Rheumatology, 2023, **62**, 3433–3438
https://doi.org/10.1093/rheumatology/kead176
Advance access publication 20 April 2023
Concise Report

British Society for Rheumatology RHEUMATOLOGY OXFORD

Clinical science

CONQUER Scleroderma: association of gastrointestinal tract symptoms in early disease with resource utilization

Sarah Luebker[1,2], Tracy M. Frech [1,2], Shervin Assassi[3], Brian Skaug [3], Jessica K. Gordon[4], Kimberly Lakin[4], Elana J. Bernstein [5], Yiming Luo[5], Virginia D. Steen[6], Ami A. Shah[7], Laura K. Hummers[7], Carrie Richardson [8], Duncan F. Moore[8], Dinesh Khanna [9], Flavia V. Castelino[10], Lorinda Chung[11], Puneet Kapoor[11], Faye N. Hant[12], Victoria K. Shanmugam[13], John M. VanBuren[14], Jessica Alvey[14], Monica Harding[14], Ankoor Shah[15], Ashima Makol[16], Dorota Lebiedz-Odrobina[17], Julie K. Thomas[17], Elizabeth R. Volkmann [18], Jerry A. Molitor[19], Nora Sandorfi[20,*]

[1]Division of Rheumatology and Immunology, Department of Medicine, Vanderbilt University Medical Center, Nashville, TN, USA
[2]Department of Medicine, Tennessee Valley Health Care System, Veterans Affair Medical Center, Nashville, TN, USA
[3]Division of Rheumatology, Department of Medicine, University of Texas Health Science Center at Houston, Houston, TX, USA
[4]Division of Rheumatology, Department of Medicine, Hospital for Special Surgery, New York City, NY, USA
[5]Division of Rheumatology, Department of Medicine, Columbia University Irving Medical Center, Vagelos College of Physicians and Surgeons, New York, NY, USA
[6]Department of Medicine, Georgetown University Medical Center, Washington, DC, USA
[7]Division of Rheumatology, Department of Medicine, Johns Hopkins University, Baltimore, MD, USA
[8]Division of Rheumatology, Department of Medicine, Northwestern University, Chicago, IL, USA
[9]Division of Rheumatology, Department of Medicine, University of Michigan, Ann Arbor, MI, USA
[10]Division of Rheumatology, Department of Medicine, Massachusetts General Hospital, Boston, MA, USA
[11]Division of Immunology and Rheumatology, Department of Medicine, Stanford University and Palo Alto VA Health Care System, Palo Alto, CA, USA
[12]Division of Rheumatology, Department of Medicine, Medical University of South Carolina, Charleston, SC, USA
[13]Department of Anatomy, George Washington University, The George Washington University School of Medicine and Health Sciences, Washington, DC, USA
[14]Division of Pediatric Critical Care, Department of Pediatrics, University of Utah, Salt Lake City, UT, USA
[15]Division of Rheumatology and Immunology, Department of Medicine, Duke University, Durham, NC, USA
[16]Division of Rheumatology, Department of Internal Medicine, Mayo Clinic, Rochester, MN, USA
[17]Division of Rheumatology, Department of Internal Medicine, University of Utah, Salt Lake City, UT, USA
[18]Division of Rheumatology, Department of Medicine, David Geffen School of Medicine, University of California, Los Angeles, CA, USA
[19]Division of Rheumatic and Autoimmune Diseases, Department of Medicine, University of Minnesota, Minneapolis, MN, USA
[20]Division of Rheumatology, Department of Medicine, University of Pennsylvania, Philadelphia, PA, USA

*Correspondence to: Nora Sandorfi, Division of Rheumatology, Department of Medicine, Perelman Center for Advanced Medicine, 3400 Civic Center Boulevard, Philadelphia, PA 19104, USA. E-mail: Nora.Sandorfi@pennmedicine.upenn.edu

Abstract

Objectives: SSc is associated with increased health-care resource utilization and economic burden. The Collaborative National Quality and Efficacy Registry (CONQUER) is a US-based collaborative that collects longitudinal follow-up data on SSc patients with <5 years of disease duration enrolled at scleroderma centres in the USA. The objective of this study was to investigate the relationship between gastrointestinal tract symptoms and self-reported resource utilization in CONQUER participants.

