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COVID-19–related personal product shortages are associated with psychological distress in people living with gastrointestinal disorders: A cross-sectional survey

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Abstract

Background: The mental health response to the coronavirus (COVID-19) pandemic–related product shortages in those living with chronic gastrointestinal (GI) disorders has received little attention. We aimed to explore the association between the pandemic-related product shortages and psychological distress in people with GI disorders.

Methods: This online cross-sectional survey was nested within an ongoing, international, prospective study of well-being in people with GI disorders. The study was advertised in multiple countries in May-September 2020 via patient organizations and social media. The primary outcome measure was distress, evaluated by the Depression Anxiety Stress Scale. We utilized linear regressions, adjusting for covariates and testing individual moderation effects.

Key Results: Overall, 831 people completed the survey from 27 countries, of whom 82% were female (mean age = 49 years). The most common disorders included

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inflammatory bowel disease (n = 322), celiac disease (*n* = 273), and irritable bowel syndrome (*n* = 260). Significant problems accessing food were reported by 19.8%, non-medical therapies by 16%, toilet paper by 10.8%, and essential medication by 8.9% of the sample (>5% pain medication). There was a positive association between toilet paper and pain medication shortages and distress, and a negative association between food shortages and distress. Significant moderation effects were identified for COVID-19 prevalence and toilet paper and food shortages, and between COVID-19 fear and pain medication shortages.

Conclusions and Inferences: The study documented a significant relationship between product shortages and psychological distress, which were associated with COVID-19 prevalence and fear. Strategies addressing COVID-19 fear could potentially modify the relationship between shortages and distress.

KEYWORDS
COVID-19, distress, gastrointestinal disorders, product shortages, psychological distress

1 | INTRODUCTION

To date, the novel coronavirus (SARS-CoV-2) has caused over 3 million deaths, with over 170 million people infected worldwide, and infection and death rates rising daily.[1] The coronavirus (COVID-19) pandemic has put significant pressure on health services, often limiting access to routine and preventive care, and in some cases limiting access to urgent care needed for acutely ill patients. The pandemic has also interrupted supply chains, particularly at production and distribution levels, at times resulting in shortages of items such as medications and personal hygiene products.[2-4]

While the burden of the pandemic on the global economy[5] and society well-being[6,7] is indisputable, it has been further amplified for those living with gastrointestinal (GI) disorders. GI disorders affect at least one third of the population worldwide, with functional gastrointestinal disorders, such as irritable bowel syndrome (IBS), being the largest contributor to overall prevalence.[8,9] GI disorders are debilitating, costly,[10] and responsible for more than a quarter million deaths each year in the United States alone.[11] GI disorders are also frequently accompanied by anxiety and depression, which are known to be significantly associated with the GI symptoms and illness severity.[12-15] GI disorders are often managed by daily medication use, with some of the affected populations requiring immunosuppressive therapies, complex dietary approaches, and high demand for personal hygiene products, the latter related to the nature of the symptoms, such as diarrhea.

The COVID-19 pandemic has caused major shortages of medical products such as ventilators,[16] medication,[17] acute beds,[18] face masks,[19] face shields,[20] and hand sanitizer[21] as well as supply fluctuations resulting in access to more mundane products such as toilet paper and certain foods.[2-4] In addition to supply or production shortages, stockpiling and panic buying have been well documented during the pandemic.[22] This behavior is hypothesized to provide short-term reduction in anxiety,[23,24] by offering a sense of control during unpredictable times. However, while stockpiling may temporarily relieve anxiety in some people, it may aggravate it for those who need the products urgently. Difficulty accessing healthcare services, shortages of medication used to manage GI symptoms, and other co-morbid conditions, together with food (eg, specialty food such as lactose-, gluten-free), protective equipment (eg, masks), and personal hygiene product shortages (eg, toilet paper and stoma appliance supplies), may therefore further exacerbate psychological distress and undermine coping in this population. However, the mental health response to the shortages of products and services has received little attention thus far, with the effect of shortages on those living with chronic GI disorders unexplored to date. The present study aimed to:

Aim 1: explore the association between the COVID-19 pandemic–related product shortages and symptoms of stress, anxiety, and depression (collectively called psychological distress) in people with GI disorders.

Key Points

- The first study to explore the relationship between product shortages and distress among adults living with GI disorders during the COVID-19 pandemic.
- The study documented a significant relationship between personal product shortages, specifically toilet paper, pain medication, and food shortages, and psychological distress.
- The relationship between product shortages and distress was moderated by COVID-19 prevalence and fear.

Aim 2: identify vulnerable subgroups who were most affected by the product shortages.

We hypothesized that there is a positive relationship between the COVID-19 pandemic–related product shortages and psychological distress in people with GI disorders.

2 | MATERIALS AND METHODS

2.1 | Design

This online cross-sectional survey was nested within an ongoing, international, prospective study of well-being in people with GI disorders during the COVID-19 pandemic.

