Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Longitudinal assessment of the common sense model before and during the COVID-19 pandemic: A large coeliac disease cohort study

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ABSTRACT

Objective: Psychosocial factors likely play a substantial role in the well-being of those living with coeliac disease, especially during the COVID-19 pandemic, however, little research has examined well-being in this cohort using an integrated socio-cognitive model. This study had two aims: (1) Examine changes in gastrointestinal symptoms, psychosocial factors, and well-being outcomes (i.e., psychological distress, quality of life [QoL]) associated with the pandemic, (2) Examine the interrelationship of these variables across timepoints using the Common Sense Model (CSM).

Methods: 1697 adults with coeliac disease (Time 1, pre-pandemic; 83.1% female, mean age = 55.8, SD = 15.0 years) and 674 follow-up participants (Time 2, pandemic; 82.8% female, mean age = 57.0, SD = 14.4 years) completed an online questionnaire. Hypotheses were tested using repeated measures MANOVA and cross-lagged panel model analyses.

Results: Participants reported improved QoL, and reduced gastrointestinal symptoms, negative illness perceptions and maladaptive coping from pre-pandemic to during the pandemic. There was no significant change in pain catastrophising or psychological distress. Cross-lagged effects showed gastrointestinal symptoms to predict negative illness perceptions, which in turn were predictive of poorer outcomes across all variables except pain catastrophising. Consistent with the CSM, there was a reciprocal relationship between illness perceptions and QoL over time. Maladaptive coping and pain catastrophising demonstrated limited predictive utility.

Conclusion: The COVID-19 pandemic appears to have had a small beneficial effect across several indices of well-being among adults with coeliac disease. Cross-lagged relationships highlight illness perceptions as a predictor of well-being outcomes and a potential target for psychosocial interventions.

1. Introduction

The COVID-19 pandemic has led to the deaths of millions, caused substantial socioeconomic difficulties [1], and has been associated with a significant reduction in psychological well-being [2,3] and quality of life (QoL) [4]. The pandemic has also presented notable challenges to those living the chronic illness due to both increased vulnerability to adverse COVID-19 outcomes [5,6] and impeded access to relevant medical support structures [7].

Affecting over 1% of individuals globally [8], coeliac disease is a chronic immune illness characterised by inflammation in the small bowel and various gastrointestinal (GI) and extra-intestinal symptoms [9]. The disease is principally treated with life-long and strict exclusion of dietary gluten (i.e., the gluten-free diet) [10]. Concerns regarding the impact of pandemic-related lockdown measures on access to gluten-free food products have been commonly reported by those living with the illness [11]. Moreover, while current evidence indicates that coeliac individuals are not at a greater risk of COVID-19 infection or serious COVID-19 symptoms [12–15], individuals with coeliac disease have commonly reported concerns regarding an increased vulnerability to the virus [11,16]. Findings regarding pandemic-related changes in quality of life (QoL) in coeliac cohorts have been mixed. Comparisons of pre-

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and mid-pandemic cross-sectional studies have suggested a potential decrease in QoL associated with the pandemic in Italian coeliac cohorts [11,17]. In contrast, findings in a Brazilian coeliac cohort have indicated a potential increase in QoL associated with the pandemic [18,19].

The literature to date provides strong evidence for the role of psychosocial factors in post-diagnosis QoL in coeliac cohorts (for review, see [20]). Studies examining the comparative effects of clinical and psychosocial factors in relation to QoL in coeliac disease have shown psychosocial factors (e.g., perceived gluten-free diet difficulty, coping) to predict QoL over and above clinical disease measures (e.g., dietary adherence, coeliac symptom frequency/severity, histological findings, serology) [21,22]. Other psychosocial factors found to be associated with reduced QoL include illness perceptions (e.g., poor illness understanding, greater perceived burden and belief in negative illness consequences) [23,24], maladaptive coping [25] and psychological distress symptoms [22,26]. Despite the strong evidence base for psychosocial predictors of QoL, limited research to date has explored this relationship using an integrated socio-cognitive model as seen in coeliac studies of gluten-free diet adherence (e.g., Theory of Planned Behaviour) [27–29].

The Common Sense Model (CSM) [30,31] is a widely used socio-cognitive model that describes the cognitive, affective, and behavioural processes by which individuals respond to illness threats (for review, see [32,33]). In brief, illness threats (e.g., symptoms) impact patient outcomes (e.g., QoL, psychological well-being) via cognitive/affective representations of illness (e.g., perceived consequences, controllability, coherence, treatment efficacy, emotional representations) and coping patterns (e.g., adaptive/maladaptive coping strategies). Further, the model postulates that illness perceptions, coping strategies and outcomes are dynamically interrelated, changing over time via a process whereby appraisal of outcomes modulates illness beliefs and/or coping strategies [30].

A CSM-guided study of 1697 coeliac disease adults conducted approximately five months prior to the COVID-19 pandemic identified several potential psychosocial mediators in the relationship between GI symptoms and QoL [34]. Specifically, greater GI symptoms were associated with more negative representations of illness (e.g., severe perceived life impact and illness concern, limited personal/treatment control), maladaptive coping (i.e., behavioural disengagement, venting, self-blame), pain catastrophising (i.e., tendency to focus on/magnify pain, feeling helpless toward the experience of pain), and psychological distress symptoms (i.e., depressed mood, anxiety, and stress symptoms). These factors were in turn predictive of reduced QoL, with psychological distress symptoms and negative illness perceptions being the strongest predictors/mediators of QoL. To our knowledge the Möller et al. [34] study was the first study to investigate the concurrent relationship between the CSM's core components (i.e., illness perceptions, coping) and QoL in an adult coeliac sample.

