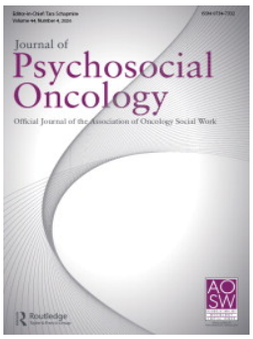

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The mediating effect of emotion regulation on the relationship between childhood trauma and physical and cognitive symptoms in cancer patients and survivors

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ABSTRACT

Background: In addition to psychological wellbeing, adverse childhood experiences (ACEs) can pose a significant threat to physical health as individuals age. These risks may be particularly burdensome for cancer survivors.

Aims: This study assessed relationships between ACEs and physical symptoms associated with cancer survivorship in a mixed cancer sample. We used multiple mediation to test if different emotion regulation mediated the relationship between ACEs and physical health. Moderated mediation tested whether these mediation effects differed between those who were currently undergoing or had finished cancer treatment.

Methods: Cancer patients and survivors ($N = 244$) completed the Adverse Childhood Experiences Scale (ACES) to assess histories of traumatic experiences before age 18. Patients and survivors also completed the Short Form-36 to measure their self-reported health, physical functioning, pain, and fatigue and the PROMIS Applied Cognition subscale to assess self-reported cognitive difficulties. To index emotion regulation, they completed the Difficulties with Emotion Regulation Scale, Penn State Worry Questionnaire, Rumination-Reflection Questionnaire, and the Mindful Attention and Awareness Scale.

Results: Worry, rumination, mindfulness, and difficulties with emotion regulation mediated the association between ACEs and pain, fatigue, self-rated health, physical functioning, and cognitive problems. Moderated mediation models revealed that with difficulties with emotion regulation as the mediating variable, models were significant only for participants who were currently undergoing cancer treatment.

Conclusions: Maladaptive and adaptive emotion regulation strategies provide a pathway through which ACEs can alter physical health during cancer treatment and survivorship. These findings emphasize the need for emotion regulation skills training to ameliorate the physical impact of ACEs as individuals navigate cancer.

KEYWORDS
ACEs; cancer; emotion regulation; trauma

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Background

Adverse childhood experiences (ACEs) include direct impacts to children and adolescents (e.g. abuse and neglect) and indirect impacts that occur within their living environments (e.g. parental conflict, substance abuse, or mental illness within the household).[1] In addition to the clear impacts on development and functioning in childhood and adolescence, ACEs have a lasting impact on people's psychological health as they age, including being associated with increased depressive symptoms, more suicide attempts, heavier substance use, and lower perceived well-being.[2,3] Adults who experienced adverse childhood events also report a higher number of daily stressors and negative affect than people without such histories.[4] In addition to the sustained psychological impact of early traumatic experiences, the biological embedding hypothesis highlights how childhood trauma can promote long-term physiological changes. This theory suggests that the physiological changes experienced due to early childhood trauma puts people at an increased risk for poor physical health throughout adulthood.[5,6] Indeed, childhood trauma is associated with many long-term health problems throughout adulthood, including cardiopulmonary symptoms, chronic pain, obesity, digestive diseases, and lower self-rated health.[7–9] Further, ACEs can impact cognitive function throughout adulthood. ACEs are prospectively linked to difficulties in self-reported cognitive function as individuals age.[10] Individuals who report a higher number of ACEs also perform worse on behavioral tasks measuring executive function.[11] Taken together, past research highlights a notable cognitive, physical, and psychological toll on individuals which can persist well into adulthood.

While the health threats associated with ACEs are clear throughout development in physically healthy people, these risks may be amplified among cancer patients and survivors. An estimated 40-95% of cancer survivors report at least one adverse childhood experience.[12] ACEs are consistently linked to increased risk for cancer in adults.[13,14] Among cancer survivors, adverse childhood experiences are also associated with lower quality of life,[15] and increases in the number of ACEs experienced corresponds to incrementally lower health-related quality of life among cancer survivors.[16] Cancer patients and survivors experience high rates of pain and fatigue along with poor self-reported health and physical functioning.[17–19] Although ACEs show a clear connection to increased depression, anxiety, and distress in cancer patients and survivors,[12,20] less is known about how ACEs may amplify physical symptoms and cognitive impairments in this population. Higher reporting of ACEs is associated with increased self-reported cognitive issues among breast cancer patients and survivors.[21,22] Across two studies, cancer patients who reported more ACEs were more likely to experience worse fatigue[12] and increased inflammation.[23] Independent of a cancer diagnosis,

people who report a higher number of ACEs are also more likely to experience pain and pain-related disability.[24] However, there is no comprehensive understanding of the impact of ACEs on physical functioning and overall health throughout cancer treatment and survivorship.

