Psychological Factors in Symptom Severity and Quality of Life in Raynaud's Phenomenon

Abstract

Background Despite emotional stress being recognised as a key trigger for Raynaud's phenomenon episodes, research in the area is still in its infancy.

Aims This study investigated the role of psychological factors relating to symptom severity and quality of life, and differences between Raynaud's types (primary and secondary) to further inform the development of intervention in this field.

Method A cross-sectional design was used. Two hundred and ten adults with Raynaud's completed an online questionnaire measuring stress, anxiety, depression, anxiety sensitivity, beliefs about emotions, symptom severity and quality of life.

Results Primary and secondary Raynaud's groups differed in anxiety ($p < .004$), symptom severity ($p < .001$) and quality of life ($p < .001$). Stepwise multiple regressions indicated anxiety and Raynaud's type explained 23% variance in hand symptom severity ($p < .001$); anxiety, Raynaud's type and anxiety sensitivity explained 29% variance in symptom severity (global impact, $p < .001$); depression, Raynaud's type and anxiety sensitivity explained 32% variance in quality of life ($p < .001$).

Conclusions Results highlight the importance of psychological factors in Raynaud's phenomenon, indicating possible targets for treatment. Interventions such as cognitive behavioural therapy, which target both physical and psychological wellbeing, bear some promise as an adjuvant therapy for this group.

Keywords: Raynaud's Phenomenon, quality of life, symptoms, anxiety, depression, psychological distress.

Raynaud's phenomenon is an intrusive condition that causes vasospastic episodes in the extremities, usually in response to cold, sudden temperature changes or emotional stress, which can induce pain and paraesthesia, compromising hand function (Shapiro & Wigley, 2017). The condition is either primary and idiopathic, or secondary to an underlying condition, such as scleroderma where more than 95% patients have Raynaud's (Meier et al., 2012). Primary Raynaud's affects approximately 5% of the general population, although rates vary by country and population (Garner et al., 2015).

Although most Raynaud's episodes are precipitated by cold exposure, studies have shown that emotional stress triggered approximately a third of episodes and that thematically relevant stressors (e.g. losing gloves in a snowstorm) are particularly important (Freedman & Ianni, 1983, 1985; Hughes et al., 2015). Raynaud hypothesised that this response is due to overactivity of the sympathetic nervous system in Raynaud's patients, which exaggerates vasoconstriction via the release of norepinephrine (Fardoun et al., 2016; Freedman & Ianni, 1983). An inability to habituate to stressful stimuli has been alternatively suggested to explain repeated excessive vasoconstriction in Raynaud's patients (Edwards et al., 1998). Affective factors can trigger or exacerbate symptoms in other episodic and inflammatory conditions, demonstrating the interaction between psychological and physical functioning (Harth & Nielson, 2019; Marmura, 2018).

The National Institute for Health and Care Excellence (NICE) recommend reducing stress and retaining warmth if this is a trigger as a first-line management of the condition but there are currently no interventions in line with these recommendations or other lifestyle recommendations (Daniels et al., 2018; NICE, 2022). A systematic review by Daniels and colleagues (2018) which examined the efficacy of behaviour change interventions concluded that there was not currently enough evidence to support or refute behaviour change interventions in Raynaud's due to low quality studies, but posited that there remained a

strong case to further a psychological understanding of the condition, which could provide targets for intervention.

Evidence-based non-pharmacological interventions may provide a more acceptable alternative to pharmacological treatments which are commonly ineffective or cause adverse side effects, such as headaches, dizziness and oedema (Choi, & Henkin, 2021).

However, prior to the development of such an intervention there is a need to operationally define the terms used to describe triggers of an episode, "emotional stress" being the most commonly used in the literature, and suggests a combination of anxiety and stress, which are also used interchangeably in the field. Stress can be characterised as a 'response' to pressure caused by an *external* trigger, whereas anxiety is more of a persistent, excessive worry that remains even without the stressor being present (American Psychological Association, 2019). Brown et al. (2001) investigated both constructs and concluded that anxiety, rather than stress, predicted frequency and severity of attacks. The term "emotional distress" is also used, which more broadly includes depression (Evers et al., 2011; Newton et al., 2012). Depression is common across many physical health conditions and often associated with poorer outcomes (Daré et al., 2019); depressed patients may have lower treatment adherence and less likely to take care of themselves by keeping warm or less willing to seek help for symptoms, thereby increasing symptom severity (DiMatteo et al., 2000). The non-specificity in the literature creates confusion and resolving this is likely to be pivotal in the development of appropriate non-pharmacological interventions for this group, where there are currently none.