2.2 | Participants, recruitment, and procedure

The study was advertised to potential participants in multiple countries around the world in May-September 2020 via gastrointestinal-specific patient organizations and associated social media.

Participants needed to meet the following eligibility criteria: (a) ≥18 years of age, (b) diagnosed (self-reported) by a physician with a GI disorder, and (c) able to provide informed consent. While the study was advertised broadly, it required understanding English as the questionnaire was provided in this language only. Consent was obtained by the participant's decision to complete the questionnaire. This study was approved by the Swinburne University of Technology Human Research Ethics Committee on May 25, 2020 (Ref: 20202978–4430).

2.3 | Measures

Patient demographics and health characteristics were collected with a questionnaire developed by the investigators. Income data were provided in the local currency and converted to US dollars using an approximate average conversion rate for the study period.[25] Income was ranked into percentiles: 5th, 10th, 25th, 50th, 75th, 90th, and 95th. GI disorders were self-reported.

2.3.1 | Depression, anxiety, and stress scale (DASS-21)

The DASS is a 21-item self-report scale that measures symptoms of distress (ie, stress, anxiety, and depression) over the past week. Each question is rated on a 4-point Likert scale from 0 (did not apply to me at all) to 3 (applied to me very much or most of the time). The DASS-21 has been shown to possess adequate construct validity and reliability for measuring the dimensions of depression, anxiety, and stress.[26]

2.3.2 | Gastrointestinal symptom rating scale (GSRS)

The 15-item GSRS is a widely used and reliable self-report measure that captures the severity of GI symptoms across a range of GI conditions.[27] Respondents rate their level of discomfort for a range of GI symptoms over the past week, using a 7-point Likert scale with anchor points of "no discomfort at all" to "very severe discomfort." The total score ranges from 15 to 105, with higher scores reflecting more severe symptoms.

2.3.3 | COVID prevalence

Average COVID cases per million between March and November 2020 were estimated using the online coronavirus pandemic data explorer.[28] Participant nations were then ranked according to lowest prevalence in that time frame (New Zealand, Australia, Canada) to highest (Belgium, United States, Switzerland). England, Northern Ireland, Scotland, and Wales were pooled to align with estimates from the data explorer.

2.3.4 | COVID Infection

Participants reported whether they or someone from their household had been diagnosed with COVID-19, and responses were dichotomized to reflect participants who reported self/familial infection and those who did not.

2.3.5 | The brief illness perception questionnaire (Brief IPQ)

Brief IPQ is a widely used and reliable measure of illness perception.[29] This 8-item measure asks the respondents to rate their views regarding their level of concern in living with their illness (eg, controllability, impact, severity, duration) on a scale from 0 to 10, with 0 = no concern and 10 = extremely concerned. The authors of the scale encourage its adaptation to other illness settings.[30] Therefore, in the present study, we adapted the Brief IPQ to the COVID context, utilizing two IPQ subscales: GI-specific (IPQ-GI, 8 items) and COVID-19–specific (IPQ-COVID, five items). In the first subscale (IPQ-GI), to ensure that the scale assessed GI-specific perceptions, the word "illness" was replaced with "gastrointestinal condition," for example, "How much control do you feel you have over your illness?" became "How much control do you feel you have over your gastrointestinal condition?" The 8-item scale has a strong reliability (α = .83). A second version of this scale (IPQ-COVID) was used to assess perceptions relating to COVID-19. For each of the original items, the word "your illness" was replaced with "COVID-19," for example "How much control do you feel you have over your illness?"

TABLE 1 Sample characteristics

	N (%)	Missing	Mean	Standard deviation	Minimum	Maximum
Age	793	38	49.1	16.1	18	94
Dependents	569	262	0.866	1.16	0	9
USD Income	424	407	75015	84456	0	1,103,832
Distress	831	0	26.9	25.4	0	126
GI disorder activity	831	0	36.2	16.6	15	97
Illness perception of GI	831	0	5.3	1.73	1.25	9.5
Illness perception of COVID	831	0	4.7	1.19	1.13	8.25
Perception of COVID spread	831	0	2.54	0.865	1	4
Fear related to COVID scale	831	0	26.51	8.5	9	45
Self/familial COVID infection (yes/no)	34/797 (4.1)	0				

became "How much control do you feel you have over COVID-19?". After three items (4, 5, and 7) were discarded based on Cronbach's alpha, the reliability was good (α = .75). IPQ-GI and IPQ-COVID totals were created by averaging items, with higher scores indicating poorer GI illness perceptions or poorer perceptions relating to COVID-19 respectively.

2.3.6 | Perception of COVID spread

Participants were asked to give their perception of the current state of coronavirus in their state or province ("What is your sense of the COVID-19 pandemic spread in your state/province?"), on a four-point scale: 1 = "Cases of COVID-19 are rising quickly"; 2 = "Cases of COVID-19 are rising slowly"; 3 = "Cases of COVID-19 have flattened out with only a few new cases each time"; and 4 = "No cases of COVID-19."

