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SPECIAL ISSUE: SOCIAL ISOLATION AND LONELINESS IN ACUTE AND CHRONIC ILLNESS

Moderators of Loneliness Trajectories in People with Systemic Sclerosis During the COVID-19 Pandemic: A SPIN COVID-19 Cohort Longitudinal Study

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Abstract

Background Many individuals with systemic sclerosis (SSc) are at heightened risk for COVID-19 related morbidity and isolation due to interstitial lung disease, frailty, and immunosuppressant use. Minimal research has explored loneliness predictors in individuals with chronic illnesses during COVID-19. This study evaluated moderators of loneliness trajectories in individuals with SSc during COVID-19.

Methods Longitudinal data were analyzed across 30 timepoints from April 2020 to May 2022 from 775 adults in the Scleroderma Patient-centered Intervention Network (SPIN) COVID-19 Cohort. Hierarchical linear modeling evaluated cross-level moderators of loneliness trajectories, including marital status, baseline number of household members, number of virtual or telephone one-on-one or virtual group conversations, number of hours spent enjoying in-person household conversations or activities, and satisfaction with quality of in-person household conversations (all in the past week). Level-1 moderation analyses assessed effects of conversation, activity, and satisfaction means and slopes over time.

Results Baseline values were not statistically significant moderators of loneliness trajectories. Higher mean (averaged over time) virtual or telephone one-on-one and in-person household conversations, in-person household activity, and in-person household conversation satisfaction were associated with lower loneliness trajectories ($ps < .05$). The relationship between in-person household conversation satisfaction and loneliness trajectory was statistically significantly but minimally attenuated over time ($p < .001$).

Conclusions For people with SSc, higher mean conversation, activity, and satisfaction variables were associated with lower levels of loneliness during the pandemic, but changes in these social variables were generally not predictive of changes in loneliness.

Keywords Systemic sclerosis · Scleroderma · Social support · Loneliness · COVID-19

Introduction

Loneliness, or the perception that social relationships do not fulfill social needs, is an important biopsychosocial stressor to consider in individuals with chronic illnesses, and studies prior to COVID-19 have reported loneliness as a challenge for persons with a variety of chronic illnesses [1, 2]. Individuals with chronic illnesses, particularly those with substantial symptom burden, may experience greater difficulties in engaging in interpersonal interactions, placing them at risk of greater isolation from others. Sustained loneliness is associated with negative cognitive and mental health outcomes as well as poorer physical health and higher risk of mortality [2, 3].

Risks of loneliness-related consequences and persistent isolation may be especially elevated as an effect of

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COVID-19. A systematic review and meta-analysis (N = 34 studies with 215,026 participants) found that loneliness increased across multiple populations (e.g., general population of middle-aged or older adults, adolescents, individuals with cancer) during the COVID-19 pandemic relative to pre-pandemic times by a small amount (standardized mean difference = 0.27, 95% confidence interval 0.14 to 0.40) [4]. Deficits in quantity and quality of interactions have been traditionally linked to loneliness [5], and are an important consideration in the context of the COVID-19-related social isolation. Study findings on associations between quantity and quality of interactions or social relationships and loneliness during COVID-19 generally suggest that a higher number of close relationships and face to face interactions, more meaningful relationships, and living with others have been associated with decreased loneliness and other related health outcomes such as quality of life [6–14]. Some findings, however, have been mixed. For example, one study of older adults over four weeks at the start of the pandemic found that higher frequency of social interactions across different modalities (e.g., video chat, phone, text message) and satisfaction with communication predicted lower levels of loneliness, but that only satisfaction with communication significantly predicted changes in loneliness over time [7]. In contrast, another recent study found that more frequent virtual contact was associated with greater loneliness longitudinally during the pandemic [9]. More longitudinal research is needed to determine how quantity and quality of interactions have influenced loneliness trajectories over the course of the COVID-19 pandemic.

Few studies have also considered the unique experiences of loneliness in individuals with chronic illnesses during the COVID-19 pandemic, and how quantity and quality of interactions might influence loneliness trajectories in these populations [15]. This is an important consideration due to the shifting nature of the pandemic over time, and the unique difficulties individuals with chronic illnesses faced during COVID-19 that could result in greater social isolation, including increased physical distancing and limitations on in-person gatherings due to higher risk of COVID-19 symptom burden and mortality [15].