As found in other medical conditions, Raynaud's symptoms have a detrimental influence on quality of life, with impact on everyday activities and the requirement of adjustment and adaptation (Murphy et al., 2021; Pauling et al., 2018). However, current research has not gone beyond simply showing that Raynaud's patients have poorer quality of

life than healthy individuals, and that quality of life is lower in secondary Raynaud's compared to primary (De Angelis et al., 2008; Fábián et al., 2019). The latter of which may be attributed to the absence of underlying pathology and lesser severity in primary Raynaud's (Shapiro & Wigley, 2017). Further research is needed to address this knowledge gap; improving quality of life is considered at least as important as treating symptoms (Shapiro & Wigley, 2017).

There has been a growing interest in the psychophysiology literature about the role of anxiety-related constructs in health conditions. Anxiety sensitivity, the fear of anxiety symptoms (physical and emotional) and believing they may cause illness, harm or embarrassment, is one such construct (Horenstein et al., 2018). Anxiety sensitivity may be particularly relevant to Raynaud's patients due to the symptomatic presentation (tingling, numbness) and visible nature of the symptoms (triphasic colours). An overlapping yet distinct construct with anxiety, anxiety sensitivity has been independently associated with symptomology and quality of life in other conditions (Asmundson et al., 2000; Smitherman et al., 2014). Anxiety sensitivity has also been reported to affect quality of life by perpetuating anxiety, depression and avoidance of physical and mental health-promoting activities (Bernstein et al., 2019; Ouimet et al., 2016); anxiety sensitivity may inadvertently increase symptom severity and worsen quality of life through increased fear and avoidance.

Understandable fear of anxiety may give rise to negative beliefs about experiencing and expressing emotions, a factor reported to be associated with adverse health outcomes (Bowers & Wroe, 2016; Brooks et al., 2017). Consistent with this hypothesis, a qualitative study reported that patients with scleroderma, most of whom have Raynaud's, reported coping with distress by actively suppressing upsetting thoughts and feelings and were reluctant to seek support (Newton et al., 2012). These avoidant strategies are likely to result

in reduced social support and helpful coping strategies, serving to induce or maintain low mood (Bowers & Wroe, 2016; Ouimet et al., 2016).

Biopsychosocial models, which explain conditions as a complex interplay between biological, psychological and social factors as seen in Raynaud's, have been increasingly used to explain symptomology in physical health problems and promote a multidisciplinary approach to treatment (Greenen & Dures, 2019; Miaskowski et al., 2020). Efficacious and acceptable interventions in behavioural medicine which draw on this model, such as cognitive behavioural therapy, are well placed to be adapted for use in this group. Based on the notion that thoughts, feelings, behaviour and physiology are interlinked, evidence supports use in similar conditions such as inflammatory arthritis (Marques et al., 2021). Such an integrated approach has the potential to improve care by broadening intervention options and optimising efficacy of treatment (Daniels & Turner-Cobb, 2017).

The study seeks to address gaps in the literature that could inform future treatment development. Specifically, the relative impact of psychological factors on symptom severity and quality of life in Raynaud's phenomenon, with a view to identify possible targets for intervention.

Method

Participants and Procedure

Cross-sectional online questionnaire data was collected from adults with Raynaud's using Qualtrics software, recruited via snowballing techniques on social media and two associated charities (Scleroderma & Raynaud's UK and Raynaud's Association). Inclusion criteria stipulated only adults (18+) who self-identified as having either primary or secondary Raynaud's be included in the study sample. After reading the information sheet, participants completed an informed consent form before moving on to the questionnaires battery. Participants could withdraw by exiting the survey before the end. Data was collected between

9th June and 7th July 2020, early on in the Coronavirus infectious disease (CovID-19) pandemic. Sampling took place over a limited four-week period to ensure stability of the relative temperature and weather. Ethical approval was granted by the Psychology Research Ethics Committee at University of XXXX (ref: 20-114).