The findings of Möller et al. [34] were nonetheless based on cross-sectional data, thus susceptible to the biases of cross-sectional mediation analysis [35]. Moreover, correlational data is methodologically limited in testing the causal and dynamic interrelationships proposed by the CSM [32,33,36]. To address the predominance of cross-sectional CSM research, Hagger and Orbell [33] advocated strongly for the use of longitudinal cross-lagged panel model designs in future research. Such designs provide a more appropriate test of the CSM by testing effects across time (i.e., establishing directionality/temporal precedence), testing reciprocal effects between model variables, and accounting for the effects of variables on themselves over time (i.e., autoregression) [33]. As applied to the present study (see Fig. 1), this approach allows for testing pathways consistent with the CSM's mediation principles (i.e., that the relationship between GI symptoms and outcome [e.g., psychological distress, QoL] is mediated by illness perceptions and coping) as well as the CSM's feedback mechanisms (i.e., that outcomes [e.g.,QoL] may predict or reinforce particular illness perceptions or coping strategies).

Extending on the findings of Möller et al. [34], the present study had

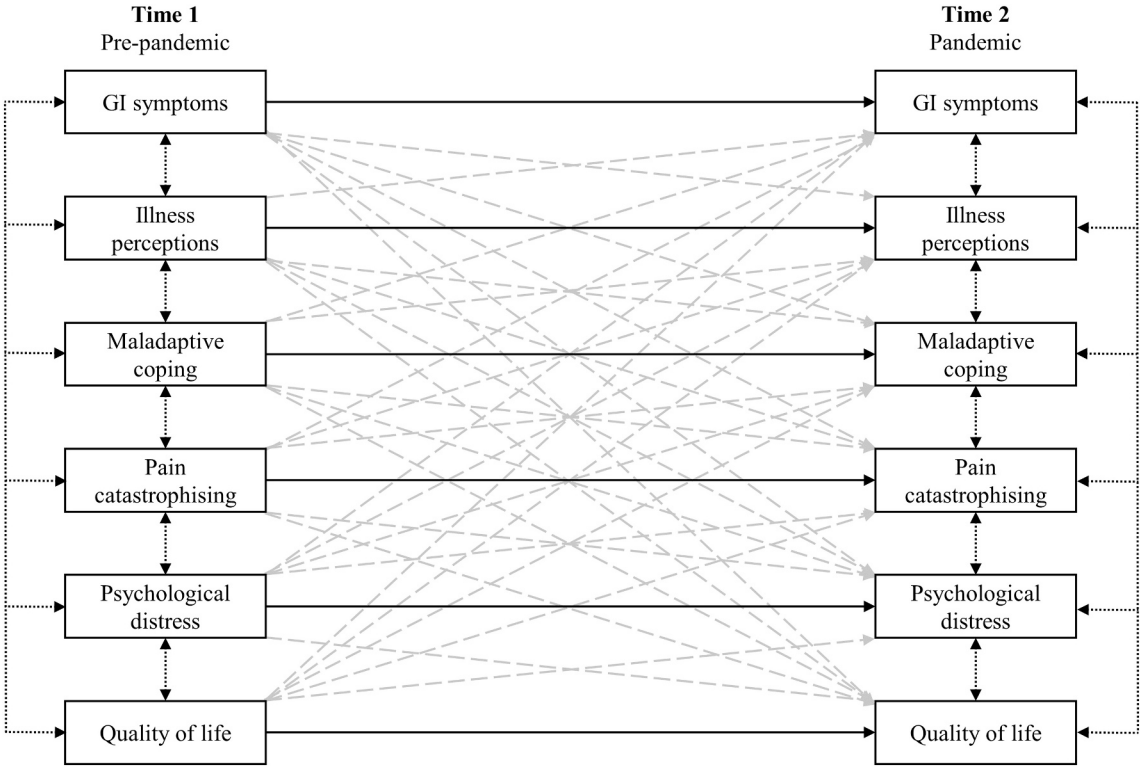

Fig. 1. Cross lagged panel model.
Note. Solid lines indicate stability of construct over time (i.e., autoregressive effects). Grey dashed lines indicate cross-lagged (i.e., reciprocal) effects. For presentation clarity, intercorrelations among variable error terms at their respective timepoints are indicated with double-arrow short-dash black lines.

two aims. Firstly, to assess changes in the psychosocial factors identified pre-pandemic in Möller et al. [34] by assessing participants approximately 9 to 12 months later during the COVID-19 pandemic. Secondly, to conduct a CSM-guided investigation of the interrelationship between the same model variables across time.

It was hypothesised that:

1.) Participants would report greater GI symptoms, negative illness perceptions, maladaptive coping, pain catastrophising, psychological distress, and lower QoL during the pandemic (Time 2) compared to their pre-pandemic baseline (Time 1).