2.3.7 | The fear relating to COVID-19 Scale (COVID-19 fear)

The Fear Relating to COVID-19 Scale is derived from the Fear of AIDS Scale,[31] has been validated in the IBD population, and showed excellent psychometric properties.[32] This 14-item scale asks respondents to indicate the level of fear/concern they are experiencing regarding different situations, such as contracting COVID-19 or having contact with health professionals. For the present study, five GI-amplified items were added regarding (a) whether COVID will worsen the GI disorder; (b) whether COVID will affect access to medical care; (c) whether COVID will affect the management of the GI disorder; (d) whether the GI disorder will increase the risk of contracting COVID; and (e) whether having a GI disorder will increase the risk of death from COVID. All items are rated on a 5-point scale from 1 (no fear) to 5 (very much fear). Scale scores ranged from 14 to 70, and higher scores indicated greater fear/concern about COVID-19. The scale presents two factors: General Fear of COVID and GI-amplified Fear of COVID, both with acceptable internal reliability (α = .93 and α = .88, respectively).

Product shortages were evaluated with a series of 4-point Likert scales ranging from "no problem at all" to "serious problem." This measure was developed by the investigators, utilizing multi-country experiences to date and the unique context of a global pandemic. Items included shortages of medications, pain medications, food, toilet paper, and non-medical therapies. Scores ranged from 1 to 4, with higher scores reflecting greater difficulties with product shortages.

2.4 | Statistical analysis

Missing data were deemed to be missing at random with no evidence of systematic missingness. Data met assumptions of linearity and independence of errors and fell within acceptable ranges of normal distribution. Bivariate correlations were performed for all variables in the model, using Pearson's r for continuous variables and Spearman's rho for ordinal variables.

To explore whether specific vulnerable populations would experience stronger associations between COVID shortages and psychological distress, we performed a series of linear regressions, adjusting for the presence of other variables and testing individual moderation effects. The total distress score was the dependent variable in all models, and we examined five specific shortages common to gastrointestinal patients. The moderator variables entered into the models were as follows: parent/caregiver status, chronic condition, employed, COVID prevalence, perception of COVID spread, COVID fear, income, diarrhea severity, COVID infection, IPQ-COVID, IPQ-GI, GSRS, and age.

To accommodate the number of model effects and control the type I error rate, we developed our final model by running individual moderator-specific models that contained all univariate main effects, and the interactions of a single moderator variable with each of the shortage variables. All analyses were performed in R[31] and Jamovi,[33] using the *car*[34] (*Fox* & Weisberg, 2018) and *emmeans* packages.[35]

TABLE 2 Demographic characteristics

Gender	Counts	% of total	Marital status	Counts	% of total	Nation	Counts	% of total	COVID prevalence rank[a]	Condition	Counts
Male	142	17.1%	Single	232	27.9%	Australia	101	12.2%	1	Celiac disease	273
Female	684	82.3%	Married	464	55.8%	Austria	2	0.2%	15	Colonic inertia	9
Equally/neither/unsure/prefer not to say	5	0.6%	De facto	54	6.5%	Belgium	1	0.1%	20	Diverticular diseases	54
			Widowed	19	2.3%	Brazil	1	0.1%	13	Functional dyspepsia	20
			Divorced	50	6.0%	Canada	28	3.4%	3	Gallstones	35
			Separated	12	1.4%	Denmark	34	4.1%	5	Gastroparesis	18
						England	313	37.7%	7	GERD/GORD	96
Education levels	Counts	% of Total	Employment levels	Counts	% of Total	France	1	0.1%	16	Globus	5
Elementary to 8th grade	7	0.8%	Full-time employed	270	32.5%	Germany	8	1.0%	4	Hemorrhoids	74
Some high school, no diploma	39	4.7%	Part-time employed	109	13.1%	Ireland	4	0.5%	7	IBS	260
High school degree or equivalent (eg, GED)	84	10.1%	Casually employed	14	1.7%	The Netherlands	38	4.6%	14	Crohn's disease	177
Some college credit, no degree	75	9.0%	Other	49	5.9%	New Zealand	69	8.3%	1	Ulcerative colitis	123
Trade/technical/vocational training	89	10.7%	Self-employed	49	5.9%	Poland	79	9.5%	11	Indeterminate colitis	22
Associate degree (eg, AA, AS)	39	4.7%	Unemployed	63	7.6%	Portugal	8	1.0%	12	Other:	129
Bachelor's degree (eg, BA, BS, BBA)	279	33.6%	Retired	153	18.4%	Romania	11	1.3%	9		
Master's degree (eg, MA, MS, MEng, MSW, MBA)	150	18.1%	Pensioner	48	5.8%	Scotland	32	3.9%	7		
Professional degree (eg, MD, DDS, JD, DVM)	36	4.3%	Home duties	38	4.6%	Sweden	4	0.5%	8		
Doctoral degree (eg, PhD)	33	4.0%	Student	38	4.6%	Switzerland	1	0.1%	18		
						United States of America	63	7.6%	19		
						Wales	16	1.9%	7		
						Spain	8	1.0%	10		
						Northern Ireland	4	0.5%	7		

[a]Variable is ranked 1 to 20, with higher values indicative of greater COVID prevalence among the countries reported in the sample.