Emotion regulation, or the ability to intervene on one's emotional experience, is an important consideration among cancer patients and survivors.[25] Notably, the ability to adaptively regulate emotions can play a role in better adjustment following cancer treatment during survivorship.[26] For example, mindfulness, or the ability to view things from a detached, non-judgmental, and present-moment perspective, benefits survivors psychological and physical health.[27] Greater mindfulness corresponds to better physical health among adults with and without chronic diseases.[28–30] Among breast cancer patients and survivors, trait mindfulness is negatively correlated with pain sensitivity and fatigue.[31] In contrast, worry and rumination, or thinking repeatedly about things that may or may not happen in the future or have happened in the past, are considered maladaptive emotion regulation strategies.[32] Breast cancer survivors reporting higher worry and rumination also have poorer self-rated health, as well as greater self-reported pain and fatigue.[33,34] Emotion regulation also has broad implications for cognitive function both cross-sectionally and prospectively.[35] The biobehavioral model of negative emotionality highlights emotion regulation as a potential mediator between contextual stressors such as ACEs and physical health issues.[36] Within this framework, the use of maladaptive emotion regulation strategies can enhance psychological distress, ultimately altering biological dysfunction among distressed individuals.[36] This biological dysfunction resulting from emotion regulation difficulties then amplifies physical symptoms that commonly occur throughout cancer treatment and survivorship, ultimately leading to long-term physical difficulties that reduce quality of life and overall well-being.[36] Emotion regulation may therefore serve as one factor that affects the association between ACEs and physical symptoms.

Previous research supports this notion, as emotion regulation has been found to mediate the relationship between ACEs and depressive symptoms, trauma symptoms, and self-rated health among physically healthy adults diagnosed with post-traumatic stress disorder.[37] Likewise, in a related study, emotion regulation difficulties mediated the association between ACEs and psychological distress among adults seeking psychological treatment.[38] Importantly, specific emotional regulation skills may be considered more adaptive (e.g. mindfulness, cognitive reappraisal) than others (e.g. worry, rumination) given that they tend to be associated with more positive psychosocial outcomes.[39,40] As a result, the use of adaptive versus maladaptive emotion regulation skills may differentially mediate these associations.

Furthermore, these results have not been replicated among people with chronic illnesses, including cancer. Thus, examining whether emotion regulation serves as a pathway through which ACEs relates to physical symptoms associated with treatment and survivorship may prove useful in identifying how to intervene on psychological experiences to improve physical health for cancer patients and survivors alike.

Current study

This study examined the association between ACEs and physical symptoms in a mixed sample of cancer patients and survivors. Given that prior research has suggested that ACEs amplify physical symptoms in adulthood,[7] our first aim was to expand this research to explore if childhood trauma was associated with increased physical symptoms and cognitive problems among adult cancer patients and survivors. Consistent with prior research,[37,38] our second aim was to use multiple mediation to assess the indirect effects of different aspects of emotion regulation in the association between ACEs and physical and cognitive symptoms. We hypothesized that worry, rumination, mindfulness, and self-reported difficulties with emotion regulation would mediate the relationship between ACEs and pain, fatigue, self-reported health, physical functioning, and cognitive problems in cancer patients and survivors. The National Cancer Institute classifies someone as a cancer survivor from the time they are diagnosed with cancer until the end of their life. However, there may be notable psychological and physical differences between those currently undergoing treatment compared to those who had completed their primary cancer treatments. Accordingly, the final aim of this study was to test moderated mediation to examine if treatment status moderated the indirect effects of emotion regulation on the relationship between ACEs and physical health. This aim was exploratory in nature, and we were interested in examining if the trend of relationships among ACEs, emotion regulation, and physical symptoms differed between cancer survivors and individuals actively receiving cancer treatment. Although we expected these mediational relationships to exist within both groups, given the acute physical demands of cancer treatment, we expected that these associations would be stronger among participants currently in treatment compared to those in survivorship.

Methods

Participants and procedures

Participants ($N = 244$) were adults who had a current or past diagnosis of cancer. Inclusion criteria included being at least 18 years old, being able to read and understand English, and to have been diagnosed with cancer

and be willing to provide information regarding their diagnosis, staging, and treatment. In terms of those in the survivorship period, individuals had to be within 20 years of their primary treatment completion to be eligible. Being in survivorship was defined as completing primary cancer treatment (i.e. surgery, chemotherapy, and/or radiation). Survivors were permitted to be on long-term hormonal and/or endocrine therapies.

All participants were recruited *via* Prolific, an online data collection platform that allows potential participants to complete prescreening surveys and sign up for surveys that they meet eligibility criteria for. Participants who signed up for the study on Prolific completed self-report questionnaires online after being provided with informed consent documents. All participants provided written informed consent. Questionnaire completion took approximately 30-45 min and all individuals completing the survey received $12 for their participation. Although Prolific includes a database of potential participants from across the world, only participants residing in the United States, Canada, or the United Kingdom were eligible to participate in this study. All individuals who reported being diagnosed with cancer on the Prolific prescreening, were at least 18 years old, and lived in one of the three above-mentioned countries were eligible to participate and therefore received notification of the study being posted on the platform. Participants then self-selected into the study until the specified sample size was achieved. This study was approved by the University of Southern Mississippi Institutional Review Board (protocol #23-0599).