Methods: CONQUER participants who had completed a baseline and 12-month Gastrointestinal Tract Questionnaire (GIT 2.0) and a Resource Utilization Questionnaire (RUQ) were included in this analysis. Patients were categorized by total GIT 2.0 severity: none-to-mild (0–0.49); moderate (0.50–1.00), and severe-to-very severe (1.01–3.00). Clinical features and medication exposures were examined in each of these categories. The 12-month RUQ responses were summarized by GIT 2.0 score categories at 12 months.

Results: Among the 211 CONQUER participants who met the inclusion criteria, most (64%) had mild GIT symptoms, 26% had moderate symptoms, and 10% severe GIT symptoms at 12 months. The categorization of GIT total severity score by RUQ showed that more upper endoscopy procedures and inpatient hospitalization occurred in the CONQUER participants with severe GIT symptoms. These patients with severe GIT symptoms also reported the use of more adaptive equipment.

Conclusion: This report from the CONQUER cohort suggests that severe GIT symptoms result in more resource utilization. It is especially important to understand resource utilization in early disease cohorts when disease activity, rather than damage, primarily contributes to health-related costs of SSc.

Keywords: SSc, gastrointestinal tract, health status, health outcomes

Received: 2 February 2023. **Accepted:** 13 April 2023

Rheumatology key messages

- Examination of the economic burden of systemic sclerosis requires assessment of the relationship of gastrointestinal tract symptoms with resource utilization.
- Self-report of health-care resource utilization is highest in those patients with systemic sclerosis who have severe gastrointestinal tract symptoms.
- Incident disease cohorts allow an understanding of the self-reported health-care needs associated with assessment of disease activity.

Introduction

The cost of SSc, scleroderma care imposes a significant economic burden on patients and their families [1]. Interstitial lung disease, pulmonary hypertension, and digital ulcers are complications that are associated with substantial morbidity and disability in SSc, and they are commonly examined as contributors to economic burden; however, gastrointestinal tract symptoms occur in the majority of patients with SSc and result in significant resource utilization [2]. Studies of resource utilization associated with the presence of disease features aim to inform reduction in hospital admissions to reduce the economic burden of SSc [3]. It is especially important to understand resource utilization in incident disease cohorts when disease activity, rather than damage, is the primary contributor to health-related costs of SSc [4].

The Collaborative National Quality and Efficacy Registry (CONQUER) is a collaborative longitudinal study that collects data on a large cohort of early scleroderma patients that meet classification criteria for SSc [5] within 5 years of their first non-RP symptom [6]. CONQUER participants are followed at SSc centres of excellence in the USA, which currently includes the geographic representation of California, Texas, Utah, Minnesota, Illinois, Michigan, Pennsylvania, Massachusetts, New York, Maryland, Washington D.C., North Carolina, South Carolina, and Tennessee. In CONQUER, clinical data, biorepository specimens, and patient-reported outcomes (PROs) are collected at 6-month intervals [6–8]. For this project, two PROs, the Scleroderma Clinical Trials Consortium University of California Los Angeles Gastrointestinal Tract Questionnaire (SCTC UCLA GIT 2.0) and the Resource Utilization Questionnaire (RUQ) were examined to evaluate the association of gastrointestinal symptom burden and patient-reported resource utilization in the CONQUER cohort. The purpose of this analysis is to understand resource utilization related to early SSc patients' active gastrointestinal tract symptoms.

