with more severe AF symptoms and poorer hr-QOL [34,35], younger age has been associated with more severe AF-specific symptoms [34] and elevated BMI has been associated with poorer hr-QOL scores [36]. A role for LV diastolic function and elevated left-sided intra-cardiac pressures in symptom severity has been suggested, but invasive hemodynamic studies have demonstrated normal or even low pressures during AF [37], and much attention in the ambulatory care setting is given to ventricular rate control during AF episodes despite a lack of data demonstrating good symptom control in patients with strict rate control [38,39]. Again, the current study did not identify any relationship between either ventricular rate during AF episodes or LV diastolic function measured on echocardiography and either AF symptom severity or hr-QOL.

The recently-published SMURF study [7] was one other study that did simultaneously analyse clinical and psychological variables, in a population undergoing catheter ablation of AF. Clinical variables evaluated were age, BMI, CHA_2DS_2Vasc score, perceived AF episode frequency and duration, circulating biomarkers of inflammation and myocardial strain, directly-measured RV pressures at the time of catheter ablation, and LA size and LVEF measured from echocardiography. The authors did report a relationship between elevated RV diastolic pressure and poorer hr-QOL, but did not include direct measurement of LV filling pressures or echocardiographic measures of LV diastolic function in their regression models. They reported a significant influence from LA size and low grade inflammation on AF symptoms severity, and a significant influence from obesity, a higher CHA_2DS_2Vasc score, higher perceived AF episode frequency and the presence of low-grade inflammation on physical hr-QOL. In addition, anxiety was associated with AF symptom severity and depression with poorer hr-QOL, but it is quite conceivable that such symptoms may in fact be a consequence of AF symptom rather than a driving force. Unlike in the current study, state and trait aspects of fundamental psychological functioning were not evaluated.

Another strength of this study is the use of implantable loop recorders to quantify the AF burden in an evaluation of the drivers of AF symptom severity. Previously Gehi et al. [31] employed continuous 1-week looping monitors and did not find any relationship between symptom severity and the occurrence of AF. Sears et al. [6], in a specific population with paroxysmal AF and an implantable cardioverter defibrillator with atrial tachyarrhythmia therapies in situ, did report the number of device-counted and treated AF episodes to be one factor associated with symptom severity, but also found psychological distress to be a more powerful predictor of AF symptoms than any device-recorded objective measure of AF burden. With the great majority of participants undergoing ILR monitoring of the AF burden, this study again indicates

that the AF burden does not play a significant role in AF symptom severity or hr-QOL.

Overall, this study suggests that significantly more attention should be paid to patients' psychological function than is typical in contemporary clinical AF management. Whilst there is often a strong focus on such factors as ventricular rate control as a method of optimizing symptom control, the preponderance of the available evidence suggests that such factors are relatively unimportant. Personality as assessed by the TDPS is considered to be relatively resistant to change [40], but multiple studies have demonstrated that psychological interventions such as mindfulness and yoga can significantly reduce stress perception [23,41,42]. Thus such low-cost interventions, delivered in a multidisciplinary AF clinic [43] as is becoming the accepted gold standard for AF management, may lead to significant improvement in symptom control and hr-QOL in patients with AF. Given the lack of data demonstrating benefits from rhythm control in AF with respect to mortality or other major cardiovascular outcomes, symptom control and quality of life remain the key goals of AF rhythm control [10], and significant improvements would have the potential to impact on the rapidly rising rates of AF-related health care utilization [8,9]. It may also be that such domains of psychological function predict the magnitude of the response to effective AF rhythm control, and so their evaluation might allow identification of patients most likely to benefit from an aggressive rhythm control strategy, independent of the ability of change stress perception. Further studies will be required to evaluate this.

4.1. Limitations

This was a prospective observational study in which all eligible patients undergoing AF management in a tertiary arrhythmia service were invited to participate. It is conceivable that those patients declining to participate might share demographic or clinic features with the potential to influence the study outcome measures, but a consent rate of 68% amongst eligible patients is broadly in line with that reported in many prospective clinical studies. With the study population drawn from a tertiary referral arrhythmia centre, its results may not be generalizable to populations managed in less specialized settings. For example, in populations with less well controlled ventricular rates during AF episodes, this variable may emerge as a significant predictor of AF symptom severity. Given the potential for the presence of LV systolic dysfunction to exert a dominant influence on symptom severity and overall hr-QOL in patients with both systolic heart failure and AF, in this study that aimed to explore the specific contribution to AF symptom severity of clinical factors such as LV diastolic function and ventricular rates during periods of AF, patients with significant LV systolic dysfunction were excluded, limiting its generalizability to this group of patients. Next, the representation of female participants was lower than that of male participants, potentially compromising its power to demonstrate female gender as an important predictive variable. Finally, whilst the current study suggests that AF symptom severity and hr-QOL are primarily influenced by individual personality-based characteristics, other factors not tested in this study such as cultural factors and pre-existing health beliefs might also be expected to have an influence.

5. Conclusion

In a tertiary AF population with preserved LV systolic function and in models incorporating both clinical variables and variables of psychological function, only psychology consistently predicted both AF-related symptoms and hr-QOL. None of LV diastolic function, AF burden or persistence, or ventricular rate during AF predicted AF symptom severity or hr-QOL.

Conflict of interest

No author has any relevant conflicts to disclose.

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