Of the 269 who participated, 59 participants were removed due to incomplete data or failing to meet age inclusion criteria, leaving a final sample of 210 (n = 92 primary; n = 101 secondary Raynaud's). Average time since diagnosis was 18.35 years (SD = 14.60) and mean age was 47 years old (SD = 13.63). The sample was mostly female (94.3%), white (94.8%) and either married/partnered (71.4%), with 55.2% having an education level of Bachelor's degree or higher and only 6.2% were current smokers.

Measures

Independent Variables. The 21-item Depression, Anxiety and Stress Scales (DASS-21; Lovibond & Lovibond, 1995) contains three 7-item subscales measuring depression, anxiety and stress. Participants rate how much each statement (e.g. *I found it hard to wind down)* applied to them over the previous week and relevant item scores (0-3) are summed and multiplied by two to calculate subscale scores. The developers have recommended cut-off scores for "normal", "mild", "moderate" "severe" and "very severe" that correspond to each subscale (Lovibond & Lovibond, 1995). Internal consistency was good or acceptable for stress (α = .88), anxiety (α = .71) and depression (α = .92) subscales in the current study. The total scale and subscales have been validated (Antony et al., 1998).

The 16-item Anxiety Sensitivity Index (Reiss et al., 1986) measures anxiety sensitivity. Participants responded to items such as *"Unusual body sensations scare me"* using a 5-point Likert scale (0 = "very little" to 4 = "very much"). Item scores can be summed to produce a total score. Scale items were internally consistent here (α = .91) and validity has been established (Peterson & Plehn, 1999).

The 12-item Beliefs about Emotions Scale (Rimes & Chalder, 2010) measures beliefs about the unacceptability of experiencing and expressing emotions, with items such as *"I should be able to control my emotions"*. Participants respond using a 7-point Likert scale (6 = "totally agree" to 0 = "totally disagree"). The scale showed strong internal consistency within this sample (α = .93) and has good validity (Rimes & Chalder, 2010).

Dependent Variables. Due to the lack of suitable outcome measures for this group (Daniels et al. 2018), it was necessary to use two symptom severity measures to assess specific and global aspects, a method used in other measures, such as the EQ-5D (EuroQol, 2017). The questionnaires battery consisted of measures with low overall item totals, making it convenient for participants who may tire from completing larger, more time-consuming batteries, especially within clinical samples (Waltz et al., 1991).

The Symptom Burden Index–Hands (Kallen et al., 2010) was used to measure symptom severity (hand function). It is a 5-item subscale of a 40-item measure of symptom burden in systemic sclerosis, a closely related condition. For this study, participants were asked to consider symptoms relating to Raynaud's (Pauling et al., 2018) over the last two weeks and responded to items (*e.g. How often were hands a problem?*) using a rating scale (0-10). The subscale showed excellent internal consistency in this study (α = .98), while the complete index has been validated in systemic sclerosis patients (Kallen et al., 2010).

The Bath Ankylosing Spondylitis Patient Global Score (Jones et al., 1996) was used to measure symptom severity (global impact). Two VAS items (0-10) that ask participants to indicate the effect their disease has had on their wellbeing over the last week and last six months are averaged to provide the global score. The two items were highly correlated (r = .77, $p < .001$) and the measure has been previously validated (Jones et al., 1996).

The ONS4–Life Satisfaction (Tinkler & Hicks, 2011) is a validated single-item measure of personal wellbeing asking "*Overall, how satisfied are you with your life*

nowadays?" (0-10). As wellbeing is comparable to quality of life, the measure was considered suitable given the lack of relevant measures for this group (Camfield & Skevington, 2008). It is included in the Office for National Statistics (ONS) Annual Population Survey to estimate personal wellbeing in the UK, demonstrating its utility as a wellbeing measure (ONS, 2018). The single item measure also allows for direct measurement of personal wellbeing, reflecting good face validity (Wanous et al., 1997).

Analytic Strategy

Total (sub)scale scores were computed in SPSS, v.26. Missing data was replaced with the series mean, as was suitable given the sizable sample and low rate of missing data (1.5%) that were missing completely at random, as determined using Little's MCAR test (Parent, 2012). Cronbach's alpha coefficient was calculated to assess the internal consistency of each scale.