Materials and methods

The CONQUER Registry has institutional board review (IRB) approval at each participating site (VUMC IRB# 210639). Each CONQUER participant is identified from clinical care practice, is consecutively enrolled if eligible and with <5 years' SSc disease duration, and provides written consent prior to data entry. All data are stored and available at the CONQUER Data Coordinating Center in Utah. The inclusion criteria for this specific analysis stipulated CONQUER participants who had completed a baseline (to establish baseline symptoms) and a 12-month SCTC UCLA GIT 2.0 and RUQ [9]. The 34-item SCTC UCLA GIT 2.0 allows a clinician to assess the patient's symptoms and their impact on mental and social well-being in the preceding 7 days, including assessment of reflux, bloating/distention, diarrhoea, constipation, soilage, and the emotional and social impacts of gastrointestinal symptoms, and to then place them into an absent-to-mild, moderate, or severe category. The total score is the average of 6 symptom scales (with the exception of constipation), which score ranges from 0 (better) to 3 (worse) [10, 11]. For this project, each SCTC GIT 2.0 total score status of none/mild (0–0.49), moderate (0.50–1.0), or severe to very severe (1.01–3.0) at 12 months was examined in the context of RUQ response.

The RUQ records information on visits to health professionals, diagnostic procedures, purchased aids, alternative treatments, outpatient procedures and surgeries, hospitalizations, rehabilitation or nursing home admission, time spent seeing physicians or other health professionals and undergoing medical tests, and need of an accompanying person. The RUQ is a patient-reported numerical report in each of these categories. The RUQ is scored by a summation in each category. The association of patient clinical and demographic characteristics with SCTC UCLA GIT score at 12 months was assessed using the Chi-squared test for categorical variables, Fisher's Exact test with Monte Carlo approximation for categorical variables with small cell counts, and the Kruskal–Wallis test for continuous variables. The 12-month RUQ responses were summarized by GIT score categories at 12 months. As these analyses were considered exploratory in nature, no adjustment for multiple comparisons was performed.

Results

At the time of data analysis, there were 211 CONQUER participants who met the inclusion criteria of completion of two GIT 2.0 questionnaires and a RUQ. The socio-demographic and disease characteristics of those 211 participants are shown in Table 1. Most participants were female ($n = 181$, 86%) and non-Hispanic white ($n = 156$, 74%), with a mean (S.D.) age of 51 years (S.D. 13.84) and disease duration of 2.6 years (S.D. 1.38) from the time of onset of the first non-RP symptom of SSc. Except for employment status and GIT 2.0 categorization at baseline, there were no significant baseline clinical or medication differences in this patient cohort based on the 12-month GIT categorization. The GI subscale in the Medsger Severity Disease Scale that is noted as 'Abnormal Gastrointestinal Tract' in Table 1 indicated that there was no significant difference in physician-reported objective data between GIT 2.0 severity categories [12]. There was no subcategory that drove the GIT 2.0 total score. Between baseline and 12-month analysis, only patients in the severe category worsened ($P = 0.006$). There were 5 patients on plecanatide, 1 on linaclotide, 1 on prucalopride, 1 on pyridostigmine, 1 on metoclopramide, and 8 patients on antibiotic therapy for small bacterial