Adverse childhood experiences

The Adverse Childhood Experiences Scale is a 10-item self-report measure developed as part of the original ACE Study.[1] The items assess exposure to potentially traumatic events that an individual may have experienced from birth to 18 years old. Participants select which, if any, of the events happened to them prior to age 18, with total scores derived from the total number of items checked off. This results in scores ranging from 0 to 10, with higher scores indicating that an individual experienced a higher number of these events in their childhood/adolescence. The Adverse Childhood Experiences Scale exhibited good reliability and validity in prior research[1] and is widely used to assess adverse early childhood experiences.

Mediator variables

Difficulties with Emotion Regulation Scale

The Difficulties with Emotion Regulation Scale (DERS) is comprised of 36 items that assess multiple aspects of emotion regulation difficulties[41] with higher scores indicating greater degrees of difficulty regulating

emotions. The total score was used to assess trait-level emotion regulation difficulties. In the current study, internal consistency for the DERS was excellent (Cronbach's α = .96).

Rumination-Reflection Questionnaire (rumination subscale)

The Rumination-Reflection Questionnaire (RRQ) is a self-report measure that contains 12 items to assess rumination.[42] The respondent is asked to rate items such as, "I never ruminate or dwell on myself for very long" on a five-point scale with 1 = strongly disagree and 5 = strongly agree, with higher scores indicating increased likelihood of ruminating. The RRQ demonstrated excellent internal consistency in this study (Cronbach's α = .95).

Penn State Worry Questionnaire

The 16-item Penn State Worry Questionnaire (PSWQ) measures pathological worry in adults.[43] The respondent is asked to rate items about worrying, such as "My worries overwhelm me" on a five-point scale with 1 = not at all typical and 5 = very typical of me with higher scores indicating greater difficulty with trait-level worry. In the current study, the PSWQ demonstrated excellent internal consistency (Cronbach's α = .96).

Mindful Attention and Awareness Scale

The Mindful Attention and Awareness Scale (MAAS) is a 15-item measure that assesses characteristics of mindfulness.[44] The respondent is asked to rate items such as, "I could be experiencing some emotion and not be conscious of it until some time later" on a 6-point scale with 1 = almost always and 6 = almost never. Higher scores indicate higher trait-levels of mindfulness. In the current study, the MASS demonstrated excellent internal consistency (Cronbach's α = .92).

Outcomes

Promis Applied Cognition Scale

The Promis Applied Cognition Scale is a self-report measure that assessed participants' cognitive functioning in the past week. Responses are on a 5-point Likert scale ranging from never to very often (5 = never, 4 = rarely (once), 3 = sometimes (two or three times), 2 = often (about once a day), 1 = very often (several times a day)). The range of possible scores is 5 to 40. The internal consistency in this study was excellent (Cronbach's α = .96).

Short Form 36 pain, energy/fatigue, physical functioning, and general health subscales

The Short Form 36 (SF-36) is a 36-item self-report measure that assesses general health, well-being, and quality of life in the past 4 wk.[45] Participants

in this study completed the pain, energy/fatigue, physical functioning, and general health subscales. Higher scores on these scales indicate better health, well-being, and quality of life. The internal consistency for the pain, energy/fatigue, general health, and physical functioning subscales ranged from good to excellent (pain α = .88; energy/fatigue α = .87; general health α = .88; physical functioning α = .92).

Data analysis plan

All analyses were conducted in SPSS version 29. Bivariate correlations between study variables examined associations among ACEs, emotion regulation, and physical symptoms. Independent samples t-tests assessed differences in emotion regulation, physical health, and cognitive variables between people currently in treatment versus those in survivorship. The Hayes PROCESS Macro, Model 4[46] tested simple indirect effects of ACEs on physical and cognitive symptoms through emotion regulation factors among participants. Consistent with modern approaches to testing mediation models,[47–49] we tested the indirect effect of emotion regulation on the association between ACEs and physical/cognitive health regardless of significant a and b paths within the models.

We then examined whether treatment status (i.e. if a participant was actively in cancer treatment or had finished treatment) moderated these indirect effects. We used PROCESS Model 59 to examine which, if any, paths of the mediation model were moderated by treatment status (0 = no longer receiving cancer treatment, 1 = currently receiving cancer treatment). Conditional (i.e. moderating) and indirect effects were tested with 95% bias-corrected confidence intervals, and the confidence intervals for the indirect effects were also tested with 10,000 bootstrapped samples. Moderated mediation was confirmed if the index of moderated mediation did not include zero. Continuous variables were mean-centered prior to the moderation analyses to improve interpretability and interaction terms were computed as the product of the mean-centered variables. Results from Model 59 were used to determine which moderated mediation models would be most appropriate. Model 8 was used for final moderated mediation models that showed significant pathways, as significant moderating effects were found across variables for the a path, but not the b or c paths.

Separate models were run for each mediating variable and outcome. A two-sided significance level of α = .05 was used for all tests. Due to risks of Type I error, the Benjamini-Hochberg method was used to correct for family-wise comparisons to correct for multiple comparisons. All reported p-values reflect the application of this correction.

Covariates were chosen based on their theoretical and empirical relationships with emotion regulation, physical health, and cancer.[50–53] All models controlled for age, race, sex, income, medical comorbidities, cancer stage, and cancer type.