Descriptive statistics were calculated for the total sample, as well as primary and secondary Raynaud's separately, for stress, anxiety, depression, anxiety sensitivity, beliefs about emotions, symptom severity (hand function), symptom severity (global impact) and quality of life, as were the proportion within each DASS-21 subscale severity label. Summary data *t*-tests were calculated to make comparisons with previous normative/nonclinical data.

Bivariate correlations (*Pearson's R*) assessed the relationship between stress, anxiety, depression, anxiety sensitivity, beliefs about emotions, symptom severity (hand function), symptom severity (global impact) and quality of life. Concern for multicollinearity was considered using a threshold of $r > .8$ (Field, 2013).

Two-tailed independent samples *t*-tests were performed to assess group differences between primary and secondary Raynaud's in stress, anxiety, depression, anxiety sensitivity, beliefs about emotions, symptom severity (hand function), symptom severity (global impact) and quality of life. Welch's *t*-test was reported where appropriate as indicated by Levern's

test for violations in equality of variances assumption. To account for nonnormal distribution of (sub)scale scores, 95% percentile bootstrapped confidence intervals (2,000 resamples) were calculated for *t*-tests (Field, 2013). As Raynaud's type could not be inferred from participants who did not specify this, 17 cases were excluded from these analyses.

Stepwise multiple regressions were conducted separately on symptom severity (hand function), symptom severity (global impact) and quality of life to assess the R^2 variance accounted for by stress, anxiety, depression, anxiety sensitivity and beliefs about emotions. Based on prior research, Raynaud's type, condition duration, age, gender and smoking history were controlled for in each regression to account for confounding (Garner et al., 2015). Violations of linearity, normality and homoscedasticity were judged through visual inspection of histograms and scatterplots of the residuals and models were checked for influential outliers (standardized residuals ±3 and Cook's distance > 1) and multicollinearity (Tolerance < .01). An alpha level of .05 was used for analyses.

Results

Descriptive statistics for variables and participant proportions within each DASS-21 severity label category are presented in Table 1. In comparison to normative data (Crawford & Henry, 2003; Peterson & Plehn, 1999), participants had significantly higher stress ($t(251.93) = 7.73$, $p < .001$), anxiety ($t(236.78) = 10.62$, $p < .001$), depression ($t(243.10) = 7.46$, $p < .001$) but not anxiety sensitivity ($t(220.01) = -0.14$, $p = .89$). Participants also had significantly higher negative beliefs about emotions than a previous non-clinical sample (Rimes & Chalder, 2010; $t(175.36) = 5.01$, $p < .001$).

Bivariate correlations showed that measures of stress, anxiety, depression, anxiety sensitivity, beliefs about emotions, symptom severity and quality of life were all significantly correlated in the expected directions (Table 2). A strong correlation was found between hand function and global impact ($r = .78$, $p < .001$) due to the convergence around symptom

severity measurement. Strong correlations were also found between stress and depression (r = .65, p < .001) and anxiety and anxiety sensitivity (r = .63, p < .001) indicating the variables were related but below the threshold for possible multicollinearity, i.e. they are distinct constructs.

Independent samples t-tests indicated that participants with primary Raynaud's had significantly lower anxiety (t(172.10) = -2.89, p = .004, 95% bootstrapped CI [-4.69, -0.97], d = .41), symptom severity in the domain of hand function (t(191) = -5.11, p < .001, 95% bootstrapped CI [-2.64, -1.22], d = .74) and domain of global impact (t(191) = -5.30, p < .001, 95% bootstrapped CI [-2.36, -1.12], d = .76) but were higher in relation to quality of life (t(188.52) = 3.46, p = .001, 95% bootstrapped CI [0.44, 1.60], d = .49) than participants with secondary Raynaud's. The two diagnostic groups did not significantly differ on measures of stress (t(191) = -0.23, p = .822, 95% bootstrapped CI [-2.82, 2.07] d = .03), depression (t(191) = -1.97, p = .051, 95% bootstrapped CI [-4.99, -0.97], d = .28), anxiety sensitivity (t(184.57) = -1.69, p = .092, 95% bootstrapped CI [-6.13, 0.37], d = .24), or beliefs about emotions (t(191) = -0.55, p = .582, 95% bootstrapped CI [-5.85, 3.22], d = .08).