TABLE 3 COVID-19–related product shortages

	No problem at all	%	Minor problem	%	Moderate problem	%	Serious problem	%
Medication	499	67.9%	170	23.1%	51	6.9%	15	2.0%
Toilet paper	501	63.7%	201	25.5%	64	8.1%	21	2.7%
Food	352	43.8%	292	36.4%	134	16.7%	25	3.1%
Pain medication	566	82.4%	83	12.1%	28	4.1%	10	1.5%
Non-medical therapies	303	55.5%	154	28.2%	59	10.8%	30	5.5%

3 | RESULTS

Overall, 831 people completed the survey, of whom 82% were female and were, on average, 49 years old (SD = 16.5). The majority were married (56%), had a university degree (60%), and came from the United Kingdom (*n* = 365); see Tables 1 and 2.

The most common GI disorder types included IBD (*n* = 322), celiac disease (*n* = 273), and IBS (*n* = 260), with 448 (53.9%) identifying living with a co-morbid chronic illness (see Table 2). The mean scores for distress symptoms were within the normal range, and the severity of GI symptoms was also low (M = 36.2, SD = 16.6).

Product shortages data are presented in Table 3. Moderate serious problems accessing food were reported by almost one in five of the sample, with 16% affected by shortages of non-medical therapies and 10.8% by toilet paper shortages, while essential medication shortages affected 8.9% of the sample.

3.1 | Aim 1

3.1.1 | Correlations

The univariate correlations between the variables of interest are presented in Table 4. Diarrhea severity, illness perceptions of COVID and gastrointestinal illness, total gastrointestinal symptom severity, and shortages of medications, toilet paper, special diet food, pain medication, and non-medication therapies were each significantly and positively correlated with distress, with the strongest association observed for fear of COVID.

TABLE 4 Univariate correlations

	1	2	3	4	5	6	7
DISTRESS	—						
PARENT/CAREGIVER	0.006	—					
CHRONIC CONDITION	−0.02	−0.076	—				
EMPLOYED	0.034	0.208[c]	−0.146[aa]	—			
COVID PREVALENCE	−0.023	−0.009	−0.001	−0.033	—		
COVID PERCEPTION OF SPREAD	0.036	−0.016	−0.043	0.008	0.133[c]	—	
COVID FEAR	0.307	−0.047	0.076[a]	−0.075[a]	0.077[a]	0.203[c]	—
INCOME	−0.076	0.106	−0.147[c]	0.199[c]	−0.067	−0.009	−0.054
DIARRHEA SEVERITY	0.29	0.003	−0.062	−0.059	0.057	0.052	0.16[c]
COVID INFECTION	−0.093	−0.011	0.028	−0.036	0.001	0.007	0.025
IPQ_GI	0.496[c]	0.04	−0.057	−0.001	0.07	0.063	0.283[c]
IPQ_COVID	0.458	0.037	0.033	0.023	−0.03	0.14[c]	0.572[c]
GSRS_BASE_COVID	0.484	0.014	0.025	−0.026	0.034	0.069[a]	0.249[c]
AGE	−0.198	−0.064	0.354[c]	−0.358[c]	−0.042	−0.143[c]	−0.03
MEDICATIONS	0.219	0.013	0.041	0.039	0.022	0.081[a]	0.222[c]
TOILET PAPER	0.171[c]	−0.041	0.028	0.046	−0.191[c]	0.03	0.122[c]
FOOD	0.108[b]	0.027	0.065	0.058	−0.044	0.055	0.154[c]
PAIN MEDICATION	0.175[c]	0.003	−0.004	0.054	0.05	0.077	0.15[c]
NON-MEDICATION THERAPIES	0.211[c]	0.056	0.055	−0.028	−0.047	0.063	0.168[c]

[a]$p < 0.05$.
[b]$p < 0.01$.
[c]$p < 0.001$.

Age was the sole negative correlate with distress, meaning that younger participants reported greater distress, and frequently observed to negatively correlate with other variables except for chronic condition diagnosis.

Interestingly, we observed a weak negative association between current employment status and annual pre-tax household income, suggesting that a not-insubstantial number of participants had lost employment during the COVID crisis. Each of the five shortage variables was positively correlated with the others, generally with small but robust associations. The strongest associations were between toilet paper and special food shortages (r = .505), and between general medications and pain medications (r = .517).

3.1.2 | Regression models

The COVID-19 pandemic–related product shortages of toilet paper, pain medication, and food were significantly associated with distress. In particular, there was a positive association between toilet paper and pain medication shortages and distress, and there was a negative association between food shortages and distress (Table 5, the final regression model).