Results

Participant characteristics

Participant characteristics are provided in Table 1. A total of 25.10% of participants were currently undergoing cancer treatment. While the largest percentage of participants were diagnosed with breast cancer (25.82%), cancer types were varied. For example, 15.15% of participants were diagnosed with a gynecological cancer (i.e. cervical, uterine, ovarian, endometrial), 12.30% with melanoma, 9.02% with prostate, 8.20% with leukemia, 6.56% with thyroid, 3.69% with testicular, 2.87% with colorectal, and 16.39% with other varied cancer types (i.e. lung, brain, bone, etc.).

Most participants were White (82.30%), heterosexual (81.56%), and married (55.33%). Their cancer stage was relatively varied across the sample, with most of the participants reporting being diagnosed with either Stage I or II cancers (66.94%). A total of 45 participants (26.33%) denied ever experiencing an adverse childhood event. In contrast, 179 participants (73.67%) reported experiencing at least one adverse childhood event (range = 1-10, $M = 2.60$, $SD = 2.38$). There were no differences in the number of ACEs reported between patients and survivors X^2 (10, $N = 243$) = 4.77, p = .91.

Independent samples t-tests revealed no significant differences between patients and survivors in worry (M_{diff} = −1.47, $t = -0.63$, p = .53), rumination (M_{diff} = −2.01, $t = -1.16$, p = .25), or mindfulness (M_{diff} = .17, $t = 1.22$, p = .22). In contrast, participants currently undergoing cancer treatment reported significantly more difficulties with emotion regulation compared to those in survivorship (M_{diff} = −8.80, $t = -2.32$, p = .02). In terms of physical health and cognition, patients reported significantly worse physical functioning (M_{diff} = 10.43, $t = 2.81$, $p < .01$), pain (M_{diff} = 8.11, $t = 2.34$, p = .02), and cognitive problems (M_{diff} = −2.78, $t = -2.30$, p = .02) compared to survivors. There were no differences between patient and survivor self-rated health (M_{diff} = 4.10, $t = 1.05$, p = .30) or fatigue (M_{diff} = 4.41, $t = 1.23$, p = .22).

Associations between ACES, emotion regulation, and physical symptoms

Correlations among study variables are presented in Table 2. Consistent with study hypotheses, a higher number of ACEs experienced was related to greater difficulties with emotion regulation, worry, and rumination, as well as lower trait mindfulness, among the patients and survivors in this sample. ACEs were also significantly associated with all physical and

Table 1. Participant characteristics.

	Mean (*SD*) or N (%)	N (%)
Age	53.27 (13.83)	
% Female		147 (63.93%)
Race		
White		200 (82.30%)
Black/African American		28 (11.48%)
Mixed Race		6 (2.46%)
Asian American/Asian		6 (2.46%)
% Heterosexual		199 (81.56%)
% employed		167 (68.44%)
Household Income	$72,445 ($62,250)	
Relationship status		
Single		73 (29.94%)
Married		135 (55.33%)
% with health insurance		157 (64.34%)
Cancer type		
Breast		63 (25.82%)
Colorectal		7 (2.87%)
Gynecological		37 (15.15%)
Melanoma		30 (12.30%)
Leukemia		20 (8.20%)
Prostate		22 (9.02%)
Thyroid		16 (6.56%)
Testicular		9 (3.69%)
Other cancer types		40 (16.39%)
Current Treatment		58 (25.10%)
Years since diagnosis	9.33 (8.46)	
Chemotherapy treatment		111 (45.49%)
Radiation treatment		105 (43.21%)
Cancer stage		
Stage I		94 (38.84%)
Stage II		68 (28.10%)
Stage III		43 (17.77%)
Stage IV		13 (5.37%)
DERS	76.10 (25.87)	
RRQ	39.23 (11.58)	
PSWQ	49.08 (15.84)	
MAAS	64.03 (14.29)	
SF-Pain	71.47 (23.56)	
SF-Energy	45.68 (24.20)	
SF-General Health	50.67 (26.33)	
SF-Physical Functioning	72.13 (25.65)	
PROMIS Applied Cognition	17.26 (8.18)	

Note. Other cancer types include bladder cancer, brain cancer, appendix cancer, lung cancer, bowel cancer, and head/neck cancers. *DERS* = Difficulties with Emotion Regulation Scale; *RRQ* = Rumination and Reflection Questionnaire, Rumination subscale; *PSWQ* = Penn State Worry Questionnaire; *MAAS* = Mindful Attention Awareness Scale; *SF–Pain* = Short Form 36 Pain; *SF–Energy* = Short Form 36 Energy/Fatigue; *SF–General Health* = Short Form 36 General Health; *SF–Physical Functioning* = Short Form 36 Physical Functioning; *PROMIS Applied Cognition* = PROMIS Applied Cognition subscale.

cognitive symptoms assessed in the expected direction: higher reported numbers of ACEs corresponded to worse self-rated health, physical functioning, pain, fatigue, and cognitive problems.

Simple mediation models

Within the mediation models, as expected, ACEs were associated with greater worry ($b = 1.02$, $SE = .42$, $p = .02$), as well as higher rumination ($b = .81$, $SE = .30$, $p = .01$), more difficulties with emotion regulation

Table 2. Correlations between and among study variables.