Stepwise regression analyses indicated that anxiety and Raynaud's type (primary or secondary) explained 23% of the variance in symptom severity (hand function; R^2 = .23, F(2, 207) = 30.50, p < .001), see Table 3. Anxiety accounted for 16% of the variance (β = .40, p < .001), while Raynaud's type accounted for an additional R^2 change of 7% (β = .27, p < .001). All other entered variables were excluded.

A three-predictor model containing anxiety, Raynaud's type and anxiety sensitivity accounted for 29% of the variance in symptom severity (global impact; R^2 = .29, F(3, 206) = 27.34, p < .001), see Table 4. Anxiety explained 20% of the variance (β = .44, p < .001). Raynaud's type contributed an additional R^2 change of 7% (β = .26, p < .001) and anxiety

sensitivity explained a further R^2 change of 2% (β = .19, p = .016). All other entered variables were excluded.

Three significant predictors explained 32% of the variance in quality of life (R^2 = .32, $F(3, 206) = 32.68$, $p < .001$), see Table 5. Depression accounted for 29% of the variance (β = -.54, $p < .001$), Raynaud's type explained an additional R^2 change of 2% (β = -.15, p = .011), anxiety sensitivity contributed a further R^2 change of 1% (β = -.13, p = .046) to the model. All other entered variables were excluded.

The regression models met the necessary assumptions of linearity, normality, and homoscedasticity of the residuals. A single outlier was identified but retained as Cook's Distance indicated that it was not influential. Tolerance values confirmed absence of multicollinearity, meaning the regression models were statistically stable and regression coefficients were reliable (Field, 2013). As prior power analysis indicated a sample of 98 was needed to detect a medium effect size observed in prior related work (Ryan & McGuire, 2016; Wan et al., 2014) using α = .05, 1 – β = .8, we can confidently report these results.

Discussion

Stress, anxiety and depression were found to be higher in those with Raynaud's when compared to normative data, consistent with a body of research showing that mental health is poorer in people with physical conditions (Crawford & Henry, 2003; Daré et al., 2019). Those with primary and secondary Raynaud's did not significantly differ in terms of stress, depression, anxiety sensitivity or beliefs about emotions, suggesting overall mental health is similar between Raynaud's types, however anxiety was higher in those who experience Raynaud's secondary to another health problem.

Group differences in relation to symptom severity and quality of life reflect a more significant detrimental impact in secondary Raynaud's in comparison to primary Raynaud's,

298 in keeping with prior research (Fábián et al., 2019; Shapiro & Wigley, 2017). This may be
299 partly attributable to more systemic health problems in those with secondary Raynaud's.
300 Taken together, these findings suggest that psychological factors and quality of life
301 are integral to functioning and physical health and should be routinely assessed in Raynaud's
302 alongside a primary focus on symptom severity and health status.
303 Advancement of our understanding regarding the role of psychological factors is
304 reflected in the finding that anxiety, not stress, was independently associated with symptom
305 severity. This suggests that the term anxiety may more accurately describe the "emotional
306 stress" commonly purported to trigger episodes. This result agrees with previous findings by
307 Brown et al. (2001), however the sample here consisted of both primary and secondary
308 Raynaud's participants rather than just primary Raynaud's. It also provides further support
309 for Raynaud's original sympathetic overactivity hypothesis, which describes a hyperactivity
310 of internal fear-response systems that are associated with anxiety.
311 Anxiety, known to be amenable to evidence-based therapies such as cognitive
312 behavioural therapy, may provide a target for intervention in Raynaud's. As an intervention
313 which targets emotional wellbeing, quality of life and promotes effective-self management in
314 Raynaud's, cognitive behavioural therapy would be suitably aligned as a potential treatment
315 option, with further modification for this clinical group. It is particularly relevant given the
316 prolific evidence-base for cognitive behavioural therapy as a treatment for anxiety (NICE,
317 2020), which inherently aims to reduce hyperactive sympathetic responses associated with
318 anxiety that are thought to facilitate vasoconstriction in these patients. Given the
319 neurobiological basis behind Raynaud's, it is important that any psychological intervention
320 emphasises these aspects alongside targeting illness specific beliefs and behaviours which are
321 serving to maintain an overactive sympathetic nervous system (Mosely & Butler, 2015).
322 Employing a multidisciplinary approach which incorporates input from specialist

physiotherapy alongside cognitive behavioural therapy might be especially beneficial to people with Raynaud's.