Regarding the cross-lagged panel model, it was hypothesised that after controlling for all autoregressive effects and the effects of other predictors:

2a.) Gastrointestinal symptoms at Time 1 would predict greater negative illness perceptions at Time 2.
2b.) Negative illness perceptions at Time 1 would predict greater maladaptive coping, pain catastrophising, psychological distress and poorer QoL at Time 2.
2c.) Maladaptive coping and pain catastrophising at Time 1 would predict greater psychological distress and poorer QoL at Time 2.
2d.) Psychological distress and poor QoL at Time 1 would predict greater GI symptoms, negative illness perceptions, maladaptive coping and pain catastrophising at Time 2.

2. Methods

2.1. Participants

A total of 1697 participants completed the questionnaire at Time 1 (pre-pandemic; 83.1% female, mean age = 55.8, SD = 15.0 years) and 674 at Time 2 (pandemic; 82.8% female, mean age = 57.0, SD = 14.4 years) with virtually all participants being from Australia and New Zealand. See Table 1 for a summary of sample characteristics pre-pandemic (completed Time 1 only) and during the pandemic (Time 1 and 2 completers).

2.2. Measures

2.2.1. Coeliac Disease Gastrointestinal Symptom Rating Scale (CeD-GSRS)

Gastrointestinal symptoms were measured using the 10-item coeliac-specific version of the GSRS (i.e., CeD-GSRS) [38]. This version of the GSRS omits five items regarding upper GI and constipation-related GI symptomatology. Respondents are asked about GI symptoms over the

Table 1
Sample characteristics.

	Completed Time 1 only (Pre-pandemic) N = 1, 023		Completed Time 1 and Time 2 (Pre-pandemic and pandemic) N = 674		
	M (*SD*)	*N* (%)	*M* (*SD*)	*N* (%)	*p*
Age (years)	55.0 (15.3)		57.0 (14.4)		0.005
Gender					
Female		852 (83.3%)		558 (82.8%)	
Male		169 (16.5%)		113 (16.8%)	
Other [a]		2 (0.2%)		3 (0.4%)	
Country					
Australia		871 (85.1%)		559 (82.9%)	
New Zealand		122 (11.9%)		95 (14.1%)	
Other [b]		30 (2.9%)		20 (3.0%)	
Time since diagnosis (years)	13.4 (10.0)		14.0 (11.2)		
Method of diagnosis					
Small bowel biopsy [c]		950 (92.9%)		629 (93.3%)	
Serology without biopsy		51 (5.0%)		33 (4.9%)	
Other [d]		22 (2.2%)		12 (1.8%)	
Dietary adherence cut-off (CDAT) [e]					
Adequate adherence (score < 13)		648 (63.3%)		453 (67.2%)	
Inadequate adherence (score ≥ 13)		375 (36.7%)		221 (32.8%)	
Relationship status					
Married/de-facto		775 (75.8%)		514 (76.3%)	
Single		109 (10.7%)		86 (12.8%)	
Separated/divorced/widowed		94 (9.2%)		61 (9.1%)	
Partnered but not living together		35 (3.4%)		12 (1.8%)	
Prefer not to answer		10 (1.0%)		1 (0.1%)	
Education level					
No formal schooling		0 (0.0%)		1 (0.1%)	
Primary school		2 (0.2%)		0 (0.0%)	
Secondary school		244 (23.9%)		114 (16.9%)	0.001
TAFE		243 (23.8%)		156 (23.1%)	
Undergraduate degree		298 (29.1%)		216 (32.0%)	
Postgraduate degree		236 (23.1%)		187 (27.7%)	0.03
Annual gross household income					
<$20,000		35 (3.4%)		21 (3.1%)	
$20,000 - $50,000		171 (16.7%)		121 (18.0%)	
$50,000 - $100,000		270 (26.4%)		179 (26.6%)	
$100,000 - $200,000		284 (27.8%)		173 (25.7%)	
>$200,000		107 (10.5%)		66 (9.8%)	
Prefer not to answer		35 (3.4%)		114 (16.9%)	

[a] Time 1: $n = 2$ transgender/genderqueer/non-binary, $n = 3$ missing data. Time 2: $n = 1$ genderqueer/non-binary.
[b] Includes two cases where country information was missing (Time 1).
[c] Biopsy with or without coeliac serology.
[d] Cases identified diagnosis based on symptoms/genetic testing/associated conditions. TAFE = Technical and further education.
[e] Based on Celiac Dietary Adherence Test (CDAT; [37]).

previous seven days using a 7-point response format (1 = "*No discomfort at all*", 7 = "*Very severe discomfort*"). A total score, ranging from 10 to 70, is calculated by summing all items. Higher total scores indicate greater coeliac GI symptoms. Internal consistency for the CeD-GSRS was good at both timepoints (T1: α = 0.85, T2: α = 0.86).

2.2.2. Depression, Anxiety, Stress Scales (DASS-21)

Psychological distress was measured using the DASS-21 [39]. The DASS-21 is a composite measure of psychological distress comprised of items relating to symptoms of depression, anxiety, and stress. Each item (e.g., "*I felt that I had nothing to look forward to*") is measured on a uniform 4-point scale (0 = "*Did not apply to me at all*", 3 = "*Applied to me very much, or most of the time*"). A total score (0–126), wherein higher scores reflect greater psychological distress, is calculated by summing all items and multiplying by two. The DASS-21 had excellent internal consistency at both timepoints (T1: α = 0.94, T2: α = 0.93).