	1	2	3	4	5	6	7	8	9	10	11
1. ACEs	–										
2. DERS	.20**	–									
3. RRQ	.19**	.61**	–								
4. PSWQ	.18**	.63**	.79**	–							
5. MAAS	−0.16*	−0.62**	−0.53**	−0.48**	–						
6. SF-Pain	−0.26**	−0.32**	−0.28**	−0.28**	.23**	–					
7. SF-Energy	−0.24**	−0.48**	−0.52**	−0.53**	.49**	.52**	–				
8. SF-Gen Health	−0.14*	−0.36**	−0.36**	−0.36**	.33**	.47**	.65**	–			
9. SF-Phys Func	−0.19**	−0.24**	−0.23**	−0.21**	.12	.67**	.50**	.54**	–		
10. PROMIS Cog	.29**	.60**	.49**	.48**	−0.59**	−0.44**	−0.54**	−0.42**	−0.31**	–	
11. Age	−0.16*	−0.33**	−0.23**	−0.28**	.33**	.04	.24**	.06	−0.15*	−0.32**	–

Note. *ACEs* = Adverse Childhood Experiences Scale; *DERS* = Difficulties with Emotion Regulation Scale; *RRQ* = Rumination and Reflection Scale, Rumination subscale; *PSWQ* = Penn State Worry Questionnaire; *MAAS* = Mindful Attention Awareness Scale; *SF–Pain* = Short Form 36 Pain subscale; *SF–Energy* = Short Form 36 Energy/Fatigue subscale; *SF–General Health* = Short Form 36 General Health subscale; *SF–Physical Functioning* = Short Form 36 Physical Functioning subscale; *PROMIS Cog* = PROMIS Applied Cognition subscale.
$p < .05$. $p < .01$. $p < .001$.

($b = 1.75$, $SE = .65$, $p = .01$), and less mindfulness ($b = -0.09$, $SE = .04$, $p = .04$). More ACEs were also associated with worse physical functioning ($b = -1.93$, $SE = .62$, $p < .01$), more pain ($b = -2.04$, $SE = .62$, $p < .01$), more fatigue ($b = -1.30$, $SE = .52$, $p = .03$), and a greater number of cognitive problems ($b = .62$, $SE = .21$, $p < .01$). In contrast, ACEs were not directly related to self-rated health ($b = -0.74$, $SE = .71$, $p = .28$).

Difficulty with emotion regulation was also directly associated with worse physical functioning ($b = -1.95$, $SE = .65$, $p < .01$), increased pain ($b = -2.01$, $SE = .60$, $p < .01$), more fatigue ($b = -1.26$, $SE = .58$, $p = .03$), and greater cognitive problems ($b = .59$, $SE = .18$, $p < .01$). In contrast, there was no direct relationship between emotion regulation difficulties and self-rated health ($b = -0.74$, $SE = .71$, $p = .28$). Similarly, rumination was associated with worse physical functioning ($b = -1.97$, $SE = .64$, $p < .01$), more pain ($b = -2.05$, $SE = .62$, $p < .01$), more fatigue ($b = -1.24$, $SE = .58$, $p = .03$), and greater cognitive problems ($b = .62$, $SE = .17$, $p < .01$). There was no direct relationship between rumination and self-rated health ($b = -0.75$, $SE = .68$, $p = .27$). Worry was also associated with worse physical function ($b = -2.09$, $SE = .66$, $p < .01$), increased pain ($b = -2.10$, $SE = .64$, $p < .01$), more fatigue ($b = -1.24$, $SE = .63$, $p = .03$), and a higher number of self-reported cognitive problems ($b = .68$, $SE = .20$, $p < .001$), but not with self-rated health ($b = -0.82$, $SE = .67$, $p = .23$). Lastly, being more mindful was associated with better physical functioning ($b = -2.16$, $SE = .64$, $p < .01$), less pain ($b = -2.17$, $SE = .63$, $p < .001$), lower fatigue ($b = -1.41$, $SE = .59$, $p = .03$), and fewer self-reported cognitive problems ($b = .62$, $SE = .17$, $p < .001$). However, there was no relationship with self-rated health ($b = -0.91$, $SE = 718$, $p = .21$).

Consistent with study hypotheses, there was an indirect effect of ACEs on health outcomes through each emotion regulation variable in the expected direction for self-rated health, physical functioning, pain, fatigue, and cognitive problems; each indirect effect is presented in Table 3. The associations between ACEs and all outcome measures, however, were significant with emotion regulation variables across the models; thus, emotion regulation only partially explained associations between ACEs and the physical and cognitive symptoms associated with cancer treatment and survivorship.

Moderated mediation models

Moderated Mediation models tested whether the mediation model effects differed based on whether someone was currently in or had finished treatment. Full model results are presented in Table 4. The a path (i.e. the association between ACEs and emotion regulation) was moderated by treatment status, and thus results from PROCESS Model 8 are provided.

Table 3. Mediation models.