Systemic sclerosis (SSc) is a rare autoimmune connective tissue disorder that damages the skin and internal organs including the lungs. Individuals with SSc are at higher risk of serious disease or mortality during COVID-19 and, thus, of isolation, given their general frailty, use of immunosuppressant medications, and the presence of interstitial lung disease in approximately 40% of individuals [16–19]. Further, individuals with SSc may suffer from debilitating physical limitations, including fatigue, chronic pain, gastrointestinal problems, and appearance dissatisfaction, that can impede social interactions even without the influence of COVID-19 [17]. Only two studies have examined loneliness in individuals with SSc. In one study, the Scleroderma Patient-centered Intervention Network (SPIN) reported mean levels of loneliness across 28 timepoints during the pandemic among 800 individuals with SSc at baseline [20]. The findings showed little overall change in loneliness for the total sample or when stratified by sex, age, country, and SSc subtype (diffuse versus limited). However, potential social moderators of loneliness trajectories were not examined. In a SPIN study of cross-sectional relationships between loneliness and sociodemographic and social factors, loneliness was significantly inversely correlated with virtual or telephone one-on-one conversations in the past week and number of virtual group conversations in the past week [21]. Research has not explored how frequency and quality of interactions might influence loneliness trajectories in patients with SSc over the course of the COVID-19 pandemic. Such findings would provide valuable insights into how predictors of loneliness that have been supported in the literature might impact individuals with SSc, particularly during times when social isolation is necessary for physical health maintenance.

The aim of the present study was to evaluate whether interaction frequency and interaction satisfaction moderated trajectories of loneliness throughout the COVID-19 pandemic in individuals with SSc. Study objectives were to 1) examine the association of baseline social characteristics, including a) number of household members, b) marital status, c) number of virtual or telephone one-on-one conversations in the past week, d) number of virtual group conversations in the past week, e) number of hours spent enjoying in-person household conversations in the past week, f) number of hours spent enjoying in-person household activities in the past week, and g) satisfaction with quality of in-person household conversations in the past week, with loneliness trajectories and 2) examine mean levels of and changes in conversation, activity, and satisfaction variables over time as predictors of loneliness trajectories.

Methods

This was a longitudinal study over 30 timepoints between April 2020 and May 2022 of participants who enrolled in the Scleroderma Patient-centered Intervention Network (SPIN) COVID-19 Cohort and completed measures of symptoms of loneliness. The SPIN COVID-19 Cohort study (#2021–2286) was approved by the Research Ethics Committee of the Centre intégré universitaire de santé et de services sociaux du Centre-Ouest-de-l'Île-de-Montréal. The SPIN COVID-19 Cohort protocol, with more detailed methods, is available online (https://osf.io/62vut/).

Participants and Procedure

Participants in the SPIN COVID-19 Cohort were recruited from both the ongoing SPIN Cohort and through social media and patient organization advertisements [22]. The SPIN Cohort includes approximately 1,100 active participants from 47 centers in Canada, the United States, the United Kingdom, France, Spain, Mexico, and Australia who complete online assessments every three months. Eligibility for the SPIN Cohort includes age ≥ 18 years, fluency in English, French, or Spanish, and meeting the 2013 American College of Rheumatology/European League against Rheumatism criteria for SSc, verified by a SPIN physician [23]. There were no additional inclusion or exclusion criteria. SPIN site personnel enroll participants by submitting an online medical form once informed consent is received. SPIN Cohort participants consent upon cohort enrollment to be contacted for additional SPIN studies.

English and French-speaking SPIN Cohort participants received emails and popups during SPIN Cohort online assessments between April 9 to April 27, 2020 to invite them to enroll in the SPIN COVID-19 Cohort. Potential participants not in the ongoing SPIN Cohort received invitations through recruitment announcements on social media (e.g., SPIN's Facebook page and Twitter account) and patient organization advertisements in English and French in Canada, the United States, France, the United Kingdom, Australia, New Zealand, and the Philippines. All SPIN COVID-19 Cohort participants were emailed measures via Qualtrics every two weeks from April 9 through July 22, 2020, then every four weeks from July 27, 2020 until May 2022. The change in frequency of assessments (from every two weeks to monthly) was made to reduce participant burden.