2.2.3. Brief Illness Perceptions Questionnaire (Brief-IPQ)

Illness perceptions were measured using the Brief-IPQ [40]. Each item (e.g., "*How much control do you feel you have over your illness?*") is answered using an 11-point scale (0−10) tailored to each question. The present study used a six-item version of the Brief-IPQ derived from an exploratory factor analysis conducted with the Time 1 data in a previous cross-sectional analysis (see Möller et al. [34]). This factor analysis was done in accordance with the recommendations of Broadbent et al. [41], and omitted items relating to the *timeline* and *coherence* dimensions. The resultant scale reflected individuals' perceptions across the following dimensions: consequences, personal control, treatment control, identity, concern, and emotional representations. These items were summed to obtain an overall score (0–60), wherein a higher score reflected more negative/maladaptive illness perceptions. The scale had good to adequate internal consistency (T1: α = 0.81, T2: α = 0.78).

2.2.4. Brief COPE

Maladaptive coping was measured using the Brief COPE [42]. Each item (e.g., "*I've been blaming myself for things that happened*") is measured using a uniform 4-point scale (1 = "*I haven't been doing this at all*", 4 = "*I've been doing this a lot*"). The present study used a five-item maladaptive coping scale identified in an exploratory factor analysis conducted in the previous cross-sectional analysis of Time 1 data (see Möller et al. [34]). Items in this scale related to strategies of behavioural disengagement, self-blame, and venting. A total score (1–4) was computed by summing and averaging scale items, with higher scores indicating a greater use of maladaptive coping strategies. The scale had adequate internal consistency at Time 1 (α = 0.74), which slightly decreased at Time 2 (α = 0.67).

2.2.5. Pain Catastrophizing Scale (PCS)

Pain catastrophising was measured using the 13-item PCS [43]. The PCS measures pain catastrophising across three dimensions: rumination, magnification, and helplessness. All items are scored on a uniform 5-point scale (0 = "*not at all*", 4 = "*all the time*"). A total score (0–52), wherein higher scores reflect greater pain catastrophising, is obtained by summing all items. The PCS had excellent internal consistency at both timepoints (T1: α = 0.94, T2: α = 0.95).

2.2.6. EUROHIS-QOL 8-Item Index

Quality of life was measures using the 8-item EUROHIS-QOL [44]. The EUROHIS-QOL is a general QoL measure including questions that span multiple domains (i.e., overall quality of life, general health, energy, daily activities, self-esteem, social relationships, finances, and home life). Each item (e.g., "*How satisfied are you with your ability to perform your daily living activities*") is answered using a question-specific 5-point scale (e.g., 1 = "*Very poor*", 5 = "*Very good*"). A total score (8–40), wherein higher scores reflect greater QoL, is calculated by summing all items. The EUROHIS-QOL had good internal consistency at both timepoints (T1:α = 0.88, T2: α = 0.87).

2.3. Procedure

Data was obtained at two timepoints: pre-COVID-19 pandemic (Time 1: August – October 2019) and pandemic (Time 2: May – July 2020). The first wave of data was obtained via email invitation to an online survey, which was sent out to 4287 individuals that had previously participated in coeliac research [45]. Participants at Time 1 were also recruited via Coeliac Australia and Coeliac New Zealand's member communications. To be eligible to take part, participants had to be aged 18 or older, able to understand English, and diagnosed with coeliac disease. The online study link directed participants to the informed consent information, followed by the study questionnaire and debrief. Consent was implied by participants' decision to complete the questionnaire. Participants who completed the questionnaire were invited to enter a prize draw for one of four $100 AUD retail gift vouchers (Time 1 only). Participants were contacted again after the emergence of the COVID-19 pandemic and invited to complete a similar questionnaire using the same online survey methodology. Ethics approval was obtained from the Swinburne University Human Research Ethics Committee (SUHREC# 2019/192).

2.4. COVID-19 context in Australia and New Zealand

Data collection for the COVID-19 follow-up questionnaire began on the 2nd of May and ended on the 16th of July 2020. The first cases of COVID-19 in Australia were reported on the 25th of January 2020, eventually resulting in a progressive increase in lockdown and infection control measures occurring from mid-to-late March, and finally, a gradual easing of restrictions from mid-May until the 6th of June, by which time only two new cases were reported nationally [46,47]. A second wave of infection centred in the state of Victoria emerged during mid-late June, resulting in the reintroduction of restrictions [48]. The first case of COVID-19 in New Zealand was reported on the 28th of February [49], with a nationwide lockdown enforced on the 25th March 2020 [50] until the 27th of April, after which restrictions were gradually lifted until June the 8th where only international border restrictions remained [51]. As summarised in Table 2, most of the sample (72%) were engaging in moderate social isolation (i.e., staying at home and only going out for food and engaging in social distancing).

2.5. Statistical analyses

Analyses were conducted using SPSS v28 and AMOS v28. Given that the variables and design of the present study were derived from the cross-sectional model in Möller et al. [34], a one-way between-groups MANOVA was conducted to assess for baseline differences across model variables between participants who participated in the follow-up and those who did not. Furthermore, as the present cross-lagged panel model utilised measures derived from exploratory factor analysis within the original cross-sectional sample (i.e., illness perceptions, maladaptive

Table 2
Sample COVID-19 social isolation status.