In comparing geographic regions, we observed that the most variation in serious shortages was reported by participants for special diet food products and toilet paper. Participants from North America reported the highest proportion of food shortages (10.9%), followed by Australia and New Zealand (4.2%). Reports of serious toilet paper shortages were highest in North America, Australia, and New Zealand (between 6% and 7%).

In a comparative examination of specific gastrointestinal diagnoses, we also observed that participants with a diagnosis of celiac disease were more likely to report moderate or serious food shortages (24% and 5.5%, respectively) compared to those with other GI diagnoses (13% and 1.7%). Participants with a celiac diagnosis were also more likely to report moderate, but not serious, shortages of toilet paper (10.1%) compared to those without a diagnosis (6.7%). Participants with celiac disease in all regions were more likely to report serious shortages of any type, though some variation was identified. Participants from continental Europe with a diagnosis of celiac disease were significantly more likely to report moderate or serious shortages of medication and non-medication therapies compared to participants with other GI disorders from that region (16.7% to 7%). In North America, the same comparison between celiac diagnoses and other diagnoses revealed substantial differences in those reporting moderate or serious shortages of toilet paper and food (25.84% to 13.3%; 52.7% to 23.4%, respectively), and a comparable proportion of responses was observed for participants from the UK and Republic of Ireland for food shortages (28.1% to 16.9%). Interestingly, participants from Australia and New Zealand with a diagnosis of celiac disease were less likely to report shortages of pain medication and non-medication therapies (2.3% to 9.52%; 13.8% to 17.2%, respectively).

8	9	10	11	12	13	14	15	16	17	18
—										
−0.062	—									
0.016	−0.061	—								
−0.018	0.479[c]	−0.027	—							
−0.063	0.157[c]	−0.133[c]	0.385[c]	—						
−0.081	0.676[c]	−0.051	0.653[c]	0.288[c]	—					
−0.161[c]	−0.112[b]	0.002	−0.123[c]	−0.074[a]	−0.133[c]	—				
0.044	0.161[c]	−0.024	0.248[c]	0.175[c]	0.24[c]	−0.12[c]	—			
0.006	0.048	−0.031	0.105[b]	0.172[c]	0.163[c]	−0.135[c]	0.283[c]	—		
0.001	−0.054	−0.075	0.054	0.209[c]	0.08[a]	−0.072[a]	0.33[c]	0.505[c]	—	
−0.015	0.088	−0.008	0.162[c]	0.122[b]	0.191[c]	−0.079[a]	0.517[c]	0.227[c]	0.319[c]	—
−0.009	0.06	−0.064	0.162[c]	0.201[c]	0.21[c]	−0.004	0.352[c]	0.201[c]	0.312[c]	0.365[c]

TABLE 5 Final regression model of the association between shortages and mental health

	Estimate	SE	T	*p*	Beta	Lower	Upper
Intercept	−109.364	44.593	−2.452	0.016			
Age	−1.491	0.132	−1.33	0.260	−0.0846	−0.4098	0.112
Income	0.597	1.126	0.531	0.597	0.0375	−0.10253	0.1776
COVID prevalence	2.776	1.900	1.461	0.147	0.0669	−0.07302	0.2068
Perception of COVID spread	0.442	2.037	0.217	0.829	0.0144	−0.11674	0.1455
Employed	−3.913	4.154	−0.942	0.348	−0.0674	−0.20917	0.0743
Chronic condition	2.997	4.078	0.735	0.464	0.0536	−0.09087	0.1981
Parent/caregiver	3.597	3.722	0.966	0.336	0.0650	−0.06820	0.1981
GI disorder activity	0.270	0.185	1.458	0.147	0.1575	−0.05644	0.3715
COVID fear	2.664	1.112	2.396	0.018	0.0205	−0.14536	0.1864
Illness perception of GI	4.672	1.498	3.119	0.002	0.2634	0.09613	0.4306
Illness perception of COVID	7.071	1.953	3.621	<.001	0.3202	0.14501	0.4953
Diarrhea	2.446	5.226	0.468	0.641	0.0263	−0.14652	0.1991
COVID infection	4.677	11.319	0.413	0.680	0.0288	−0.10923	0.1668
Medication shortages	−18.459	9.537	−1.935	0.055	−0.0534	−0.23946	0.1326
Toilet paper shortages	20.605	5.993	3.438	<.001	0.0614	−0.10923	0.2321
Food shortages	−13.495	5.620	−2.401	0.018	−0.0594	−0.23948	0.1208
Pain medication	34.320	14.844	2.312	0.023	0.0267	−0.16132	0.2148
Non-medical therapies shortages	1.622	2.538	0.639	0.524	0.0483	−0.10145	0.1981
Age × Medications	0.334	0.178	1.879	0.063	0.1339	−0.00724	0.2750
COVID Prevalence × Toilet paper	−2.690	0.832	−3.233	0.002	−0.3191	−0.51462	−0.1236
COVID Prevalence × Food	1.669	0.633	2.635	0.010	0.1999	0.04962	0.3502
COVID Fear × Pain Medications	−1.151	0.513	−2.244	0.027	−0.2259	−0.42537	−0.0265
Diarrhea × Pain Medications	−0.903	2.344	−0.385	0.701	−0.0353	−0.21717	0.1465