Measures

For SPIN Cohort participants, person-level, deterministic linking was used with email addresses to link pre-COVID-19 sociodemographic and medical data to SPIN COVID-19 Cohort outcome data. SPIN COVID-19 Cohort participants who were not part of the SPIN Cohort reported sociodemographic and basic medical data at baseline, including sex, age, race or ethnicity, marital status, education level, occupation, number of household members, time since SSc diagnosis, and SSc disease subtype (limited or diffuse). At each assessment, participants reported, via items created for this project, number of virtual or telephone one-on-one conversations in the past week, number of virtual group conversations in the past week, number of hours spent enjoying in-person household conversations in the past week, number of hours spent enjoying in-person household activities in the past week, and satisfaction with quality of in-person household conversations in the past week on a scale of 0 (*very dissatisfied*) to 4 (*very satisfied*).

Loneliness Level of loneliness was measured with the UCLA Loneliness Scale – 6 (ULS-6) [24]. The 6-item ULS-6 is a short version of the 20-item ULS, which is designed to assess subjective feelings of loneliness and social isolation [24, 25]. Respondents indicate the degree to which feelings described in each item apply to them. The assessment prompt asks participants to "Indicate how often each of the statements below is descriptive of you." Items are scored on a 4-point scale from 0 (*never*) to 3 (*often*); total scores range from 0 to 18. The correlation of the ULS-6 with longer versions of the ULS was 0.87 in adolescents and 0.92 among older adults [24, 26]. The ULS-6 items were obtained from a French version of the full ULS [27]. The ULS-6 has been shown to be reliable and valid for individuals with SSc in both English and French [21].

Analysis

Descriptive statistics were presented as means (standard deviations) for continuous variables and frequencies (percentages) for categorical variables. These were calculated for the entire sample at baseline and separately for those with diffuse and limited SSc. Hierarchical linear modeling was used to evaluate loneliness trajectories across assessments and potential moderators of loneliness trajectories in individuals with SSc over this timeframe. We identified items to be included in the model *a priori* based on factors associated with psychosocial outcomes in SSc [28].

Hierarchical linear modeling allows for nesting of all repeated timepoints as a level-1 predictor within individual subjects (grouping variable), with loneliness levels serving as the outcome variable. First, an unconditional growth model was tested using a linear version of time as the predictor variable. Building on this model, a second model added a quadratic (general non-linear) version of time as a second predictor variable. The deviance values for these two models were compared to statistically determine which model fit best. The better-fitting model was then used in subsequent analyses. The subsequent model with timepoint as a level-1 predictor included seven level-2 predictors: 1) baseline number of household members, 2) baseline marital status (married or living as married vs. separated/divorced, widowed, or single [reference category]), 3) baseline number of virtual or telephone one-on-one conversations in the past week, 4) baseline number of virtual group conversations in the past week, 5) baseline number of hours spent enjoying in-person household conversations in the past week, 6) baseline number of hours spent enjoying in-person activities in the past week, and 7) baseline satisfaction with quality of in-person household conversations in the past week. This hierarchical

linear model analyzed each of their cross-level interactions with timepoint in predicting loneliness trajectories over time. In a final model with timepoint as a level-1 predictor, predictors 3 through 7 were examined as time-varying level-1 predictors and moderators. Parameters were calculated through maximum likelihood estimation. Assumptions of homoscedasticity and normality of residuals, as well as multicollinearity, were examined, both between predictors and between predictors and ULS scores [29]. Due to issues of multicollinearity between the variable x timepoint interaction terms, the level-1 interaction analyses were run separately for each predictor. For any significant interactions, follow-up simple slope analyses were run for 1 standard deviation (SD) below the mean of a predictor over time, at the mean, and 1 SD above the mean.