Isolation status	*N* (%)
Total isolation due to having COVID-19 symptoms	3 (0.45)
Engaging in strict social isolation due to mandatory quarantine	15 (2.23)
Engaging in strict social isolation (i.e., staying at home and not going out at all)	58 (8.61)
Engaging in moderate social isolation (i.e., staying at home and only going out for food and engaging in social distancing)	484 (71.81)
Engaging in limited social isolation (i.e., mostly staying at home, but going out for food and seeing friends/family)	110 (16.32)
Engaging in no social isolation (i.e., going out and not engaging in social distancing)	4 (0.59)

Note. $N = 674$.

coping; see [34]), measurement invariance was assessed between the original cross-sectional sample ($N = 1697$) [34] and the subset of participants that completed follow-up ($N = 674$) across all model variables. This involved assessing invariance across a series of increasingly constrained, nested models (see [52]). In ascending order, these included configural invariance (i.e., the baseline model, indicating that the same latent variables are accounted for by the same indicator variables across groups), metric invariance (i.e., that each indicator variable's loading on the latent variable is similar across groups), and finally scalar invariance (i.e., equality of intercepts across groups). As suggested by Cheung and Rensvold [53], a decrease in the comparative fit index (CFI) of more than 0.01 was considered to be the threshold for non-invariance when applying an additional constraint to the model. To account for potential measurement error-related biases in the model estimates [54], the same process was then applied to assess invariance across both timepoints.

The first hypothesis was tested using a one-way repeated measures MANOVA. The remaining hypotheses were tested using observed variables within a two-wave cross-lagged model as recommended by Hagger and Orbell [33](see Fig. 1). The specified model used the full information maximum likelihood estimation, simultaneously accounting for all possible path combinations across time, as well as the covariance of error terms among all variables within their respective timepoints. This model necessarily results in a just-identified model wherein neither overall model fit (i.e., χ^2) nor alternative fit indices are computed. Consistent with established structural equation modelling techniques [55] and previous cross-lagged panel studies [56,57], non-significant paths and covariances were removed, producing fit statistics and improving model parsimony. Given the sensitivity of the chi-squared (χ^2) test statistics to trivially small deviations in large-sample SEM analysis [58,59], final model fit was primarily assessed using alternative fit indices (i.e., Root mean square error of approximation [RMSEA], comparative fit index [CFI], Tucker-Lewis index [TLI]).

3. Results

3.1. Baseline differences (baseline only group vs. follow-up group) and invariance testing

A between-groups MANOVA between participants that completed the follow-up ($n = 674$) and those that did not ($n = 1023$) revealed no significant differences across all model variables (Box's M = 51.41, $p < .001$, Pillai's Trace = 0.007, F (6,1690) = 1.92, $p = .07$). Tests for measurement invariance across Time 1 measures between the whole baseline sample ($N = 1697$) and those that completed follow-up ($N = 674$) showed strong invariance. Using the same methodology and criteria, tests across timepoints also indicated strong invariance between Time 1 and Time 2 measures.

Table 3
Univariate comparisons showing changes in model variables from pre-pandemic to pandemic.

	Time 1 Pre-pandemic	**Time 2** Pandemic			
	M (SD)	*M (SD)*	*F*	*P*	η^2
GI symptoms	18.90 (7.99)	18.14 (7.72)	8.77	0.003	0.01
Illness perceptions	19.13 (11.55)	17.47 (10.63)	30.08	<0.001	0.04
Maladaptive coping	1.38 (0.46)	1.30 (0.39)	25.89	<0.001	0.04
Pain catastrophising	8.72 (9.02)	8.93 (8.98)	0.47	0.49	0.00
Psychological distress	18.95 (18.35)	18.07 (17.53)	2.74	0.10	0.00
Quality of life	32.35 (5.34)	32.70 (5.06)	7.84	<0.01	0.01

Note. $n = 674$. Higher illness scores for illness perceptions indicate more negative cognitive/affective representations of illness. GI = Gastrointestinal.

3.2. Change in model variables from pre-pandemic to pandemic

A one-way within-subjects MANOVA found a statistically significant overall effect between the pre-pandemic and pandemic model variables (Pillai's Trace = 0.090, F (6,668) = 10.98, $p < .001$, $\eta^2 = 0.09$). As shown in the univariate tests in Table 3, contrary to hypothesis 1, participants reported small, statistically significant reductions in GI symptoms, negative illness perceptions, and use of maladaptive coping strategies from pre-pandemic to pandemic. Furthermore, contrary to hypothesis 1, QoL had a small statistically significant improvement and there were no significant differences between timepoints for pain catastrophising and psychological distress.

3.3. Cross-lagged panel model

A two-wave fully cross-lagged panel model was specified which simultaneously accounted for variable stability over time (i.e., *autoregressive* effects), the covariance of error terms among all variables within their respective timepoints (i.e., correlational relationships), and the effect of each variable on all other variables across time. A summary of results for the saturated cross-lagged model prior to removal of any paths/covariances are shown in Appendix A. After removing all non-significant paths and covariances, the subsequent model indicated that the previously significant path from QoL (Time 1) to pain catastrophising (Time 2) had become non-significant and was consequently removed. The final model (see Tables 4 and 5, Fig. 2) demonstrated an excellent fit (χ^2 (21) = 43.54, $p = .003$, $\chi 2/N = 2.07$, CFI = 0.997, TLI = 0.988, RMSEA = 0.025). Compared to the saturated model, the final model had substantially greater parsimony and a trivial weakening in model fit compared to the saturated model (ΔAIC = 1.54). Regarding Time 2 outcomes, the model accounted for 45.6% of the variance in GI symptoms, 59.5% in illness perceptions, 36.4% in maladaptive coping, 40.8% in pain catastrophising, 59.4% in psychological distress, and 67.7% of the variance in QoL.