Table 1. Patient characteristics at baseline by GIT score at 12 months

		GIT score at 12 months			
	Overall (*N* = 211)	None to mild (*N* = 135)	Moderate (*N* = 54)	Severe to very severe (*N* = 22)	*P*-value
Age (years)	211, 51.1 (13.84)	135, 51.0 (14.35)	54, 52.7 (11.25)	22, 47.4 (16.14)	0.461[a]
Male	30 (14.2%)	20 (14.8%)	7 (13.0%)	3 (13.6%)	0.953[b]
BMI (kg/m^2)	200, 26.1 (5.28)	127, 25.7 (5.17)	51, 27.0 (5.60)	22, 25.8 (5.07)	0.361[a]
Race/ethnicity					0.857[b]
Hispanic	19 (9.0%)	12 (8.9%)	3 (5.6%)	4 (18.2%)	
Non-Hispanic white	156 (73.9%)	99 (73.3%)	42 (77.8%)	15 (68.2%)	
Non-Hispanic black or African American	20 (9.5%)	12 (8.9%)	6 (11.1%)	2 (9.1%)	
Non-Hispanic Asian	12 (5.7%)	9 (6.7%)	2 (3.7%)	1 (4.5%)	
Non-Hispanic other	4 (1.9%)	3 (2.2%)	1 (1.9%)	0 (0.0%)	
Employment status					0.049[b]
Full-time	92 (44.4%)	62 (46.6%)	22 (41.5%)	8 (38.1%)	
Part-time	18 (8.7%)	9 (6.8%)	7 (13.2%)	2 (9.5%)	
Retired	36 (17.4%)	26 (19.5%)	9 (17.0%)	1 (4.8%)	
Disabled	29 (14.0%)	12 (9.0%)	11 (20.8%)	6 (28.6%)	
Other	32 (15.5%)	24 (18.0%)	4 (7.5%)	4 (19.0%)	
Smoking status					0.962[b]
Never	144 (68.2%)	92 (68.1%)	36 (66.7%)	16 (72.7%)	
Former	58 (27.5%)	37 (27.4%)	15 (27.8%)	6 (27.3%)	
Current	9 (4.3%)	6 (4.4%)	3 (5.6%)	0 (0.0%)	
Disease duration (years) from date of first non-RP symptom to baseline visit	211, 2.6 (1.38)	135, 2.7 (1.35)	54, 2.4 (1.42)	22, 2.6 (1.41)	0.372[a]
Modified Rodnan Skin Score (mRSS)	209, 12.4 (10.62)	133, 12.1 (10.74)	54, 13.0 (10.44)	22, 12.3 (10.77)	0.773[a]
SCTC GIT Total Score at baseline					<.001[b]
None to mild	127 (63.5%)	109 (84.5%)	17 (34.7%)	1 (4.5%)	
Moderate	45 (22.5%)	17 (13.2%)	22 (44.9%)	6 (27.3%)	
Severe to very severe	28 (14.0%)	3 (2.3%)	10 (20.4%)	15 (68.2%)	
SCTC GIT Total Score—change from baseline to 12 months	200, 0.0 (0.30)	129, 0.1 (0.22)	49, 0.0 (0.36)	22, -0.2 (0.48)	0.006[a]
SSc subtype					0.501[b]
lcSSc	67 (31.8%)	40 (29.6%)	18 (33.3%)	9 (40.9%)	
dcSSc	144 (68.2%)	95 (70.4%)	36 (66.7%)	13 (59.1%)	
Presence of non–full-thickness pit(s) (digital pitting scars)	53 (25.2%)	29 (21.5%)	18 (34.0%)	6 (27.3%)	0.202[c]
Digital ulcers, ischaemic ulcers, or gangrene	26 (12.3%)	15 (11.1%)	7 (13.0%)	4 (18.2%)	0.597[b]
Gastric antral vascular ectasia (GAVE)	19 (19.2%)	11 (18.3%)	6 (21.4%)	2 (18.2%)	0.932[b]
Abnormal GI tract[d]	155 (73.5%)	94 (69.6%)	42 (77.8%)	19 (86.4%)	0.182[c]
ANA-positive result	194 (95.1%)	124 (95.4%)	51 (98.1%)	19 (86.4%)	0.106[b]
ANA pattern					0.820[b]
Speckled	60 (35.1%)	36 (32.7%)	16 (36.4%)	8 (47.1%)	
Centromere	36 (21.1%)	25 (22.7%)	9 (20.5%)	2 (11.8%)	
Nucleolar	34 (19.9%)	20 (18.2%)	10 (22.7%)	4 (23.5%)	
Homogenous	26 (15.2%)	20 (18.2%)	5 (11.4%)	1 (5.9%)	
Mixed pattern	15 (8.8%)	9 (8.2%)	4 (9.1%)	2 (11.8%)	
ACA positive	36 (18.1%)	24 (18.9%)	8 (16.0%)	4 (18.2%)	0.544[b]
Anti-SCL 70 positive	55 (27.6%)	37 (29.1%)	12 (24.0%)	6 (27.3%)	0.816[b]
Anti-Polymerase III positive	61 (30.7%)	39 (30.7%)	17 (34.0%)	5 (22.7%)	0.884[b]
U1 Anti-RNP positive (ever)	12 (6.0%)	6 (4.7%)	4 (8.0%)	2 (9.1%)	0.762[b]
Medications					
AZA	3 (1.4%)	1 (0.7%)	1 (1.9%)	1 (4.5%)	0.170[b]
HCQ	47 (22.3%)	30 (22.2%)	11 (20.4%)	6 (27.3%)	0.967[b]
MTX	16 (7.6%)	8 (5.9%)	6 (11.1%)	2 (9.1%)	0.579[b]
MMF	105 (49.8%)	68 (50.4%)	27 (50.0%)	10 (45.5%)	0.438[b]
Nintedanib	3 (1.4%)	2 (1.5%)	1 (1.9%)	0 (0.0%)	1.000[b]
Prednisone	31 (14.7%)	16 (11.9%)	11 (20.4%)	4 (18.2%)	0.382[b]
Rituximab	2 (0.9%)	1 (0.7%)	1 (1.9%)	0 (0.0%)	0.594[b]
Tocilizumab	2 (0.9%)	2 (1.5%)	0 (0.0%)	0 (0.0%)	1.000[b]
PPI	127 (60.2%)	78 (57.8%)	33 (61.1%)	16 (72.7%)	0.100[b]