All models included several level-2 predictors as covariates, including age (years), sex (male, female [reference category]), language (French, English [reference category]), race or ethnicity (Black, Asian, other vs. White [reference category]), disease subtype (diffuse SSc vs. unknown SSc vs. limited SSc [reference category]), and time since diagnosis (years), all measured at baseline. Missing data were accounted for by using full information maximum likelihood estimation [30]. This strategy allowed for handling model estimation and missing data in one step, as opposed to two steps with multiple imputation, and automatically incorporated auxiliary information, which improves estimator performance in terms of power, bias, and efficiency [31].

In main analyses, data were examined for all individuals in the sample. In sensitivity analyses, only data from "completers" (participants who completed at least 23 [75%] timepoints) were included. With 775 participants who completed the ULS-6 at baseline and > 250 participants who completed the ULS-6 at each of the 30 timepoints, we anticipated that the data would be sufficiently powered for the proposed analyses. This sample size exceeded proposed requirements for hierarchical linear modeling in the literature, such as 5 observations within 200 individuals [32]. We reported unstandardized regression coefficients and *p*-values for these analyses. All analyses were conducted using Mplus software (Version 8; Muthén & Múthen).

Results

See Table 1 for participant sociodemographic information. A total of 800 participants completed at least some baseline measures; the 775 participants who completed the ULS-6 at baseline were included in analyses. The mean age was 55.6 (SD = 12.6) years, 83% (N = 638) of participants were White, and 90% (N = 697) were of female sex. Participants averaged 11.6 (SD = 8.0) years since diagnosis, and 54% (N = 407) of participants had limited subtype SSc. Participants lived in the United States (32%; N = 244), France (26%; N = 198), Canada (25%; N = 192), and the United Kingdom (9%; N = 68). At baseline, the mean score on the ULS-6 was 7.0 (SD = 4.8). At timepoint 15 (February 2021), the mean score on the ULS-6 was 6.9 (SD = 4.9). At timepoint 30 (May 2022), the mean score on the ULS-6 was 6.6 (SD = 4.8).

Participants completed 15.7 assessments on average (SD = 10.3). Thirty-five percent (N = 269) of participants completed ≥ 75% of the 30 assessments (these participants are referred to below as "completers"). For individuals who completed ≥ 75% of the 30 assessments, 90% (N = 241) were White, 87% (N = 234) were female, and 55% (N = 147) had limited subtype SSc. These individuals had a mean age of 59.9 (SD = 10.7) years and averaged 15.9 (SD = 3.5) years since their SSc diagnosis.

See Table 2 for all hierarchical linear model values for level-2 baseline predictors. Loneliness trajectories did not significantly change over time ($b = 0.00$, $p = 0.45$). The quadratic loneliness trajectory was also not significant ($b < 0.001$, $p = 0.37$). Deviance values between the two models were compared and there were not significant differences ($\chi^2 < 0.001$, $p > 0.05$). Therefore, the linear model was used for subsequent analyses.

The hierarchical linear model indicated significant inverse associations between baseline number of virtual group conversations and baseline loneliness, such that loneliness scores decreased by 0.20 points for every additional virtual group conversation ($p = 0.00$). Additionally, for every 1 hour increase in baseline number of hours spent enjoying in-person household activities, baseline loneliness scores decreased by 0.13 points ($p = 0.01$). For every 1-point increase in baseline satisfaction with quality of in-person household conversations, baseline loneliness scores decreased by 0.54 points ($p < 0.001$). Other baseline associations were not significant ($p > 0.05$). Cross-level moderating effects on loneliness over time were not significant for any baseline predictors ($p > 0.05$). Therefore, these baseline predictors did not moderate loneliness trajectories over time. Sensitivity analyses of completers indicated the same findings.