As shown in Table 4, hypothesis 2a was supported with greater GI symptoms (T1) predicting greater negative illness perceptions (T2). Hypothesis 2b was partially supported, with greater negative illness predictions (T1) significantly predicting greater maladaptive coping (T2), psychological distress (T2) and poorer QoL (T2), but not pain catastrophising (T2). Contrary to hypothesis 2c, neither maladaptive coping (T1) nor pain catastrophising (T1) predicted psychological distress (T2) or QoL (T2). The final hypothesis 2d was partially supported. Psychological distress (T1) predicted greater GI symptoms (T2), maladaptive coping (T2), and pain catastrophising (T2), but not illness perceptions (T2). Further, greater QoL (T1) predicted reduced negative illness perceptions (T2) but not GI symptoms (T2), maladaptive coping (T2), or pain catastrophising (T2).

4. Discussion

The purpose of the present study was two-fold. Firstly, to examine changes across psychosocial factors outlined in Möller et al. [34] associated with the emergence of the COVID-19 pandemic, and secondly, to conduct a CSM-guided cross-lagged panel model analysis examining interrelationships between these same factors over this period.

Hypothesis 1. Changes in psychosocial factors from pre-pandemic to pandemic.

The first hypothesis was unsupported. Contrary to expectation, participants reported small but statistically significant improvements across GI symptoms, illness perceptions, maladaptive coping and QoL. No significant changes were observed for pain catastrophising or psychological distress scores. Our findings did not support the apparent marginal pandemic-related decrease in QoL suggested by cross-sectional pre-pandemic and pandemic Italian coeliac cohorts [11,17] but were consistent with the increase in QoL observed in Brazilian coeliac cohorts

Table 4
Parameter estimates for the final cross-lagged model showing unstandardised estimates, standard errors in parentheses, followed by critical ratios, and standardised estimates.

	T2 GI symptoms	T2 Illness perceptions	T2 Maladaptive coping	T2 Pain catastrophising	T2 Psychological distress	T2 Quality of life
T1 GI symptoms	0.49 (0.03) 16.03*** 0.51	0.14 (0.04) 3.67*** 0.10				
T1 Illness perceptions	0.07 (0.02) 3.23** 0.11	0.61 (0.03) 21.61*** 0.67	0.004 (0.001) 2.94** 0.11		0.24 (0.05) 5.16*** 0.15	−0.05 (0.01) −4.32*** -0.11
T1 Maladaptive coping			0.25 (0.03) 8.19*** 0.31			
T1 Pain catastrophising			0.004 (0.001) 2.61** 0.09	0.50 (0.03) 16.31*** 0.53		
T1 Psychological distress	0.07 (0.01) 5.19*** 0.17		0.005 (0.001) 5.57*** 0.24	0.08 (0.01) 5.65*** 0.19	0.51 (0.03) 18.86*** 0.57	
T1 Quality of life		−0.14 (0.06) −2.53* -0.07			−0.47 (0.10) −4.78*** -0.14	0.70 (0.02) 28.98*** 0.75

Note. Time 1: $n = 1697$, Time 2: $n = 674$. Empty cells indicate paths removed due to non-significance in the saturated model. Higher illness scores for illness perceptions indicate more negative cognitive/affective representations of illness. GI = Gastrointestinal.
*** $p < .001$.
** $p < .01$.
* $p < .05$.

Table 5
Correlations between study variables at their respective timepoints, with Time 1 intercorrelations below the diagonal and Time 2 above.

	GI symptoms	Illness perceptions	Maladaptive coping	Pain catastrophising	Psychological distress	Quality of life
GI symptoms		0.52	0.31	0.31	0.54	−0.42
Illness perceptions	0.49		0.30	0.27	0.51	−0.50
Maladaptive coping	0.28	0.36		0.40	0.60	−0.42
Pain catastrophising	0.30	0.37	0.44		0.44	−0.36
Psychological distress	0.44	0.54	0.64	0.47		−0.64
Quality of life	−0.43	−0.56	−0.49	−0.41	−0.65	

Note. Time 1: $n = 1697$, Time 2: $n = 674$. All correlation significant at $p < .001$. Higher scores for illness perceptions indicate more negative cognitive/affective representations of illness. GI = Gastrointestinal.

[18,19]. Having used a within-subjects design and a larger sample, the present study provided the most robust test of this effect to date.

These findings may be due to pandemic-related lockdown measures that necessarily limit the number of meals consumed out of the home [60], likely facilitating greater personal control over the food preparation process, and limiting instances of coeliac-related social interference/exclusion (e.g., feeling left out of social invitations; see [61,62]). As noted by Falcomer et al. [18], this shift in dietary habits may mitigate anxieties regarding accidental gluten consumption. Further supporting this premise was the finding here that psychological distress reduced (albeit non-significantly), while illness perceptions (which included the assessment of perceived personal control of one's illness, and perceived efficacy of treatment in controlling one's illness) improved. These control beliefs are likely closely related to perceptions of dietary difficulty and beliefs in one's ability to engage in behaviours necessary for dietary adherence (i.e., self-regulatory efficacy), both of which have been identified as predictors of QoL in coeliac cohorts [21,63].