Anxiety sensitivity accounted for some of the variance (albeit marginal) in quality of life and global impact, but not hand function. This is in line with associations found in related rheumatological conditions (Bernstein et al., 2019; Mehta et al., 2016), of which many will feature Raynaud's. This finding indicates a sensitivity in the physiological response to anxiety and the physiology of their condition in Raynaud's patients, which may impact symptom experience and quality of life. Although highly correlated with anxiety, anxiety sensitivity was independently associated with symptom severity, demonstrating that they are indeed distinct constructs and worthy of consideration separately as targets for intervention.

Depression did not predict symptom severity but accounted for a large proportion of the variance in quality of life, which corresponds with associations found in prior related work (Hudson et al., 2008; Wan et al., 2016). Surprisingly, anxiety was not independently associated with quality of life, contrasting with previous research in related conditions (Anyfanti et al., 2016; Sierakowska et al., 2019). This does suggest that anxiety does not have as large an impact on quality of life in Raynaud's, as compared to depression, which may be partly attributable to the functional and emotional limitations often associated with depression. As such, treating comorbid depression should also be at the forefront of any intervention as it may work towards improving quality of life in people with Raynaud's.

Beliefs about emotions was not significantly predictive of symptom severity or quality of life in the regression models. This is contrary to findings in other stress-related conditions (Bowers & Wroe, 2016), and inconsistent with theories of emotion in Raynaud's, suggesting that cognitions surrounding the experience of emotion and physiology in Raynaud's may be more complex than in other conditions. A considerable association was exhibited between beliefs about emotions and anxiety sensitivity. Indeed, anxiety sensitivity

is a belief about emotion itself and its associated physiology, based in the belief that anxiety symptoms are harmful. Therefore, it is possible the beliefs about emotions that impact symptom severity and quality of life in Raynaud's relate specifically to the experience of anxiety and the knowledge that it can trigger episodes. As such, beliefs about anxiety specifically (i.e., anxiety sensitivity) may be more pertinent to address in this group than beliefs about emotions more generally.

By looking at beliefs about emotions more generally, we may be missing other important condition-related cognitions and belief systems which indirectly maintain symptoms in Raynaud's and give rise to avoidant coping strategies. In their development of the beliefs about sharing illness experiences scale (BASIE), Wroe and Bowers (2019) reported that beliefs regarding the unacceptability of sharing illness experiences maintained cycles of symptoms and distress in fibromyalgia patients. This may be similarly relevant in people with Raynaud's given the common feelings of fear and embarrassment related to the visibility and impact of symptoms which may further serve to trigger or maintain a Raynaud's episode.s.. Raynaud's sufferers with alexithymia who find it difficult identifying and describing feelings may be particularly vulnerable in this regard as having alexithymia may further reduce support-seeking behaviours and increase suppressive emotion regulation strategies (Fabien et al., 2020). Further research is needed to understand the complex relationship between beliefs about emotions, expression of emotion and coping strategies in Raynaud's. This may support the development and adaptation of a CBT based treatment model

The overall findings support a biopsychosocial model for use in Raynaud's; psychological factors have been found to be related to the fear-based activation of the sympathetic nervous system that inhibits blood flow to the extremities, which is likely to be moderated by beliefs that emotional factors are closely related to the activity of their

Raynaud's (Newton et al., 2012; Pauling et al., 2018). Adopting a biopsychosocial lenswhen assessing, formulating and treating anxiety, anxiety sensitivity and depression in Raynaud's patientsis vital due to the interaction between these dimensions in Raynauds, particularly the autonomic arousal, role of cognition and the social discomfort commonly seen in Raynaud's. . While the common approach to the treatment and management of long-term conditions is CBT (Daniels Psychologist mag CBT trickles down), it would be imperative that the biological components and autonomic system are adequately taken account within the physiological aspect of this approach.