Unless otherwise indicated, all variables are measured at baseline. The cohort contains subjects with completed GIT and RUQ surveys at 12 months. Continuous variables are summarized as *N*, Mean (S.D.).

[a] Kruskal–Wallis test.
[b] Fisher's Exact test with Monte Carlo approximation.
[c] Chi-squared test.
[d] Abnormal GI tract as defined by the Medsger GI Severity scale.

Table 2. RUQ at 12 months by GIT score at 12 months

	GIT score at 12 months				
	Overall ($N = 211$)	None to mild ($N = 135$)	Moderate ($N = 54$)	Severe to very severe ($N = 22$)	*P*-value[b]
Provider					
Rheumatologist	194 (92%)	125 (93%)	50 (93%)	19 (86%)	0.679
Internal medicine specialist	150 (71%)	91 (67%)	42 (78%)	17 (77%)	0.312
Orthopaedic surgeon	34 (16%)	23 (17%)	9 (17%)	2 (9%)	0.736
Podiatrist (foot doctor)	22 (10%)	14 (10%)	7 (13%)	1 (5%)	0.571
Other doctors (e.g. dermatologist, ophthalmologist, plastic surgeon, gynaecologist)	148 (70%)	97 (72%)	34 (63%)	17 (77%)	0.535
Physical therapist	52 (25%)	33 (24%)	11 (20%)	8 (36%)	0.389
Occupational therapist	34 (16%)	19 (14%)	9 (17%)	6 (27%)	0.333
Chiropractor	14 (7%)	8 (6%)	4 (7%)	2 (9%)	0.760
Other health workers (social worker or other)	23 (11%)	11 (8%)	7 (13%)	5 (23%)	0.074
Procedures and hospital stays					
X-rays (e.g. head, chest, abdomen, limbs)	100 (47%)	60 (44%)	26 (48%)	14 (64%)	0.323
CT scan	103 (49%)	65 (48%)	24 (44%)	14 (64%)	0.391
MRI scan	55 (26%)	34 (25%)	13 (24%)	8 (36%)	0.554
Blood tests (number of times blood was drawn)	204 (97%)	129 (96%)	53 (98%)	22 (100%)	0.834
Urine tests	138 (65%)	85 (63%)	35 (65%)	18 (82%)	0.303
Gastroscopy (upper endoscopy)	62 (29%)	26 (19%)	22 (41%)	14 (64%)	<0.001
Colonoscopy	30 (14%)	14 (10%)	12 (22%)	4 (18%)	0.095
Other tests (e.g. mammogram, US, breathing test, joint scan, bone density scan)	161 (76%)	99 (73%)	44 (81%)	18 (82%)	0.331
Surgery or procedure	126 (60%)	77 (57%)	34 (63%)	15 (68%)	0.527
Inpatient in a hospital	37 (18%)	16 (12%)	9 (17%)	12 (55%)	<0.001
Rehabilitation facility or nursing home	3 (1%)	0 (0%)	0 (0%)	3 (14%)	0.002
Helped by person(s)	89 (42%)	52 (39%)	20 (37%)	17 (77%)	0.003
Alternative treatment					
Alternative treatments (e.g. hypnosis, acupuncture, homeopathy, other)	82 (39%)	51 (38%)	21 (39%)	10 (45%)	0.791
Relaxation or visual imagery (e.g. mediation, relaxation response)	31 (15%)	18 (13%)	10 (19%)	3 (14%)	0.607
Commercial weight-loss program	8 (4%)	6 (4%)	1 (2%)	1 (5%)	0.755
Herbal medicine	23 (11%)	16 (12%)	6 (11%)	1 (5%)	0.751
Glucosamine sulfate/chondroitin sulfate	8 (4%)	6 (4%)	2 (4%)	0 (0%)	0.873
Energy healing (e.g. energy emitting magnets)	9 (4%)	6 (4%)	1 (2%)	2 (9%)	0.278
Massage	51 (24%)	32 (24%)	14 (26%)	5 (23%)	0.969
Spiritual healing/prayer on your own	45 (21%)	27 (20%)	10 (19%)	8 (36%)	0.207
Lifestyle diets	40 (19%)	20 (15%)	15 (28%)	5 (23%)	0.120
Megavitamin therapy (e.g. high-dose vitamins, not a daily vitamin)	8 (4%)	4 (3%)	1 (2%)	3 (14%)	0.060
Folk remedies	2 (1%)	1 (1%)	0 (0%)	1 (5%)	0.283
Self-help groups	11 (5%)	4 (3%)	5 (9%)	2 (9%)	0.120
Acupuncture	15 (7%)	11 (8%)	4 (7%)	0 (0%)	0.510
Homeopathy	8 (4%)	3 (2%)	3 (6%)	2 (9%)	0.151
Additional aids					
Use of any additional aids[a]	58 (27%)	25 (19%)	19 (35%)	14 (64%)	<.001
Cane	14 (7%)	3 (2%)	5 (9%)	6 (27%)	<.001
Crutches	4 (2%)	1 (1%)	2 (4%)	1 (5%)	0.164
Wheelchair, manual	10 (5%)	2 (1%)	3 (6%)	5 (23%)	<.001
Wheelchair, electric	4 (2%)	1 (1%)	1 (2%)	2 (9%)	0.039
Special toilet seat	7 (3%)	1 (1%)	4 (7%)	2 (9%)	0.016
Chair in shower	19 (9%)	4 (3%)	8 (15%)	7 (32%)	<.001
Hospital bed	3 (1%)	0 (0%)	1 (2%)	2 (9%)	0.009
Bath rail	15 (7%)	3 (2%)	8 (15%)	4 (18%)	0.001