Hypothesis 2. Cross-lagged panel analysis.

Research using the CSM has largely been based on cross-sectional designs, limiting conclusions regarding causal relationships between model components and their dynamic interrelationships across time [32,33,36,64]. Based on the recommendations by Hagger and Orbell [33], a two-wave cross-lagged panel model was specified to explore the interrelationship between model variables identified in Möller et al. [34] across two timepoints. To our knowledge, the current study is the first to apply this cross-lagged panel approach to evaluate the CSM, concurrently examining disease symptoms, illness perceptions, coping, and well-being outcomes (i.e., psychological distress, QoL).

The second set of hypotheses were partially supported. Consistent with hypothesis 2a and previous cross-sectional findings in GI cohorts [34,65–70], greater GI symptoms at Time 1 predicted more negative illness perceptions at Time 2. Consistent with hypothesis 2b and previous cross-sectional GI studies, greater negative illness perceptions at Time 1 predicted greater maladaptive coping [65,66,71], psychological distress and reduced QoL at Time 2 [65,66,71,72]. Contrary to hypothesis 2b, illness perceptions were not predictive of pain catastrophising. Despite maladaptive coping [64–66,71] and pain catastrophising [34,73] being associated with psychological distress symptoms and poorer QoL across various GI illness groups, hypothesis 2c was unsupported with neither maladaptive coping nor pain catastrophising at Time 1 predicting worsened psychological distress or QoL at Time 2. Finally, hypothesis 2d, which was concerned with feedback effects stemming from appraisal of outcomes (i.e., psychological distress, QoL) was partially supported, with psychological distress and QoL demonstrating differential feedback effects on other model variables. Specifically, psychological distress at Time 1 predicted greater GI symptoms, maladaptive coping, and pain catastrophising at Time 2, but not illness perceptions. In contrast, reduced QoL at Time 1 predicted poorer illness perceptions at Time 2, but had no relationship to GI symptoms, maladaptive coping, or pain catastrophising.

The cross-lagged panel analysis presented several notable findings. Firstly, illness perceptions had substantial predictive utility, predicting outcomes across time for all variables except pain catastrophising. Researchers have previously identified illness perceptions as a potential intervention target in the coeliac context [23,74] and our findings provide further support for this. Secondly, the CSM literature indicates that illness perceptions may impact well-being outcomes directly (e.g., exacerbating psychological symptoms, poorer subjective assessment of well-being/QoL) and indirectly, via coping and illness management behaviours [32]. Our findings did not support the indirect path, finding maladaptive coping to be predictive of only itself over time, and to have the least stability between timepoints of all variables. Given the strong relationship between maladaptive coping strategies and depressive

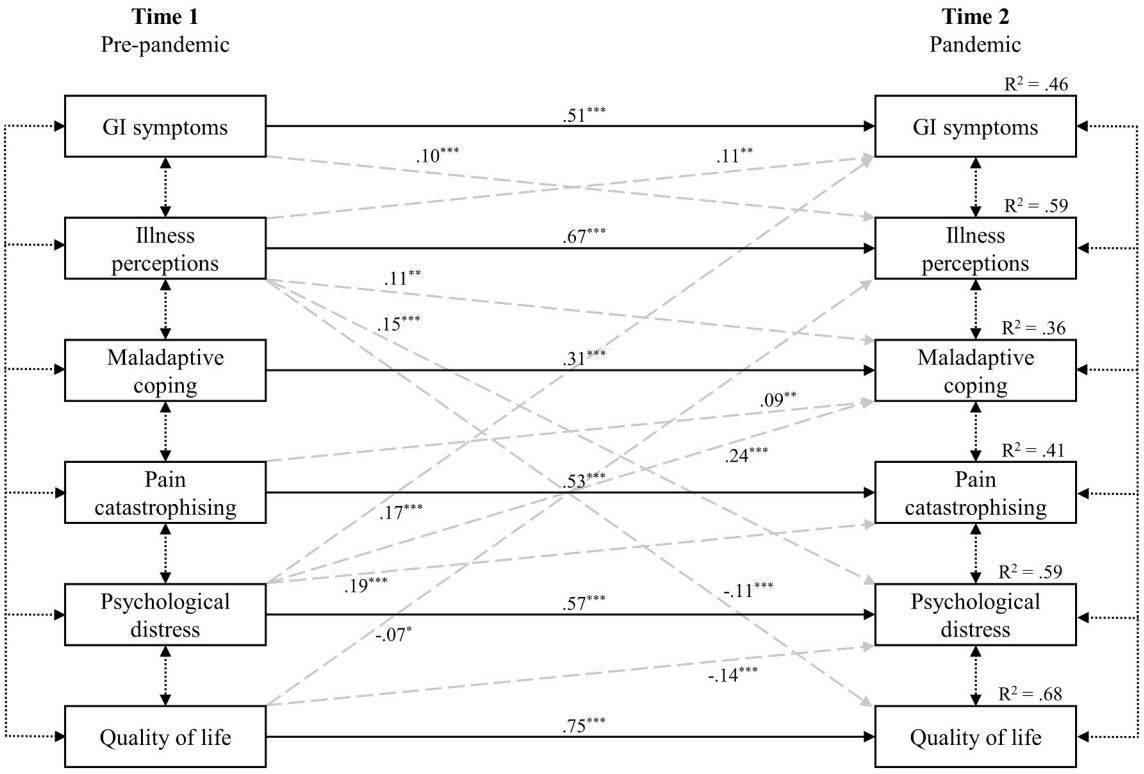

Fig. 2. Final cross-lagged panel model after removing non-significant paths.
Note. Time 1: $n = 1697$, Time 2: $n = 674$. All path coefficients are standardised. *** $p < .001$, ** $p < .01$, * $p < .05$. Stability (i.e., *autoregressive*) effects are shown with solid lines and path coefficients aligned directly down the middle of the figure. Grey dashed lines indicate cross-lagged (i.e., reciprocal) effects. For presentation clarity, intercorrelations among variable error terms at their respective timepoints are indicated with double-arrow short-dash black lines.