TABLE 6 Simple effects for moderations

Moderator	Estimates	SE	Lower	Upper	Df	T	*p*
COVID Prevalence × Toilet paper							
Mean−1·SD	13.14	4.14	4.95	21.337	115	3.177	0.002
Mean	2.12	2.98	−3.77	8.016	115	0.713	0.477
Mean+1·SD	−8.90	4.88	−18.57	0.772	115	−1.823	0.071
COVID Prevalence × Food							
Mean−1·SD	−8.87	4.26	−17.31	−0.421	115	−2.080	0.040
Mean	−2.03	3.11	−8.19	4.129	115	−0.653	0.515
Mean+1·SD	4.81	3.82	−2.77	12.381	115	1.257	0.211
COVID Fear × Pain Medication							
Mean−1·SD	0.7610	0.342	0.0836	1.439	115	2.225	0.028
Mean	0.0634	0.259	−0.4488	0.576	115	0.245	0.807
Mean+1·SD	−0.6343	0.458	−1.5420	0.273	115	−1.384	0.169

3.2 | Post hoc subgroup analyses

To account for heterogeneity of effects across different diagnoses, we performed subgroup analyses of the final regression model for participants who reported diagnoses of celiac, IBS, or IBD. The regression models and coefficients can be viewed in Supplemental Tables S1–S3. In contrast to the whole sample, no individual variable or interaction between variables was predictive of psychological distress in participants who reported a diagnosis of celiac, and the model was non-significant. Most variables only changed slightly, few changed directions. In contrast to the celiac analysis, participants who reported a diagnosis of IBS shared many similarities with the overall model but produced some unique results. The associations of COVID fear, perception of COVID, and pain medication shortages

with distress did not retain significance within the IBS sample, but a positive association between fears of non-medication therapy shortages and distress emerged (b = 13.44, t = 2.21, p = 0.034). The interaction effect between age and medication was also not retained with the IBS sample.

Analysis of the participants reporting a diagnosis of IBD revealed several differences from the overall sample. The associations between distress and employment, IPQ-COVID, pain medication shortages, and toilet paper shortages were not retained, nor the interaction effects between COVID fear and pain medications, and COVID prevalence and toilet paper shortages. In contrast, we observed significant associations between distress and age (b = −1.77, t = −2.65, p = 0.012), and diarrhea symptom severity (b = 33.63, t = 2.31, p = 0.028). We also observed significant interaction effects for age and medication shortage fears (b = 0.666, t = 2.53, p = 0.017), and between diarrhea symptom severity and pain medication shortage fears (b = −15.647, t = −2.24 p = 0.033).

We also examined mean differences between these three diagnostic subgroups across all variables entered into the model (See Supplementary Table S4 for full results). Adjusting for multiple comparisons using the Bonferroni corrections, each of the summarized differences here is significant at the p < 0.05 level. The IBD group was significantly younger and more distressed than the other two groups. The IBS group reported the highest levels of GSRS, followed by the IBD group, and reported the highest levels of IPQ-COVID scores. Neither coeliac nor IBD groups differed on the IPQ-COVID measure. The celiac group reported the lowest levels of IPQ-GI symptoms, COVID fear, and diarrhea symptoms, while the IBS and IBD groups did not differ on these measures. Finally, the celiac group reported the highest fear of food shortages, but was only statistically distinct from the IBD group, which reported the lowest.

3.3 | Aim 2

Significant moderation effects were identified for COVID-19 prevalence and toilet paper and food shortages, and between COVID-19 fear and pain medication shortages (Table 6).

Interestingly, as COVID-19 prevalence per 1 million population increased (average since March 2020), the association between toilet paper shortages and distress became negative. Participants from nations with the highest COVID-19 prevalence (Belgium, United States, Switzerland) did not achieve statistically significant associations between distress and toilet paper shortages, while nations with low prevalence (New Zealand, Australia, Canada) had strong positive associations. An almost symmetrical moderation effect was detected for the association between food shortages and distress, where nations with lower COVID-19 prevalence reported negative associations, while no associations were observed for nations with average or higher COVID-19 prevalence (Figure 1).

Regarding the moderation of the association between distress and pain medication shortages by COVID-19 fear, where COVID-19 fear is highest, the association between pain medication shortages and distress is negative, and where COVID fear is low, the association between distress and pain medication shortages is positive.