(continued)

Table 2. (continued)

	GIT score at 12 months				
	Overall ($N = 211$)	None to mild ($N = 135$)	Moderate ($N = 54$)	Severe to very severe ($N = 22$)	*P*-value[b]
Walker	8 (4%)	1 (1%)	3 (6%)	4 (18%)	0.002
Back or leg brace	3 (1%)	0 (0%)	1 (2%)	2 (9%)	0.011
Orthopedic footwear	17 (8%)	9 (7%)	5 (9%)	3 (14%)	0.469
Arm brace	6 (3%)	4 (3%)	1 (2%)	1 (5%)	0.678
Other aids	14 (7%)	8 (6%)	2 (4%)	4 (18%)	0.064

Cohort contains subjects with a complete GIT survey and RUQ survey at 12 months.
[a] Additional aids includes the use of a cane, crutches, a manual or electric wheelchair, a special toilet seat, a chair in shower, a hospital bed, a bath rail, a walker, a back or leg brace, orthopedic footwear, an arm brace, or any other additional aids.
[b] Fisher's Exact test with Monte Carlo approximation.

overgrowth. Notably, there was no significant difference in modified Rodnan skin score (mRSS), presence of a digital lesion, gastric antral vascular ectasia (GAVE), or predominant SSc auto-antibody pattern when analysed by SCTC UCLA GIT 2.0 severity groups. Most participants were on a proton pump inhibitor (PPI, $n = 127$, 60%).