See Table 3 for all level-1 interaction analysis values. Mean (averaged over time) number of virtual or telephone one-on-one conversations was significantly associated with lower loneliness slope over time, such that for every additional virtual or telephone one-on-one conversation on average, there was a 0.11 decrease in loneliness slope over time ($p = 0.00$). Additionally, for every additional virtual group conversation on average, there was a 0.40 decrease in loneliness slope over time ($p = 0.00$). For every additional hour spent enjoying in-person household conversations on average, there was a 0.30 decrease in loneliness slope over time ($p < 0.001$). For every additional hour spent enjoying in-person household activities on average, there was a 0.34 decrease in loneliness slope

Table 1 Demographic characteristics

Characteristic	Overall (N = 775)	Limited Subtype[a] (N = 407)	Diffuse Subtype[a] (N = 315)
Age[b]	55.6(12.6)	57.1(12.8)	53.6(12.0)
Female Sex[c] (%)	697(90.4)	384(94.3)	271(86.0)
Married or Living as Married[d] (%)	531(69.1)	285(70.4)	212(67.5)
Not Employed[e,j] (%)	449(58.4)	224(55.0)	194(62.0)
Ethnicity[f]			
White (%)	638(83.4)	353(86.7)	246(79.1)
Black (%)	50(6.5)	17(4.2)	31(10.0)
Other (%)	77(10.1)	37(9.1)	34(10.9)
Country[g]			
US (%)	244(31.6)	111(27.3)	116(36.9)
Canada (%)	192(24.8)	108(26.5)	66(21.0)
France (%)	198(25.6)	120(29.5)	75(23.9)
UK (%)	68(8.8)	39(9.6)	26(8.3)
Australia (%)	43(5.6)	25(6.1)	13(4.1)
Other (%)	28(3.6)	4(1.0)	18(5.7)
Years of Education[h]	15.8(3.4)	15.7(3.4)	15.9(3.5)
Years Since SSc Diagnosis[i]	11.6(8.0)	13.0(8.5)	10.4(7.1)

Values are the mean ± SD unless indicated otherwise

Due to missing data: [a]N(Limited) = 407, N(Diffuse) = 315, N(Unknown or Missing) = 53

[b]N(Overall) = 771, N(Limited) = 407, N(Diffuse) = 315

[c]N(Overall) = 771, N(Limited) = 407, N(Diffuse) = 315

[d]N(Overall) = 768, N(Limited) = 405, N(Diffuse) = 314

[e]N(Overall) = 769, N(Limited) = 407, N(Diffuse) = 313

[f]N(Overall) = 765, N(Limited) = 407, N(Diffuse) = 311

[g]N(Overall) = 773, N(Limited) = 407, N(Diffuse) = 314

[h]N(Overall) = 762, N(Limited) = 403, N(Diffuse) = 310

[i]N(Overall) = 746, N(Limited) = 399, N(Diffuse) = 311

[j]Not Employed = Homemaker, unemployed, on leave of absence, retired, on disability, full-time student only; Employed = Full-time employed, part-time employed

over time ($p < 0.001$). Finally, for every additional 1-point increase in mean satisfaction with quality of in-person conversations, there was a 1.03 decrease in loneliness slope over time ($p < 0.001$). The slope of satisfaction with quality of in-person household conversations positively moderated the effect of mean satisfaction on loneliness over time, such that for every 1-point increase in satisfaction slope over time, there was a 0.02 attenuation in the effect of satisfaction on loneliness slope over time ($p < 0.001$). Simple slope analyses (see Fig. 1) indicated significant simple slope at 1 SD below mean satisfaction over time ($\beta = -0.08$, $p < 0.001$) and at mean satisfaction over time ($\beta = -0.05$, $p < 0.001$), but not at 1 SD above mean satisfaction over time ($p > 0.05$). The slope of number of virtual group conversations positively moderated the effect of mean number of virtual group conversations on loneliness over time, such that for every 1-point increase in virtual group conversation slope over time, there was a 0.01 attenuation in the effect of virtual group conversations on loneliness slope over time ($p = 0.01$). Simple slope analyses (see Fig. 2) indicated that at 1 SD below mean number of group conversations over time, the simple slope was significant ($\beta = -0.04$, $p = 0.03$), but not at the mean or 1 SD above the mean ($ps > 0.05$). No other slopes were significant moderators of effects on loneliness trajectories ($ps > 0.05$).

Sensitivity analyses of the subsample of completers did not replicate findings for hierarchical linear modelling or level-1 interaction analysis of the number of virtual group conversations. All other sensitivity analyses of completers for hierarchical linear modelling and level-1 interaction analyses of all other predictors, confirmed the same pattern of findings as original analyses.