	Indirect effects		
	b	***SE***	**95% CI**
ACEs (X_1)	–	–	–
Emot Reg Difficulty (M_1)			
Pain (Y_1)	−0.34	.20	−0.82, −0.02
Fatigue (Y_2)	−0.64	.32	−1.34, −0.04
Physical Functioning (Y_3)	−0.38	.21	−0.86, −0.03
General Health (Y_4)	−0.52	.27	−1.11, −0.03
Cognitive Problems (Y_5)	.25	.12	.03, .51
ACEs (X_1)	–	–	–
Worry (M_2)			
Pain (Y_1)	−0.27	.18	−0.70, −0.01
Fatigue (Y_2)	−0.62	.35	−1.35, −0.06
Physical Functioning (Y_3)	−0.31	.20	−0.76, −0.01
General Health (Y_4)	−0.50	.29	−1.13, .01
Cognitive Problems (Y_5)	.16	.09	.01, .35
ACEs (X_1)	–	–	–
Rumination (M_3)			
Pain (Y_1)	−0.26	.16	−0.63, −0.01
Fatigue (Y_2)	−0.64	.33	−1.34, −0.07
Physical Functioning (Y_3)	−0.33	.19	−0.79, −0.03
General Health (Y_4)	−0.51	.28	−1.15, −0.05
Cognitive Problems (Y_5)	.18	.09	.02, .36
ACEs (X_1)	–	–	–
Mindfulness (M_4)			
Pain (Y_1)	−0.19	.15	−0.55, −0.03
Fatigue (Y_2)	−0.54	.33	−1.19, −0.06
Physical Functioning (Y_3)	−0.17	.14	−0.54, −0.02
General Health (Y_4)	−0.43	.27	−1.02, −0.05
Cognitive Problems (Y_5)	.21	.12	.02, .46

Note. *Emot Reg Difficulty* = Difficulties with emotion regulation, as measured by the Difficulties with Emotion Regulation Scale; *ACEs* = Adverse Childhood Experiences Scale; *DERS* = Difficulties with Emotion Regulation Scale; *RRQ* = Rumination and Reflection Scale, Rumination subscale; *PSWQ* = Penn State Worry Questionnaire; *MAAS* = Mindful Attention Awareness Scale; *SF–Pain* = Short Form 36 Pain subscale; *SF–Energy* = Short Form 36 Energy/Fatigue subscale; *SF–General Health* = Short Form 36 General Health subscale; *SF–Physical Functioning* = Short Form 36 Physical Functioning subscale; *PROMIS Applied Cognition* = PROMIS Applied Cognition subscale.

Specifically, difficulties with emotion regulation mediated the association between ACEs and self-rated health (conditional effect = −1.96, *SE* = .59, 95% CI = [−3.25, −0.94]), physical functioning (conditional effect = −1.27, *SE* = .43, 95% CI = [−2.22, −0.54]), pain (conditional effect = −1.17, *SE* = .44, 95% CI = [−2.15, −0.40]), fatigue (conditional effect = −2.20, *SE* = .65, 95% CI = [−3.55, −1.02]), and cognitive problems (conditional effect = .84., *SE* = .21, 95% CI = [.47, 1.29]) among those who were currently in treatment but not those who were in survivorship. Models using PROCESS Model 59 showed no conditional indirect effects for the PSWQ, RRQ, or MAAS as mediating variables. Therefore, Model 8 was not run with these predictors.

Discussion

This study used multiple mediation models to test if emotion regulation had indirect effects on the association between ACEs and physical and cognitive symptoms among cancer patients and survivors. Consistent with

Table 4. Moderated mediation results.