4 | DISCUSSION

This international survey is the first to explore the relationship between product shortages and distress among adults living with GI disorders during the COVID-19 pandemic. The study documented a significant relationship between personal product shortages, specifically toilet paper, pain medication, and food shortages, and psychological distress. This relationship was significantly moderated by COVID-19 prevalence and COVID-19 fear.

People living with GI disorders have a higher risk of distress, compared with healthy controls[36]; however, given the anxiety surrounding it, the COVID-19 pandemic is likely to exacerbate this risk. Impaired psychological functioning in the general population has been reported during this pandemic.[7] This worsening well-being has been hypothesized to stem from prolonged isolation, as people in self-isolation or under quarantine appear to have a higher risk of developing anxiety and/or depression,[37] or the loss of employment/income and rising rates of domestic violence.[38] In addition, parents have been shown to be under particular distress as they struggle combining at home work with at home schooling of their children.[39] However, ours is the first study documenting the role of product shortages in this context. Availability of products, such as toilet paper and pain medication, is essential to well-being, particularly for this population, whose symptoms often include pain, diarrhea, and/or frequent trips to the bathroom. Interestingly, we did not find

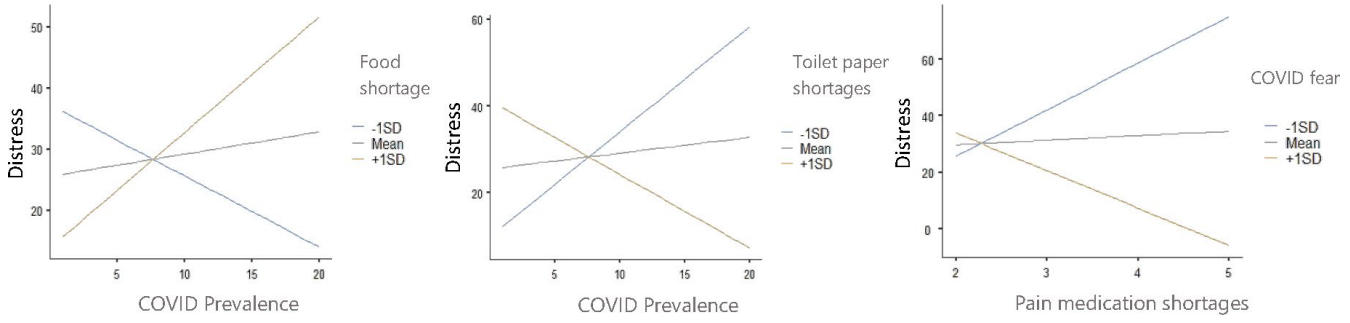


FIGURE 1 Distress and moderation simple slopes

a relationship between other medications and non-medical treatments and distress despite these shortages being more commonly reported than pain medication. This might be due to immediate sense of control provided by pain medication not offered by other treatments, which usually require time to work.

Paradoxically, we documented a negative association between food shortages and distress, where nations with lower COVID-19 prevalence reported negative associations. Nearly 20% of this study's respondents experienced moderate serious food shortages due to the COVID-19 pandemic, but it seems that those most affected by the food shortages tended not to be reporting current distress. It is possible that these participants were able to adapt, eating a more monotonous diet or simply reducing their food intake, which provided some sense of control and reduced distress. Previous studies have documented higher external locus of control in people with GI disorders such as IBD and functional gut disorders than in the healthy controls.[40] It could also be that those living in the countries with high COVID-19 prevalence such as the United States could be more focused on the virus itself, and its impact on their health, than on food shortages. Food is also a more generic category of item, and supermarkets were not completely sold out of food; responses may have been elevated if preferred foods were not able to be obtained. However, a complete lack of toilet paper for periods of time has been a feature of this pandemic. Further, the timing of the present study may also explain that, because distress due to food shortages was likely higher during the first wave of COVID-19 earlier in the year than during the second wave which is documented in the present study. Moreover, in a comparative examination of specific gastrointestinal diagnoses, we observed that participants with a diagnosis of celiac disease were more likely to report moderate or serious food shortages compared to those without those diagnoses. Due to the necessity of a specialized diet requiring strict avoidance of food with gluten, people with celiac disease would arguably be most affected by shortages of gluten-free products.

Further, our study demonstrated that participants from nations with highest prevalence of COVID-19 reported negative associations between distress and toilet paper shortages, while nations with low prevalence (New Zealand, Australia, Canada) had strong positive associations. One potential interpretation of this finding could be that the low prevalence of COVID-19 in nations such as New Zealand, Australia, and Canada was aided by this positive association—citizens from these countries had a greater distress response to COVID shortages and participated in suppression/elimination strategies more enthusiastically. Taking Australia as a case study, 17% of shoppers reported panic buying in April 2020 versus 6% in June 2020,[41] while another study demonstrated that Australians had one of the highest rates of COVID-19–related panic buying worldwide,[42] associated with government announcements on tightening physical distancing rules.[43] Since Australia has experienced only economic growth in the last 30 years, shortages are largely unknown at the population level and their sudden appearance could have resulted in widespread panic. Another driver of this finding may be the severity of the lockdown measures, with Australia and New Zealand introducing some of the harshest lockdowns worldwide. Lockdown measures make it more difficult to shop and communicate the seriousness of the virus. In addition, countries with a high prevalence of COVID-19 could have been more concerned about the risk of hospitalization or death rather than the pandemic's effects on lifestyle.