Discussion

For individuals with SSc, loneliness levels remained similar throughout the pandemic. While there were significant inverse baseline-level associations between loneliness and

Table 2 Values for baseline variables as predictors of baseline loneliness and as moderators of loneliness trajectories over time

	Unstandardized B-value[a] (95% CI)	P-value
Married or Living as Married	-.27 (-1.03,.48)	.48
Baseline # of Household Members	-.08 (-.31,.14)	.47
Baseline # of Virtual/Telephone One-on-one Conversations	-.02 (-.08,.04)	.55
Baseline # of Virtual Group Conversations	-.20 (-.32,-.08)	.00
Baseline # of Hours Spent Enjoying In-person Household Conversations	-.02 (-.12,.07)	.62
Baseline # of Hours Spent Enjoying In-person Household Activities	-.13 (-.27,-.03)	.01
Baseline Satisfaction with Quality of In-person Household Conversations	-.54 (-.75,-.33)	< .001
Baseline Marital Status x Timepoint	-.02 (-.05,.02)	.30
Baseline # of Household Members x Timepoint	.01 (-.01,.02)	.44
Baseline # of Virtual/Telephone One-on-one Conversations x Timepoint	-.00 (-.01,00)	.40
Baseline # of Virtual Group Conversations x Timepoint	.01 (-.00,.01)	.23
Baseline # of Hours Spent Enjoying In-person Household Conversations x Timepoint	-.00 (-.01,.00)	.71
Baseline # of Hours Spent Enjoying In-person Household Activities x Timepoint	.00 (-.00,.00)	1.00
Baseline Satisfaction with Quality of In-person Household Conversations x Timepoint	.00 (-.01,.01)	.86

the number of virtual group conversations, satisfaction with quality of in-person household conversations, and number of hours spent enjoying in-person household activities, these baseline social variables did not significantly predict loneliness trajectories over time. Rather, higher values of virtual or telephone one-on-one conversation and in-person household conversation variables averaged across time significantly predicted decreasing loneliness over time. The effects of satisfaction with conversations on loneliness trajectories were slightly attenuated over time. Effects of virtual group conversations averaged across time, and as level-1 moderators of loneliness trajectories, were not consistent across the full sample and completers, demonstrating a need for further investigation of these effects in future studies.

Loneliness is an important area of focus due to the isolating effects of the COVID-19 pandemic, particularly for individuals with chronic illnesses [15]. Individuals with chronic illnesses are underrepresented in the literature on loneliness, and this disparity is especially heightened for individuals with rare chronic illnesses such as SSc [3, 4]. One mixed methods longitudinal study of older individuals during the lockdown phase of the pandemic (N = 151 participants) found that individuals with functional impairments that occurred pre-COVID-19 may have felt less impacted by the social isolation, due to pre-existing needs to stay at home [33]. It is possible that due to pre-existing health concerns, individuals with SSc had higher rates of social isolation than the general population prior to the pandemic, and therefore experienced more stable loneliness over the course of the pandemic compared to the general population [17, 18].

Research is limited on protective factors for loneliness, particularly throughout the course of the COVID-19 pandemic, and even more so for individuals with chronic illnesses, despite their increased risk of isolation during the pandemic [4, 15]. While present study findings demonstrated that baseline values reflecting frequency of conversations and activities, and satisfaction with conversations, were not predictive of loneliness trajectories, higher values averaged across time did predict trajectories of decreasing loneliness. Present study findings aligned with past literature in indicating that more virtual or telephone one-on-one conversations, more in-person household interactions, and higher quality

Table 3 Values for timepoint-specific social interactions as moderators of loneliness trajectories over time