Most CONQUER participants in this analysis (64%) had mild GIT symptoms at 12 months, but 26% had moderate and 10% of these early SSc patients had severe GIT symptoms. The categorization of GIT total severity score by RUQ categories is shown in Table 2. Additional assessments by multiple types of health-care providers did not change the GIT 2.0 severity category; however, gastroenterologist assessment was not an independent category. As expected, a larger proportion of individuals reported upper endoscopy testing in the severe GIT group (64%); however, the proportion of individuals who reported colonoscopy testing was not significantly different between GIT severity groups. Inpatient hospitalization (55%), rehabilitation facility (14%), and help required by another person (77%) was self-reported as significantly higher in the CONQUER severe GIT score group compared with other categories of GIT symptomatology. The reason for hospitalization was not captured. A sensitivity analysis of the cohort showed that GIT score remained statistically significantly associated with inpatient hospital status, even after controlling for age, gender, mRSS, digital ulcers, forced vital capacity (FVC) % predicted, as well as interstitial lung disease (ILD) diagnosis. (Supplementary Table S1, available at *Rheumatology* online). When these inpatient CONQUER participants' scores for reflux, distention/bloating, faecal soilage, diarrhoea, social functioning, and emotional well-being were compared with the outpatient CONQUER participants, each GIT 2.0 subcomponent was higher. While the number of CONQUER participants using adaptive equipment was low, patients with severe GIT symptoms were categorically more likely to use additional aids, such as a cane, wheelchair, chair, or adaptive toileting and shower equipment.

Discussion

Gastrointestinal tract symptoms influence quality of life and resource utilization in SSc patients. The purpose of the present analysis was to investigate the association of gastrointestinal symptoms with self-reported health care utilization in an early scleroderma cohort. While the majority of CONQUER patients in this analysis had mild GIT symptoms, our analysis demonstrated that those with moderate and severe GIT symptoms were more likely to be disabled, were receiving more upper endoscopy testing, and required inpatient hospitalization and rehabilitation. The use of adaptive aids further supported the concept of possible frailty in the SSc patients with severe GIT symptoms. While it was not statistically significant at a threshold of 0.05, it is interesting that the percentage of patients who were disabled increased almost in a dose–response fashion with GI severity. Our report demonstrates the importance of GIT symptom assessment and health care utilization quantification in SSc.

Our study has highlighted the value of dedicated studies investigating health care utilization due to GIT disease burden in SSc, but it was not without limitations. The registry represents patients with referral to SSc centres; thus, the data captured may represent more severe disease. Additionally, the registry represents a convenient sample. The RUQ data is not compared with data from a healthy population. The RUQ is self-reported and may mischaracterize some utilization. The RUQ is not specific to GIT involvement; thus, it is possible that the included SSc patients had other more severe disease features in general. We only used three multivariable models for the RUQ (internal medicine specialist, endoscopy or colonoscopy, and inpatient status), and did not use a multivariable model for every variable presented in Table 2. However, our sensitivity analysis suggests that GIT symptoms, rather than skin or lung disease, are significantly associated with self-reported inpatient hospitalization and rehabilitation facility needs in CONQUER participants. It is possible that the colonoscopy data does not differ significantly between GIT severity categories because this procedure was ordered for cancer screening rather than symptom assessment. CONQUER did not find SSc clinical features previously reported to correlate with more severe GIT involvement, such as digital ulcers or gastric antral vascular ectasia (GAVE) in this early disease cohort [13].

The CONQUER cohort is a valuable resource for investigating multiple different phenotypes of early SSc [6]. Longitudinal cohorts such as CONQUER can provide information about the economic burden of disease in SSc by organ involvement [7, 14]. While the RUQ was not restricted to only GIT symptomatology, the data presented showed that severe GIT symptoms lead to more self-reported resource utilization and are an important area of focus for future SSc health care cost analysis and rehabilitation considerations. Ongoing follow-up of this longitudinal USA-based early SSc cohort is planned for further understanding of the financial burden of disease.

Supplementary material

Supplementary material is available at *Rheumatology* online.

Data availability

The data underlying this article will be shared on reasonable request to the corresponding author.