Study findings also provide empirical support for NICE first-line recommendations that Raynaud's patients minimise their emotional stress to help manage the condition (NICE, 2022). Qualitative research reported that those with scleroderma, of whom almost all will have Raynaud's, were reluctant to seek psychosocial support specifically for their distress, therefore a stepped care integrated approach may be most suitable to accommodate the different levels of care desired by individuals (Newton et al., 2012). Low-intensity care might include patient education and self-management strategies based on the principles of cognitive behavioural therapy (e.g., non-avoidance of temperate changes/stress), as recommended by NICE for anxiety (NICE, 2020).

There are several services available in the UK National Health Service (NHS), as part of an initiative to integrate physical and mental healthcare for people with long-term physical conditions (NHS, 2018). Talking Therapies in the NHS currently only offer interventions which focus on low mood and anxiety, addressing only part of the care pathway for people with Raynaud's. It would be optimal to offer a more holistic model and approach from which these services can work from, focusing on the nervous system through education, formulation to identify relevant beliefs and behaviours, and intervention using cognitive behavioural

398 therapy, as part of a multidisciplinary approach. Improving Access to Psychological
399 Therapies (IAPT) services co-located in physical health services allow patients to access
400 NICE-recommended therapies alongside physical treatment (NHS, 2018). This approach
401 promotes greater coordination between healthcare providers to comprehensively address the
402 needs of Raynaud's patients and improve overall care but may not be available everywhere.
403 The findings here could relate to other conditions which are underpinned by the
404 similar physiological mechanisms (e.g. a sensitised autonomic nervous system) and may also
405 benefit from a multidisciplinary approach to treatment. Future research in this area is needed
406 to consider the benefits of having a holistic approach to managing conditions such as this
407 where the relationship between physiological and psychological experience are closely bound
408 by the cognitions and neurobiological mechanisms that trigger and maintain them.
409 **Limitations and Future Research**
410 Due to the cross-sectional design of the study, causal direction cannot be inferred
411 from these results. Prospective longitudinal research is needed to establish a greater
412 understanding of the direction of influence. Nevertheless, the identification of psychological
413 factors that predict variance in symptom severity and quality of life in Raynaud's is important
414 to inform the direction of such research.
415 It was evident that there is a lack of suitable outcome measures for this group, as
416 reported in Daniels et al. (2018), and the online cross-sectional design prohibited the use of
417 the traditional Raynaud's Condition Score diary (Daniels et al., 2018). However, the
418 measures adapted for this study showed good reliability and produced meaningful results that
419 corresponded to measures used in prior Raynaud's studies (Brown et al., 2001; Fábián et al.,
420 2019; Hughes et al., 2015). These should be further tested and considered for use in future
421 research.

Self-selection via online recruitment and self-reporting of Raynaud's type potentially undermined the credibility of the sample. This could have resulted in a biased sample that may not be fully representative, a common challenge in online studies (Gosling & Mason, 2015). Future research would benefit from a clinically confirmed representative sample rather than a self-selected online sample.

Data was collected during a short period in early summertime in the UK, which limited the confounding role of temperature, given its importance in Raynaud's. It would be useful to repeat this study or use a longitudinal design to observe whether the influence of these factors change with the seasons. As data collection took place early on in the Coronavirus infectious disease (CovID-19) pandemic, it is worth noting the potential impact that elevated anxiety and depression experienced during this time may have had in the context of this study, as anxiety is a known trigger for Raynaud's (Gigante et al., 2020; Rettie & Daniels, 2021). Although elevated levels of anxiety are unlikely to have altered the nature of the relationships between the key variables.

Conclusion

These findings provide pivotal insight into the psychological factors associated with symptom severity and quality of life in people with Raynaud's phenomenon; an area that has previously been relatively under researched despite having a strong theoretical and practical basis for study in this condition. Study results suggest a multidisciplinary biopsychosocial approach which address psychological factors in addition to physical needs may be most appropriate for the treatment of Raynaud's and provide empirical support for NICE first-line recommendations that patients minimise emotional stress to help manage the condition. Cognitive behavioural therapy is suitably aligned as a potential treatment option, considering its recommendations for use with anxiety and robust evidence base supporting its delivery in rheumatological and other medical conditions. This paper presents initial findings that may

447 underpin the adaption of cognitive behavioural therapy for this common, debilitating
448 problem.
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