	Unstandardized B-value (95% CI)	P-value
# of Virtual or Telephone One-on-one Conversations		
Mean # of Conversations on Loneliness Slope	-.11 (-.18,-.04)	.00
# of Conversations Slope as a Moderating Effect	.00 (-.00,.01)	.60
# of Virtual Group Conversations		
Mean # of Conversations on Loneliness Slope	-.41 (-.58,-.23)	.00[a]
# of Conversations Slope as a Moderating Effect	.01 (.00,.02)	.01[a]
# of Hours Spent Enjoying In-person Household Conversations		
Mean # of Hours of Conversations on Loneliness Slope	-.30 (-.38,-.23)	< .001
# of Hours of Conversations Slope as a Moderating Effect	.00 (.00,.01)	.08
# of Hours Spent Enjoying In-person Household Activities		
Mean # of Hours of Activities on Loneliness Slope	-.34 (-.44,-.24)	< .001
# of Hours of Activities Slope as a Moderating Effect	.00 (-.00,.01)	.27
Satisfaction with Quality of In-person Household Conversations		
Mean Satisfaction on Loneliness Slope	-1.03 (-1.20,-.86)	< .001
Satisfaction Slope as a Moderating Effect	.02 (.01,.03)	< .001

[a]Not replicated in sensitivity analyses

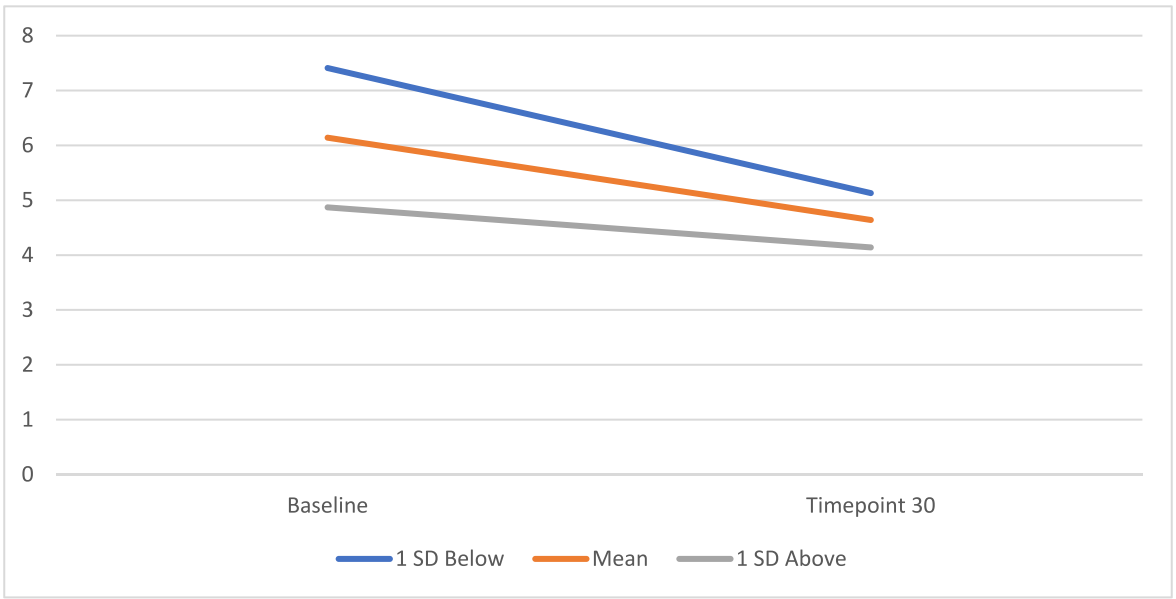

Fig. 1 Simple slopes plot of level-1 moderating effect of satisfaction with conversations x timepoint on loneliness scores