	Moderated mediation			Current treatment			Survivorship		
	b	*SE*	95% CI	*b*	*SE*	95% CI	*b*	*SE*	95% CI
Emot Reg Difficulty									
Genl Health	**−1.66**	**.65**	**−3.07, −0.53**	**−1.96**	**.59**	**−3.25, −0.94**	−0.30	.31	−0.94, .32
Phys Function	**−1.07**	**.44**	**−2.01, −0.32**	**−1.27**	**.43**	**−2.22, −0.54**	−0.19	.21	−0.67, .18
Fatigue	**−1.86**	**.71**	**−3.34, −0.55**	**−2.20**	**.65**	**−3.55, −1.02**	−0.34	.35	−1.04, .33
Pain	**−0.99**	**.44**	**−1.96, −0.25**	**−1.17**	**.44**	**−2.15, −0.40**	−0.18	.20	−0.66, .17
Cognition	**.72**	**.23**	**.29, 1.19**	**.84**	**.21**	**.47, 1.29**	.13	.13	−0.12, .40
Worry									
Gen Health	−0.44	.65	−1.91, .70	−0.92	.61	−2.35, .07	−0.48	.32	−1.16, .11
Phys Function	−0.25	.40	−1.18, .41	−0.53	.39	−1.49, .03	.28	.20	−0.74, .06
Fatigue	−0.57	.82	−2.31, .87	−1.20	.76	−2.88, .09	−0.63	.39	−1.45, .11
Pain	−0.27	.41	−1.21, .43	−0.57	.40	−1.52, .05	−0.30	.22	−0.79, .07
Cognition	.16	.22	−0.21, .64	.32	.20	−0.01, .79	.16	.10	−0.03, .37
Rumination									
Gen Health	−0.32	.54	−1.49, .66	**−0.91**	**.49**	**−2.03, −0.09**	**−0.59**	**.31**	**−1.26, −0.03**
Phys Function	−0.18	.32	−0.88, .45	**−0.53**	**.31**	**−1.24, −0.04**	−0.34	.22	−0.84, .002
Fatigue	−0.39	.68	−1.83, .84	**−1.12**	**.60**	**−2.44, −0.07**	**−0.73**	**.37**	**−1.50, −0.05**
Pain	−0.18	.32	−0.87, .40	**−0.50**	**.30**	**−1.23, −0.04**	**−0.33**	**.20**	**−0.80, −0.02**
Cognition	.12	.19	−0.22, .54	**.32**	**.17**	**.04, .72**	**.20**	**.10**	**.01, .41**
Mindfulness									
Gen Health	−0.20	.69	−1.71, 1.002	−0.67	.67	−2.21, .44	−0.47	.29	−1.09, .05
Phys Function	−0.07	.29	−0.77, .42	−0.25	.30	−1.02, .15	−0.18	.14	−0.51, .02
Fatigue	−0.25	.87	−2.13, 1.32	−0.84	.81	−2.64, .58	−0.59	.35	−1.33, .05
Pain	−0.10	.35	−0.92, .50	−0.32	.35	−1.16, .19	−0.22	.16	−0.59, .03
Cognition	.12	.31	−0.44, .78	.33	.30	−0.18, .98	.22	.13	−0.02, .48

Note. *Emot Reg Difficulty* = Difficulties with emotion regulation, as measured by the Difficulties with Emotion Regulation Scale; *ACEs* = Adverse Childhood Experiences Scale; *DERS* = Difficulties with Emotion Regulation Scale; *RRQ* = Rumination and Reflection Scale, Rumination subscale; *PSWQ* = Penn State Worry Questionnaire; *MAAS* = Mindful Attention Awareness Scale; *SF–Pain* = Short Form 36 Pain subscale; *SF–Energy* = Short Form 36 Energy/Fatigue subscale; *SF–Gen Health* = Short Form 36 General Health subscale; *SF–Physical Functioning* = Short Form 36 Physical Functioning subscale; *PROMIS Applied Cognition* = PROMIS Applied Cognition subscale. Bolded effects are significant. PROCESS Model 8 was models using the DERS. PROCESS Model 59 was used for all other models.

the biobehavioral model of negative emotionality,[36] we hypothesized that emotion regulation skills would serve as a pathway through which contextual stress, such as childhood trauma, would correspond to physical and cognitive symptoms in adulthood among cancer patients and survivors. We specifically assessed adaptive (e.g. mindfulness) and maladaptive (e.g. worry, rumination) skills use as well as emotion regulation difficulties broadly. To our knowledge, this is among the first studies to examine the effects of ACEs on physical and cognitive health in a mixed sample of cancer patients and survivors, a group with particular long-term health risks. As expected, there were significant associations among ACEs and all health symptoms and emotion regulation variables, with the exception of associations between these variables and self-rated health. Overall, these associations highlight that adverse childhood experiences are associated with psychological, physical, and cognitive health among cancer patients and survivors.

Consistent with study hypotheses, each emotion regulation variable mediated the associations between ACEs and pain, fatigue, self-rated health, physical functioning, and self-reported cognitive problems. The findings from this study are consistent with prior research showing emotion regulation as a mediator between childhood trauma and physical health among cancer-free adults with post-traumatic stress disorder.[37] Further, among adults seeking mental health treatment, emotion regulation difficulties also mediated the association between ACEs and psychological distress.[38] Expanding upon prior research, our findings highlight these associations among cancer patients and survivors, a group that is characterized by high physical and emotional distress.[54–56] These findings highlight the critical role that emotion regulation plays in the link between contextual stress (such as childhood adverse experiences) and physical health even through adulthood and among individuals facing a chronic illness.

Notably, this study expands the current research examining the association between ACEs and mental and physical health in adulthood[7] by examining these associations in cancer patients and survivors. Extending prior research showing worse mental health symptoms and health-related quality of life in cancer patients and survivors with a history of ACEs,[12,16] this study identified emotion regulation as a key mechanism connecting ACEs to better or worse health. This is important because ACEs and poorer health in survivorship have been linked to greater inflammation and early mortality.[23] The current study shows emotion regulation as a potential intervention point to reduce physical and cognitive problems among cancer patients and survivors, protecting their long-term health.