In addition, analysis of the diagnostic subgroups revealed some distinctive patterns of distress between the largest diagnoses. Interestingly, our attempts to predict distress within the celiac sample were largely unsuccessful compared with IBS or IBD, though our analyses suggest that reported distress within this group was significantly lower than the other groups with less than half the variance present. Our lack of an overall significant model predicting distress within this diagnostic subgroup may also suggest that the experience of distress is experientially distinct from those with IBS or IBD. The presence of significant models for IBS and IBD, as well as the individually predictive variables, in contrast, allows exploration of key features of distress within each group. For example, we see that the IBS group was uniquely distressed by concerns related to non-medication therapies. Within the IBD group, we observed that younger age and lower diarrhea severity predicted fewer distress symptoms and that with increasing age came increased distress associated with fears of medication shortage. Curiously, the negative interaction effect between diarrhea severity and pain medication suggests that each of these variables had an inverse effect upon the association of the other with distress—that is, those with higher levels of diarrhea severity reported negative associations between distress and fears of pain medication shortages, and vice versa. One explanation for this interaction effect could be immediacy, where the more proximal concern to a participant (diarrhea symptoms) reduces concern about the more distal.

Finally, we showed that those with a higher level of concern about their GI illness or about COVID-19 and with higher levels of COVID-19–related fear reported higher distress. However, when COVID-19 fear is highest, the association between pain medication shortages and distress is negative, whereas when COVID fear is low, more pain medication shortages are associated with higher distress. Therefore, strategies addressing COVID-19 fear, such as educational campaigns or psychological interventions improving coping strategies and fostering a greater sense of self-efficacy, could potentially modify the relationship between shortages and distress.

4.1 | Limitations

This survey used a convenience and un-controlled sample recruited online, and therefore, participant demographics may not correspond to those seen in clinical populations. However, since recruitment for research studies at health clinics has become impractical (due to lockdown of clinics/research labs), given the risk of the virus for researchers, and also due to the burden of the pandemic on health practitioners, we opted to conduct the study online and recruit via GI-related groups and social media. Arguably, this sample might be more representative of the general population. This is supported

by the sample's reported low levels of GI symptoms and good mental health. On the other hand, our sample had a high proportion of persons with university education, which makes it more educated than the general population. In addition, the participants were predominantly female, which limits the generalizability of its findings to males with GI disorders. Nevertheless, for many of these conditions (eg, IBS), the prevalence is much higher among females. For practical reasons, we relied on self-report measures. We relied on a self-reported diagnosis, which was not confirmed by a physician since this was most practical during the pandemic. In addition, while some of the scales we used are well-standardized (eg, DASS-21), others have not yet undergone a proper psychometric evaluation. For example, our adaptation of the Brief IPQ to the COVID context, while necessary for the study, has not been validated. We have, however, provided reliability scores for this scale. Nonetheless, to undertake our survey on COVID pandemic issues, especially regarding stresses experienced, as close to the time of the pandemic onset as possible, it was necessary to adapt already validated scales in other diseases for our study. Further, while we advertised widely, our inclusion criteria meant we only included people who speak English, which reduces the study's generalizability. We also collected a sample not reflective of the prevalence of specific GI disorders, with IBD and celiac disease overrepresented and IBS underrepresented, most likely due to more effective advertising via these consumer organizations. Finally, the countries of origin of our sample are not equally represented, and therefore, cross-country comparisons were not practical.

5 | CONCLUSION

This international survey documented a significant relationship between personal product shortages, specifically toilet paper, pain medication, and food shortages, and psychological distress in people living with GI conditions at the time of the COVID-19 pandemic. This relationship was significantly moderated by COVID-19 prevalence and COVID-19 fear. Since COVID-19 fear is a potentially modifiable moderator of this relationship, interventions, and strategies addressing COVID-19 fear, such as educational campaigns or psychological interventions improving coping and fostering a greater sense of self-efficacy, could potentially modify the relationship between shortages and distress.

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CONFLICT OF INTEREST

The authors have no conflict of interests in relation to this study.

DISCLOSURES

The other authors have nothing to report.

AUTHORS' CONTRIBUTIONS

AMW conceived and drafted the manuscript and is the guarantor of the article. DS analyzed and interpreted all data. All authors contributed to study design, promotion, and data collection, commented on drafts of the paper, and approved the final draft of the manuscript. SK ran the final check of the data accuracy and manuscript and provided final approval for the study.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on a reasonable request from the senior author, SK. The data are not publicly available due to restrictions.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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