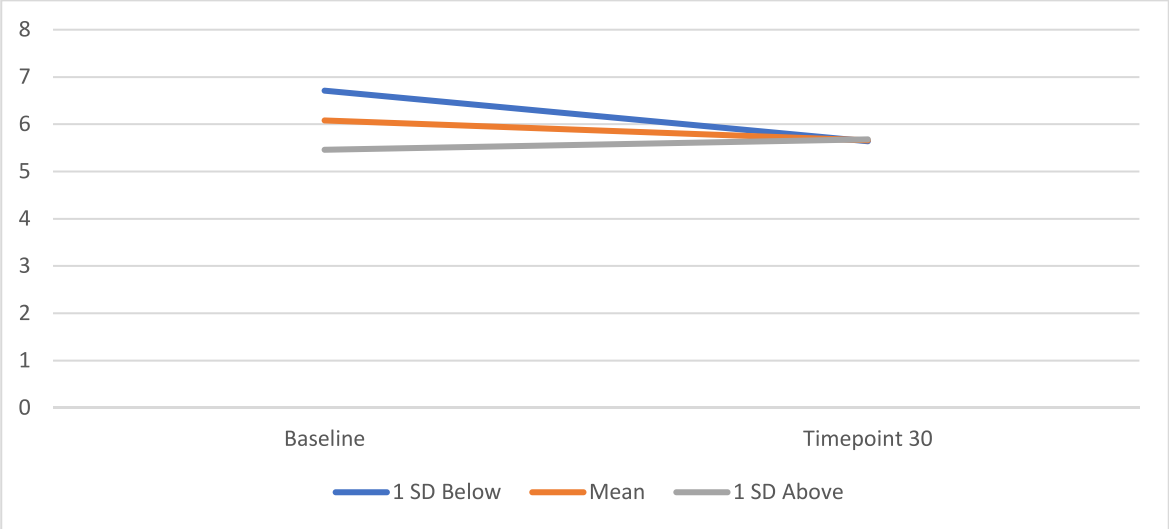

Fig. 2 Simple slopes plot of level-1 moderating effect of number of virtual group conversations x timepoint on loneliness scores

in-person household conversations, on average, may protect against loneliness [6, 7, 9–14]. The lack of consistent findings supporting virtual group conversations as protective against loneliness is of interest due to widespread organizational and informal efforts during the pandemic to organize and provide virtual group meetings, including social support groups for persons with chronic illness. The present findings suggest that one-on-one virtual interactions may be more beneficial.

Surprisingly, neither marital status nor number of household members were related to baseline loneliness or trajectories of loneliness over time, despite previous research suggesting otherwise [13]. A longitudinal study of adults during the pandemic (N = 311) indicated that while living with others (versus living alone) and relationship status both significantly predicted decreased loneliness, living with others accounted for loneliness score variance beyond relationship status [13]. This study, however, did not include frequency of interactions as a predictor. In the present study, it is possible that marital status and number of household members may have overlapped with frequency of interaction variables, thereby reducing their significance. In other words, static relationships in the home may serve as proxy variables for quantity or quality of interactions in predicting loneliness.

This study provides insights into how quantity and quality of interactions can influence loneliness trajectories in individuals with SSc over time during a particularly vulnerable period. Findings suggest that average levels of interactions over time were more impactful on loneliness trajectories than baseline levels of interactions, demonstrating that sustained levels of interactions over time were potentially more useful than levels of interactions when the pandemic began. This demonstrates the potential value of facilitating sustained interactions, both remotely and in-person, in interventions combatting loneliness in individuals with SSc during times of necessary social isolation. Future research can also explore whether these findings replicate in other populations with chronic illnesses.

This longitudinal study had multiple strengths, including its large, multi-national sample of persons with a chronic illness who completed multiple assessments throughout the course of the COVID-19 pandemic. Limitations included use of a convenience sample and that data collected during the pandemic reduce the ability to extrapolate findings beyond the context of COVID-19. Further, individuals without internet access were unable to participate in the study, allowing for potential selection bias. This study used study-constructed items to measure frequency of interactions and interaction satisfaction, and there is a lack of reliability or validity information for these items. Further, measures of in-person household activities did not elaborate on examples of these activities, leaving this up to participant interpretation; these likely include non-social as well as social activities. In addition, the study did not examine other potential variables of interest that may have impacted findings, such as in-person social activities outside the home and perceptions of social support. Additional research should be conducted to investigate elements that may impact the nature of interactions and loneliness trajectories, particularly for persons with chronic illnesses, and especially within the context of socioenvironmental threats to health. Such research could help to identify modifiable social factors that can be leveraged to protect against loneliness in at-risk populations.

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Data Availability De-identified individual participant data with a data dictionary and analysis codes that were used to generate the results reported in this article will be made available upon request to the corresponding author and after presentation of a methodologically sound proposal that is approved by the Scleroderma Patient-centered Intervention Network Data Access and Publications Committee. Data will be available beginning 12 months after publication. Data requestors will need to sign a data transfer agreement.

Declarations

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

Conflict of Interest There are no conflicts of interest to declare.

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