The final aim of this study was to understand whether these patterns of results differ based on whether someone was currently undergoing or had finished cancer treatment. Interestingly, using moderated mediation

models, the mediation effects for emotion regulation difficulties were only significant for participants currently undergoing treatment. Within these models, the a paths, or the association between ACEs and the emotion regulation variables, were significant, but no other pathways showed moderating effects. Further, none of the moderated mediation models using worry, rumination, or mindfulness as mediating variables were significant. Although these analyses were exploratory in nature, we hypothesized that associations would be stronger for cancer patients, compared to survivors, given the acute nature of treatment and its associated health burdens. The findings highlighted the impact of emotion dysregulation for those currently undergoing cancer treatment health compared to who have already completed treatment, but the use of specific skills did not offer additional benefits or risks for patients relative to survivors. Prior research highlighted trait worry and mindfulness as differential predictors of trajectories of fatigue, pain, and memory problems in breast cancer survivors.[57] The lack of significant moderated mediation findings highlights the importance of emotion regulation strategies for *both* cancer patients and survivors. In contrast, emotion regulation difficulties may be particularly burdensome for cancer patients as they navigate the acute, and sometimes severe, physical side effects associated with their cancer status and treatment rather than survivors, in that it serves as a pathway through which ACEs increase physical symptoms in this population. Although the specific emotion regulation strategy measures, as well as the DERS, assess trait-level function, results suggest that trait-level emotion dysregulation broadly may be more closely linked to ACEs and physical health compared to the more specific strategies for participants undergoing cancer treatment. Emotion regulation is a complex, multifaceted process,[58] and our findings suggest that the complexity of emotion regulation may be more impactful among individuals facing an acute biological and emotional stressor such as cancer treatment.

Clinical implications

These results highlight the importance of adaptive emotion regulation throughout cancer survivorship. Our findings suggest that emotion regulation may play an important role in understanding how early life stress may influence physical and cognitive health among cancer patients and survivors. Consistent with the biobehavioral model of negative emotionality,[36] our findings suggest that both emotion regulation and ACEs are critical for the severity of physical symptoms in both cancer patients and survivors. First, we recommend that cancer patients are screened for ACEs at the time of diagnosis to identify who may be at increased risk for worse physical symptoms throughout treatment and survivorship. Evidence-based

interventions such as mindfulness-based stress reduction, dialectical behavior therapy, and cognitive behavioral therapy are beneficial in offsetting some of the psychological and physical symptom consequences associated with cancer treatment and survivorship *via* teaching emotion regulation skills.[59–63] Despite known effectiveness of psychological interventions, many barriers can limit cancer patient and survivors use of these treatments including not having access to these interventions, medical appointment burden, physical health complications, and/or the affordability of specialized mental health services.[64] There is a clear need for brief, feasible, emotion-regulation interventions to be widely disseminated to improve physical and psychological health among cancer patients and survivors, particularly those who have experienced adverse childhood experiences.

Strengths and limitations

This study had several notable strengths. First, the use of a mixed cancer type sample of individuals currently in treatment and those in survivorship offers the ability to develop a broad understanding of the relationships between ACEs, emotion regulation, and physical and cognitive symptoms in cancer. Recruiting participants from the Prolific online database also allowed us to recruit geographically diverse participants who may have had differing access to healthcare. However, we limited participation to only a limited number of countries, potentially limiting broader generalizability across countries and cultures. This study also used several emotion regulation measures and health outcomes, and generally saw consistent effects across mediators and outcomes, bolstering evidence for the established associations. Notably, our results therefore suggest that there are health benefits to the use of adaptive emotion regulation skills (e.g. mindfulness) for cancer patients and survivors, and conversely, health detriments for those who engage in higher use of more maladaptive skills (e.g. worry and rumination). Despite these strengths, results should be interpreted considering several limitations. As is the case with most survey data, participants self-selected into this study, potentially creating bias and therefore may not be representative of cancer patients as a whole. The use of cross-sectional data prohibited the ability to draw causal inferences from these data. Additionally, although data was collected throughout the United States and United Kingdom, the sample was relatively homogenous in terms of race and ethnicity, thus limiting generalizability. Most participants were also female and heterosexual, further limiting generalizability. Further, the majority of participants were diagnosed with an early-stage cancer, and these findings therefore may not be generalizable to patients with more severe staging or with worse prognoses. The ACES questionnaire only collects information on whether participants expired a certain adverse

event, and therefore does not account for the severity, frequency, or enduring impact of such experiences. It is possible that the severity or impact of such experiences may have influenced the strength of the pathways tested in this study. Future research should attempt to expand upon this study by assessing these relationships with other measures of adverse childhood experiences that may assess severity or while accounting for trauma-related symptoms. We also did not assess several potential confounds that may affect these associations, including educational status or social support. Lastly, this study only assessed three specific types of emotion regulation strategies (e.g. worry, rumination, and mindfulness) and it is possible that other types of emotion regulation (e.g. cognitive reappraisal, suppression, or avoidance) might be more potent mediators in the relationship between ACEs and physical health in cancer patients and survivors.

Conclusions

Taken together, findings from this study underscore the importance of emotion regulation in the association between contextual stressors, such as adverse childhood events, and health in cancer patients and survivors. Although emotion regulation mediated the association between ACEs and physical health, these results did not differ based on whether someone was in treatment or survivorship (except for difficulties with emotion regulation). These findings suggest that adaptive emotion regulation skills as someone ages and faces a chronic illness such as cancer may serve as one protective factor in the impact ACEs have on later health outcomes.

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Data availability statement

The data that support the findings of this study are available from the corresponding author upon request.

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