symptomatology [75], it is possible that the effects of such strategies on outcomes were largely accounted for by psychological distress symptoms in the present study.

Extending on current theory, the findings from this novel study provide crucial longitudinal evidence for the CSM. Overall, the findings reflected a dynamic interrelationship of model variables that was broadly consistent with the foundational principles of the CSM. Specifically, the time-lagged effects reflected a process model wherein illness perceptions play a potential mediating role in the relationship between GI symptoms and well-being outcomes (i.e., psychological distress, QoL). Moreover, QoL was reciprocally related to illness perceptions across time, consistent with the appraisal and feedback process inherent to the CSM [30].

4.1. Limitations and future research

This study had several strengths, including the large repeated measures sample, use of a cross-lagged panel model methodology, and assessment of several well-being indices (i.e., GI symptoms, psychological distress, QoL), however, there are several limitations. Unlike other studies which compared pre/post COVID QoL in coeliac groups [11,17,18], the present study used a within-subjects design, allowing for a more robust test of this effect. It is nonetheless difficult to make meaningful comparisons between studies given the substantial variation in COVID-19 case numbers, infection rates, duration and severity of restrictions/lockdowns, and socioeconomic conditions across both time and geographical regions during this period. The study sample was also comprised largely of participants that had previously self-selected to take part in coeliac studies, limiting the generalisability of our findings. Because there were only two timepoints, sequential mediation tests could not be conducted. Furthermore, as noted by Hagger et al. [33], the cross-lagged approach used in the current study is not sensitive to rapid changes in model variables over time. Accordingly, methodologies such as ecological momentary assessment [76], which rely on regular real-time assessment of experiences and behaviours in participants' natural environment, may be more instructive [77][33].

It is also important to note that this study examined illness perceptions and coping as singular, composite scales derived from factor analysis, rather than their constituent dimensions/coping strategies. While this validated these measures within this sample and is consistent with recommendations by the scale developers [41,42] and past research [65–67,71,78], future research may benefit from exploring these variable dimensions independently, preferably across three or more timepoints. This type of analysis would allow for tests of sequential mediation effects while identifying specific illness beliefs associated with illness management strategies and well-being outcomes. Finally, while this study examined illness perceptions as predicted by GI symptoms, it should be noted that those living with coeliac disease can be asymptomatic. These individuals are nonetheless vulnerable to potential long-term complications associated with ongoing gluten-exposure (for review, see [79]) and it may therefore be instructive for future investigations to examine non-symptomatic predictors of threatening illness perceptions, such as concerns regarding hidden or inconspicuous gluten exposures.

4.2. Clinical implications

Whilst the literature has emphasised the value of medical and dietary follow-up of those living with coeliac disease [80], this work highlights a key role for the psychologist in facilitating post-diagnosis well-being. Consistent with past recommendations [20], psychological assessment and follow-up care may be particularly beneficial in this cohort, especially for those experiencing psychological distress symptoms and/or reduced QoL. Importantly, this study demonstrated that illness

perceptions were the best predictor of well-being outcomes (i.e., psychological distress and QoL) across time, and that illness perceptions were reciprocally related to QoL. These findings underline the value of illness perceptions as a potential modifiable target for intervention. At the clinical level, reflecting past recommendations in CSM-based GI cohorts [64,65,68], improvement in psychological distress and QoL are likely to occur through the active targeting of maladaptive illness beliefs (e.g., limited personal control). Psychological strategies such as cognitive behavioural therapy or acceptance and commitment therapy may therefore be helpful to promote personal control and facilitate non-avoidance-based coping strategies.

4.3. Conclusion

Extending on the findings of Möller et al. [34], the present study assessed pandemic-related changes in several key indices of well-being in a large adult coeliac cohort and is the first to our knowledge to test the CSM using a cross-lagged panel model methodology.

The findings suggest that the COVID-19 pandemic resulted in improvement across multiple psychosocial factors and well-being indices, including GI symptoms, negative illness perceptions, maladaptive coping, and QoL. Building on the large body of predominantly cross-sectional CSM studies [32,33], this study identified several time-lagged relationships supportive of the CSM as a theoretical foundation for illness adjustment in coeliac disease. Specifically, the time-lagged relationships were consistent with the purported mediating role of illness perceptions in the symptom-to-outcome relationship described in the CSM. Furthermore, as evidenced by the reciprocal relationship between illness perceptions and QoL, the results were consistent with the CSM's appraisal and feedback mechanisms. The present findings provide crucial longitudinal evidence for the CSM, indicating that illness perceptions likely play an important role in illness adjustment in coeliac disease. Future studies may benefit from examining these relationships at three or more timepoints and examining illness perception dimensions independently.

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Ethical approval

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

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