Funding

CONQUER is supported by the Scleroderma Research Foundation, but physician authors do not receive salary support. T.F.'s work is supported by a VA Merit Award I01 CX002111. E.J.B.'s work is supported by NIH/K23-AR-075112. E.R.V.'s work is supported by NIH/K23-HL150237. A.A.S.'s work is supported by NIH/NIAMS K24 AR080217. D.K.'s work is supported by NIH/NIAMS K24-063120. B.S.'s work is supported by NIH/NIAMS K08-AR081402 and the Rheumatology Research Foundation.

Disclosure statement: S.L., T.F., S.A., B.S., J.K.G., K.S.L., Y.M., V.S., A.A.S., L.H., C.R., D.M., L.C., P.K., F.H., F.V.C., D.O., J.K.T., V.K.S., J.V.B., J.A., M.H., E.R.V. and N.S. have no relevant financial or non-financial interests to disclose related to this work. Outside this work, D.K. has disclosures for Eicos, Abbvie, Genentech/Roche, Boehringer Ingelheim, Astra Zeneca, CSL Behring, GSK, Horizon, and Prometheus. Outside of this work, E.R.V. reports consulting fees from CSL Behring, Boehringer Ingelheim, Roche, and GSK, and grant support from Boehringer Ingelheim, Horizon, and Prometheus. Outside of this work, A.A.S. receives research funding from Arena Pharmaceuticals, Eicos Sciences, Kadmon Corporation and Medpace LLC.

References

1. Chen Y, Wu L, Hernández-Muñoz JJ *et al.* The economic burden of systemic sclerosis—a systematic review. Int J Rheum Dis 2022;25:110–20.
2. Zhu J, Frech T. Gut disease in systemic sclerosis – new approaches to common problems. Curr Treatm Opt Rheumatol 2019;5:11–9.
3. Knarborg M, Lokke A, Hilberg O, Ibsen R, Sikjaer MG. Direct and indirect costs of systemic sclerosis and associated interstitial lung disease: a nationwide population-based cohort study. Respirology 2022;27:341–9.
4. Padala SD, Lao C, Solanki K, White D. Direct and indirect health-related costs of systemic sclerosis in New Zealand. Int J Rheum Dis 2022;25:1386–94.
5. van den Hoogen F, Khanna D, Fransen J *et al.* 2013 classification criteria for systemic sclerosis: an American College of Rheumatology/European League against Rheumatism collaborative initiative. Arthritis Rheum 2013;65:2737–47.
6. Shanmugam VK, Frech TM, Steen VD *et al.* Collaborative National Quality and Efficacy Registry (CONQUER) for Scleroderma: outcomes from a multicenter US-based systemic sclerosis registry. Clin Rheumatol 2020;39:93–102.
7. Frech TM, VanBuren JM, Startup E *et al.* Does hand involvement in systemic sclerosis limit completion of patient-reported outcome measures? Clin Rheumatol 2021;40:965–71.
8. Castelino FV, VanBuren JM, Startup E *et al.* Baseline characteristics of systemic sclerosis patients with restrictive lung disease in a multi-center US-based longitudinal registry. Int J Rheum Dis 2022;25:163–74.
9. Bernatsky S, Panopolis P, Hudson M *et al.*; Canadian Scleroderma Research Group. Demographic and clinical factors associated with physician service use in systemic sclerosis. J Rheumatol 2009;36:96–8.
10. Khanna D, Nagaraja V, Gladue H *et al.* Measuring response in the gastrointestinal tract in systemic sclerosis. Curr Opin Rheumatol 2013;25:700–6.
11. Khanna D, Hays RD, Maranian P *et al.* Reliability and validity of the University of California, Los Angeles scleroderma clinical trial consortium gastrointestinal tract instrument. Arthritis Rheum 2009;61:1257–63.
12. Medsger TA Jr, Bombardieri S, Czirjak L *et al.* Assessment of disease severity and prognosis. Clin Exp Rheumatol 2003;21(Suppl 29):S42–6.
13. Morrisroe K, Hansen D, Stevens W *et al.* Gastric antral vascular ectasia in systemic sclerosis: a study of its epidemiology, disease characteristics and impact on survival. Arthritis Res Ther 2022;24:103.
14. Gordon JK, Domsic RT. Clinical trial design issues in systemic sclerosis: an update. Curr Rheumatol Rep 2016;18:38.